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Problem-Solving Versus Solving Problems From the ESL Math Teachers' Point of View

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Abstract

Krulik and Rudnick (1996) defined problem-solving as explaining how math tasks contain the potential to provide intellectual challenges to enhance the mathematical mindset and development. English as a Second Language (ESL) students must learn math, increase their English language use, and grow literacy skills all in one setting. ESL teachers must examine how ESL students solve, make real-world connections, and build upon learned behavior with rigor. The purpose of this qualitative study was to comprehend how math teachers of ESL students apply problem-solving to benefit the overall educational experience of these students. The research question guiding this study asked: What are the experiences of ESL math teachers who are embedding the problem-solving structure in the middle school bracket? A homogenous sample of nine middle school ESL math teachers was purposively selected from the same school district. Data collection consisted of face-to-face interviews, personal narratives, and member checking. Inductive analysis was used with the collected data, starting with initial coding and proceeding to axial coding to identify codes, create collapsed codes, and form emergent themes. Key findings of this study were that participants understood that demographic awareness, math discourse and multiple strategies, educational struggle, and motivational input were vital aspects in the problem-solving process for ESL students.

Keywords: problem-solving, English as a Second Language (ESL), Beginner ESL, Intermediate ESL, Advanced ESL, Sheltered Instruction Observation Protocol (SIOP), isolation learning, math discourse (collaborative learning), math literacy, self- discovery, Texas Essential Knowledge and Skills (TEKS), readiness standards, supporting standards, educational struggle, motivational input

Dedication

I would like to dedicate this dissertation to my mother, Denise M. Petitt, and my older brother, Paul B. Brown. Their love and support keep me motivated and grounded. Knowing that I have the opportunity to reach new bounds in my educational career, showcases that their work in raising me was not in vain. From my mother's ability to raise her sons single-handedly to my brother's tenacity to create his own success story, I want to say thank you to them for modeling how to give one's all for anything one truly loves to do. Thank you for the kind words when times were tough. Thank you for telling me to go the extra mile when my best wasn't enough. You both are the epitome, you show that the sky is not the limit when there are footprints on the moon, and now I see why.

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Chapter 1: Introduction

In today's math classrooms, there has been an increase on transitioning from the linear approach of teaching numerical computations to embedding cross-curricular methods with problem-solving interventions for long-lasting learning experiences. The objective is for teachers to focus not solely on "solving problems," but also on "problem-solving." This teaching approach and its innovative mathematical outlook might answer the question of how lessons and mathematical tasks contain the potential to provide intellectual challenges to enrich the mathematical mindset as well as the development of students. In knowing this, I believe that the problem-solving structure can benefit English as a Second Language (ESL) students' development of math skills to become adaptable when transferring to new mathematical courses or attempting to discover solutions when problems arise. The objective is to create a mathematical classroom culture of continuous engagement, understanding, and development.

ESL students' mastery levels are typically 30% to 40% lower than students who use English as their first language (non-ESL). In order to bridge this gap in academic achievement, ESL math teachers must create lessons through a problem-solving mindset because ESL students can increase their probability of accessing multiple entry points to solve a problem. ESL math teachers must be aware that the problem-solving approach contributes to the practical use of mathematics by helping students be more influenced by the learning environment than by calculation skills. The ESL math teacher must improve lessons that support ESL students' use of acquisition, working memory, and mathematical task application (Friedman, Rapport, Orban, Eckrich, & Calub, 2018; Ganor-Stern, 2016; Jõgi & Kikas, 2016). Furthermore, when solving problems, various problem-solving techniques must be applied to stretch ESL students' mathematical mindsets into more advanced mathematics (e.g., communicative, isolated, visual, and organizational deliveries in problem-solving). These actions of problem-solving must be modeled and then independently practiced to result in recalling real-world experiences and align the math curriculum with cross-curricular standards, organizational routines, student-led self-discovery, and prior knowledge of mathematics (Appleton, Farina, Holzer, Kotelawala, & Trushkowsky, 2017; Scherer & Beckmann, 2014).

In this chapter, I introduce the problem and all components of the study. The components that follow are the background, context, history, and conceptual framework for the problem. I detail the statement of the problem, purpose of study, the research question, definition of terms for clarity, assumptions, delimitations, and limitations. Lastly, I provide a summary to outline the main aspects and topics that are detailed within the chapter.

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

Problem-Solving

Within the last decade, problem-solving has been discussed by researchers on tasks in mathematical computations to advance in higher math concepts by partnering science, technology, engineering, and math (STEM), as well as career pathways (Bachman, Votruba-Drzal, El Nokali, & Castle Heatly, 2015; Beal & Galan, 2015; Bishara, 2016; Scherer & Beckmann, 2014). Researchers have detailed problem-solving through the planning, applying, checking, and evaluating (PACE) method, conceptual models, coaching and mentoring, annotating developmental patterns through reference numbers, and mathematical dialogue (Aisha et al., 2017; Bishara, 2016; Burt & Stringer, 2018; Cave, Evans, Dewey, & Hartshorn, 2018; Ganor-Stern, 2016; Hansen-Thomas & Grosso Richins, 2015; Hojnoski, Columba, & Polignano, 2014). Problem-solving is conceptualized into two categories: the everyday world of problems and the abstract world of mathematical concepts, symbols, and operations (Mwei, 2017).

Using the problem-solving process is vital in the mathematics classroom because it creates a culture for teachers to guide and model strategies to maintain explicit expectations for skills, attitudes, and knowledge that help ESL students move to different levels of math (i.e., more challenging tasks), by enhancing the transfer of classroom terminology into everyday practice (Burt & Stringer, 2018). Problem-solving assists teachers in presenting challenging math questions to assess the student's ability to apply learned math standards at levels that do not include recreating algorithms or procedures practiced in current lessons such as common mistakes, relativity, or debating mathematical hypotheses (Bishara, 2016).

ESL Math Teachers

In today's classroom, emphasis is placed on the importance of building students' math proficiency, while math is perceived as one of the most challenging fields of study in the school curriculum (Bishara, 2016). Researchers have discussed that social or cultural processes are critical when one considers ESL students' mathematical growth (Aisha et al., 2017). Basic achievement levels (e.g., numerical cognition) are focused on how ESL students solve problems and how this ability develops with age, but problem-solving is more influenced by the learning environment provided by ESL math teachers (Friedman et al., 2018; Ganor-Stern, 2016; Jõgi & Kikas, 2016). Current ESL math teachers must understand that decoding a problem entails training ESL students' awareness regarding problem-solving and showing them how to recall previously learned math knowledge as a continuous ability (Krawec, Huang, Montague, Kressler, & Alba, 2012). In improving metacognitive skills in ESLs, the ESL math teacher must apply various methods to assist ESLs when extracting relevant information, when they are unaware that an answer is incorrect because they do not understand the mathematical process (e.g., calculation skills, acquisition, working memory, and mathematical task application;

Friedman et al., 2018; Ganor-Stern, 2016; Jõgi & Kikas, 2016). Problem-solving allows ESLs to develop their ability to focus on what the math question asks them to perform, which improves clarity of unfamiliar English vocabulary, useful for their independent work and test items (Beal & Galan, 2015).

Conceptual Framework for the Problem

Social constructivism explains how learners deal with a multifaceted social reality, not given but produced and reproduced under the influence of authoritative discourse for self-presentation, identity formation, and the embodiment of culture in sets of practices that express particular ways of being in the world (Clammer, 2017; Cottone, 2016; Logan, 2015; Mishra, 2014; Sterian & Mocanu, 2016). The ESL students then become the learners, the ESL math teacher becomes the influencer of authoritative discourse, and the mathematical problem-solving process is the set practice being studied for the ESL math teacher's use toward the ESLs' long-term benefit. Social constructs provide multiple avenues for learners to learn and apply learned behavior together through applied language to share experiences and construct validity (Cottone, 2016; Logan, 2015; Mishra, 2014). Math teachers do not have the authority to introduce new entities or endorse new existential claims at will, but make only claims that agree with the facts about which mathematical entities actually populate the other realms of reality (Clammer, 2017; Logan, 2015; Mishra, 2014). This heightens the aspects of maintenance, negotiation, or possible change of social and cultural norms when questions are raised on how multiple avenues such as literacy and experiences from students' or teachers' initial articulations are extended for ESLs to reach higher-order thinking skills when problem-solving in mathematics (Clammer, 2017; Logan, 2015; Mishra, 2014).

Teachers are guides for students in prevailing in social norms, processes, and practices for discourse in academia (Clammer, 2017; Cottone, 2016; Logan, 2015; Mishra, 2014; Sterian & Mocanu, 2016). Teachers must have the ability to apply social constructs to engage learners to become aware through exposure, find strategies to access existing knowledge of the students prior to and during instruction, and foster human creativity when in the educational setting (Clammer, 2017; Mishra, 2014; Sterian & Mocanu, 2016). Students require learning to know, learning to do, learning to learn with others, and learning to be (Sterian & Mocanu, 2016). This knowledge helps to develop and sustain a classroom culture of inquiry in which a strong interface between students' everyday knowledge and school knowledge takes place (Mishra, 2014). Therefore, social constructivism was chosen as the conceptual framework for this study. The study is designed to provide an understanding of ESL math teachers' experiences and expertise to continue to help ESL students develop future learning practices in problem-solving and mathematics.

Researchers have studied problem-solving and ESLs' abilities to help students learn math through differentiated instruction from students' stances and participation. To understand commonalities and differences, I aligned both problem-solving and the ESL math teachers' points of view, which have been insufficiently studied. This knowledge gap hinders opportunities for engaging, long-lasting, and meaningful lessons for ESL students or further clarification of the benefits of applying problem-solving in ESL classrooms with limited experience.

Rationale for the Conceptual Framework

This review of the literature led to a unique conceptual framework, which purports that problem-solving strategies assist ESL students to master the rigors of math as the difficulty of math problems increases. It also assures them of long-term results of problem-solving practices for future math courses, and it will positively support their achievements in the areas of communication, cross-curricular connections, relevancy to individualized experiences, and literacy. The reviewed studies explored the following questions: What are the benefits for ESLs in establishing an individualized organizational approach within math problem-solving while mastering the four domains? What experiences in mathematics (i.e., prior knowledge in algorithms or real-world experiences) can assist the problem-solving process when ESLs learn new concepts? How can both isolation and communicative techniques heighten literacy in all mathematical representations? What are the experiences that must be recalled or training and implemented for the mathematics ESL teacher to model the problem-solving process properly?

Statement of the Problem

The problem to be explored in this study was the experience and understanding of middle school ESL math teachers regarding the problem-solving process and how their experience and understanding transpire into classroom instruction that establishes growth of mathematical operations and literacy comprehension in ESL students as they are reading, understanding, and applying all representations of mathematics. Previous researchers have studied the fundamentals of problem-solving and made extensive discoveries on how the ESL learner performs on mathematical tasks. Very few have studied the experiences and expertise of middle school ESL math teachers in using problem-solving with ESL learners through lesson preparation or instruction to support literacy, as well as communicative and recalling techniques, while the latter are learning mathematics.

Purpose of the Study

The purpose of this qualitative case study was to gain an understanding of the experiences of ESL math teachers regarding math problem-solving through the middle school bracket. Anticipated results were gaining the ability to describe, support, and develop ESL math teachers’ instruction of ESL students to problem solve. Furthermore, the case study examined, through the experiences of ESL math teachers, the benefits of ESLs’ problem-solving through math to increase connectivity in literacy skills, mastering math readiness standards through collaborative and isolated instruction, growing the ability to apply learned behavior as rigor increases, and applying problem-solving with cross-curricular instruction in mind.

Research Question

The research question posed for this study asked: What are the experiences of ESL math teachers who are embedding a problem-solving structure in the middle school bracket?

Rationale, Relevance, and Significance of the Study

Problem-solving has increased within the mathematics classroom in recent years. To discover, analyze, and answer the research question, the qualitative approach of an intrinsic case study best suited the study. A case study allowed me to be descriptive not about a problem, but about detailing the in-depth understanding of a particular case in problem-solving and describing events, problems, processes, activities, and programs for several people (i.e., ESL math teachers) within time and space (Creswell, 2007; Stake, 1995). An intrinsic case study brought familiarity to what is unfamiliar in a common language about the research question.

The case study allowed me to collaborate with participants because they were coconstructors in explaining their experiences with and expertise in problem-solving with ESL learners in mind during lesson preparation and in real time. In addition, the study offered support to what is currently used in classroom instruction, exhibited commonalities from all participants, and provided awareness of differences to expound on problem-solving for ESLs. The potential implications included understanding how ESL math teachers use problem-solving in ESL classrooms and how this method can further create long-lasting lessons. This is significant because it will allow other stakeholders and the reader to reflect on the experiences of problem-solving and teaching ESLs.

Definition of Terms

Advanced ESL: Advanced ESL students have a higher comprehension level or better English literacy skills than average. These students can often be placed with students who are non-ESL or into other mathematics courses because they have the knowledge to grow in an advanced English environment. They may have been in the country for a longer period of time (Roever & Al-Gahtani, 2015).

Beginner ESL: Beginner ESL students are students who just came to the United States; often called "newcomers." Such a student has little or no English literacy skills when reading and writing, and he or she does not know much English. (Roever & Al-Gahtani, 2015).

Educational struggle: The process ESL math teachers use to have students struggle to heighten the aspects of self-discovery and student accountability (Burt & Stringer, 2018).

English as a Second Language (ESL): A program given to students when English is not their primary or first language. This is taken into account when students are labeled as limited English proficient (LEP) or English language learners (ELL; Moses, Busetti-Frevert, & Pritchard, 2015).

Intermediate ESL: Intermediate ESL students have a higher comprehension of the English language and literacy. These students have had a longer time frame within the United States or are a newcomer who has been tested, analyzed, and targeted on that placement level from academic scoring (Roever & Al-Gahtani, 2015).

Isolation learning: Students having the ability to learn from teacher, peer, or whole-group instruction and to use the learned behavior or tasks to apply to mathematical problems (in all representations) independently (Sheraga, 1980).

Math discourse (collaborative learning): This can be either teacher-to-student or student-to-student learning. This also includes teachers instructing students or the use of peer instruction on mathematical problems and relativity to real-world situations. Teachers or students can collaborate on how to solve, experience, or apply expertise in certain areas of mathematics to provide clarity for one another (Turkan & de Jong, 2018).

Math literacy: The ability to read, write, and solve all representations of mathematics whether numerical, pictorial, graphical, or real-world algorithms (Turkan & de Jong, 2018).

Motivational input: A method used by ESL math teachers to intrinsically motivate students to reach their mathematical or English literacy goals, focus on the positive stride of academic growth, and feel included in the math classroom culture (Cave et al., 2018).

Problem-solving: Seeing how mathematical tasks contain the potential to provide intellectual challenges to enhance the mathematical mindset and development (coined by Stephen Krulik and Jesse Rudnick in the early 1980s; Krulik & Rudnick, 1996).

Readiness standards: The main math standards that detail what students must learn at their current grade level. These standards detail mathematical action tasks and objective purposes for what the student should be able to do (Capraro & Nite, 2014).

Self-discovery: The process of discovering ways into solving or creating alternatives in the midst of solving problems relating to mathematics (Lee, 2016).

Sheltered Instruction Observation Protocol (SIOP): The SIOP is 3-day training and a method for ESL math teachers use (within the district under study), which addresses the academic needs of ELLs. The SIOP model encompasses eight interrelated components: lesson preparation, background building, comprehensible input, strategies, interaction, practice/application, lesson delivery, and review/assessment (Honigsfeld & Cohan, 2008).

Supporting standards: These standards are listed in support of the readiness standards in the TEKS math document. This showcases what students should have mastered at the previous grade level to support current lessons taught by the teacher (Capraro & Nite, 2014).

Texas Essential Knowledge and Skills (TEKS): A document guide of content standards for math that details the readiness and supporting math concepts the students should have mastered at previous grade levels and what must be achieved at their current grade throughout the state of Texas (Capraro & Nite, 2014).

Assumptions, Delimitations, and Limitations

Assumptions

Assumptions are out of the researcher's control, but they must be acknowledged for a study to be relevant (Simon, 2011). In this study, it was assumed that the participants would be honest and truthful about their experiences and responses to teaching ESL students to problem solve. I used initial interviews, personal narratives, second interviews, and member checks. I assumed that participants would answer honestly because I ensured that confidentiality was preserved (Simon, 2011). In addition, the participants could withdraw from the study at any time without ramifications.

I assumed that the sample represented the population for whom I wished to make inferences. I assumed that the middle school ESL math teachers had experience and expertise in providing intellectual challenges to enhance the mathematical mindset and development of ESL students. I also assumed that the ESL math teachers were aware that the problem-solving approach contributes to the practical use of mathematics and that these skills can be adapted when one transfers into a new mathematics course or attempts to discover solutions as problems arise. ESL math teachers from each middle school have had extensive professional development on teaching the ESL learner; they know how to implement problem-solving in lesson planning and real-time instruction.

Delimitations

Delimitations are characteristics that arise from limitations and result from choices made within the study (Simon, 2011). The experiences of middle school ESL math teachers using problem-solving for their ESLs' learning experiences are a delimitation in this study. Selecting participants who were ESL math teachers with experience in problem-solving and math contributed to the importance of information gained during the interviews, member checking, and data preparation. All interviews (initial and second), member checks, and personal narratives were conducted in natural settings. Interview questions developed specifically for this study aligned with the literature review within the scope of this research. Lastly, my personal narratives, formed during the reflective portion, reinforced validity and credibility of the study.

Limitations

Limitations are defined as constraints that are beyond the researcher's control and could possibly affect the outcome of the study (Simon, 2011). I could not rule out alternative explanations because the study is suggestive of what may be found in similar organizations (Simon, 2011). I was aware of the possibility, in the future, to discover similarities in other middle school ESL math teachers' viewpoints regarding problem-solving prior to implementing data collection. Time was a possible limitation in the availability of each participant. This could have dictated when the interview could be conducted and how much time would be available. Lastly, limits could also pertain to the varying backgrounds from teacher to teacher who are teaching ESL math classes and have individual awareness of how to apply problem-solving within lessons.

To address these limitations, I used multiple interviews (initial and second, 45-minute sessions), member checks (30 minutes), and personal narratives (30-minute reflections) to provide clarity in understanding and analyzing the data. The interviewing process was based on the availability of the ESL math teachers. The number of participants was small ($N = 9$), making it easy to ensure that they all understood that both their school site and their individual identity would remain confidential. Confidentiality, in addition to being required, was thought to encourage teachers to be honest and forthcoming and elaborate on their experiences as they related to the study. I presented the questions in the same manner and allotted the same amount of time for each interview when going from site to site.

Summary

Chapter 1 included the introduction to the problem, background, context, history, and a conceptual framework for the problem, as well as the rationale for applying this framework. The problem studied represented a gap in the professional literature pertaining to a deeper understanding of the experience and application of the problem-solving process by middle school ESL math teachers to shed some light on how these experiences transpire during classroom instruction to establish both growth of mathematical operations and literacy comprehension in ESL students when they are reading, understanding, and applying problem-solving to all mathematical representations. This made an intrinsic qualitative approach most suitable. The purpose of this qualitative case study was to gain an understanding about the experiences of ESL math teachers regarding math problem-solving in the middle school bracket. *Problem-solving*, *forms of instruction*, *TEKS* and subcategories, and *ESL* were defined. Lastly, the rationale and significance, necessary assumptions, delimitations, and limitations were explained.

Chapter 2 provides a comprehensive review of the literature that aligns with the research problem, purpose, and research question posed for the study and builds upon the findings from current peer-reviewed articles. Chapter 3 details the research methods used in the case study. Chapter 4 provides the data analysis and results. Chapter 5 details conclusions and meanings based on the findings of the study and offers recommendations for practical application and further research on the topic.

Chapter 2: Literature Review

Introduction to Literature Review

In today's classroom, emphasis is placed on the importance of building students' math proficiency, while math is perceived as one of the most challenging fields of study in the school curriculum (Bishara, 2016). Math is developing in a cross-curricular direction for full participation in science, technology, engineering, and math (STEM), as well as in career pathway areas because it bestows high levels of competence (e.g., solving word problems; undertaking research tasks; presenting concepts with illustrations and representations; and comprehending math properties, terms, and the conceptual connections between them; Bachman et al., 2015; Beal & Galan, 2015; Bishara, 2016; Scherer & Beckmann, 2014). As the connectivity between content areas increases within instruction, the pressure to build math proficiency heightens the awareness that English as a Second Language (ESL) students underperform compared to their peers in math, science, and literacy areas (Beal & Galan, 2015). Because the ESL population scores 30% to 40% lower than native English speakers, stakeholders must understand the importance of math skills: Their delay will cause ESLs delays in accessing opportunities later in life, and this is not based on academic failure (Burt & Stringer, 2018; Cardimona, 2016; Master, Loeb, Whitney, & Wyckoff, 2016).

In addition to the 30% to 40% difference in mastery levels, ESLs from low-income households do not reach basic achievement levels in mathematics, making the rate two or three times higher than that of economically advantaged students in U.S. public schools (Bachman et al., 2015; Beal & Galan, 2013; Rice, Barth, Guadagno, Smith, & McCallum, 2013; Thompson, 2017). Hence, social or cultural processes are critical when one considers students' mathematical growth (Aisha et al., 2017). Previous researchers indicated that basic achievement levels (i.e., numerical cognition) focused on how ESLs solve problems and how this ability develops with age, but problem-solving is more influenced by the learning environment than calculation skills, and teachers can thus support ESLs in acquisition, working memory, and mathematical task application (Friedman et al., 2016; Jõgi & Kikas, 2016).

This literature review has five purposes. The first purpose is to define and discuss what problem-solving entails, what the benefits are for ESLs, and how it can improve the teachers' instruction and enhance professional development. The second purpose is to detail students' cognitive abilities because it is important for teachers to understand how to make use of students' comprehension levels in a baseline approach when differentiating problem-solving strategies in classroom instruction. The third purpose is to discuss the importance of literacy skills and mathematics-related discourse within the problem-solving process. The fourth purpose is to detail the variations of ESLs' emotions when problem-solving and to show that academic failure can be used as part of the problem-solving process in order to decrease mathematical errors when similar problems are given in future lessons or assessments. The last section details how teacher support can boost self-regulation in students when mathematical rigor increases or when there are alterations in mathematical representation (e.g., verbal, numerical, or pictorial) in a problem.

Conceptual Framework

Social constructivism explains how learners deal with a multifaceted social reality, not given, but produced and reproduced under the influence of authoritative discourse for self-presentation, identity formation, and the embodiment of culture in sets of practices that express particular ways of being in the world in constantly dynamic ways (Clammer, 2017; Cottone, 2016; Logan, 2015; Mishra, 2014; Sterian & Mocanu, 2016). Social constructs are highly temporally contingent and provide multiple avenues for learning what a democratic learning environment means and how it is modeled (Logan, 2015; Mishra, 2014). When students act or learn together through applied language, the opportunity grows to share experiences and construct validity (Cottone, 2016). As this social effort aligns with the mathematical content, it becomes easier for the partners (in both teacher-to-student and student-to-student partnerships) to understand that mathematical claims must be literally true in order to have their intended meaning and the truths about mathematical existence claims supervene mathematical practices (Logan, 2015).

Logan (2015) noted that, according to some thinkers, if truth requires only one time to specify, then math cannot be a temporal or a social construct, but social constructivism entails that certain objects do exist or existed at other times. Math teachers do not have the authority to introduce new entities and endorse new existential claims at will, but make only claims that support facts about which mathematical entities actually populate the other realms (reality and ideal; Logan, 2015; Mishra, 2014). Therefore, social constructs are vital components in maintenance, negotiation, or possible change of social and cultural norms when questioning how multiple avenues in solving problems are exhibited through literacy and experienced from the students' or teachers' initial articulation (Clammer, 2017). The socialization within education is strongly influenced by the expectation that the student or teacher thinks from the experience of home, teachers, and friends (Sterian & Mocanu, 2016). This updates the notion of the Self as having two components: "the social Self, acquired through the internalization of the group attitude and the personal Self, as a personal, unlearned reaction" (Sterian & Mocanu, 2016, p. 106). These components showcase the model of teaching-learning, knowledge viewed as a negotiated entity, and the voice in the process of knowing; learning should be dialogic (Mishra, 2014).

Teachers are guides for students in social norms, processes, and practices for discourse in academia (Clammer, 2017; Cottone, 2016; Logan, 2015; Mishra, 2014; Sterian, & Mocanu, 2016). Teachers (in this case middle school ESL math teachers) have the capability to apply social constructs to engage learners in becoming aware through exposure and deciphering the reality and ideal of society (Mishra, 2014). Applying social constructs is a method for teachers to take into account that the existing knowledge of their students is vital prior to and during instruction (Sterian & Mocanu, 2016). This awareness enhances teachers' comprehension of how cognitive, practical, socioemotional, and behavioral competencies concerning family life, regardless of gender, age, and beliefs, shape and develop the students' disposition and identity (Sterian & Mocanu, 2016). The students' cultural expressions and bodily presentations become the primary sites of human creativity in the educational setting (Clammer, 2017). This proves to be so when students are required to learn to know, learn to do, learn to learn with others, and learn to be (Sterian & Mocanu, 2016). This knowledge helps to develop and sustain a classroom culture of inquiry where a strong interface between students' everyday knowledge and school knowledge takes place (Mishra, 2014). Hence, social constructivism was chosen as the conceptual framework for this study.

Again, the purpose of this qualitative research was to describe and explain aspects of the problem-solving process, how these aspects contributed to the educational benefit for ESLs, and how teachers could develop effective lessons. This study was designed for the benefit of ESL math teachers to enhance their awareness of what kinds of questions, method, and reflections must be applied not only to improve their professional growth as educators, but also to assure the success of their instruction by aligning mathematical mastery with cross-curricular processes related to problem-solving. The study was guided by the following questions: What are the benefits derived by ESLs from the establishment of an individualized organizational approach in math problem-solving while emphasizing mastery in all four domains (i.e., labeling the main idea of the problem, devising a plan to solve the problem, implementing the selected method, and reflecting on the question to see if it could potentially have been solved it in a different way). What experiences (i.e., prior-knowledge of algorithms or real-world experience) in mathematics can assist the problem-solving process when learning new concepts? How can both isolation and collaboration heighten literacy and communication skills in mathematical representations? What experiences must be recalled, or what training should be implemented so that mathematics ESL teachers can properly model the problem-solving process?

These guiding questions provided an opportunity to mold a classroom culture where ESL math teachers are properly trained in questioning, reasoning, deciphering students' mathematical capabilities, and developing student accountability, while the students are able to collaborate, provide proof as validation, and reflect on mathematics beyond a one-step solving process. This literature review details what problem-solving entails and provides a rationale for its importance in improving competencies and achieving developmental levels of ESLs that mirror non-ESL statistics. The literature review explored how literacy and communicative skills within lessons allowed ESLs to access prior knowledge, make connections to real-world references, and discover connections between other content areas. Lastly, the literature provided a comprehensive awareness of professional development, training, and reflective actions that ESL teachers must perform to create lasting learning experiences in their students, which the students will be able to implement in future math courses.

Review of Research Literature and Methodological Literature

Teaching Math to ESL Students

This literature comprehensively showcases the importance of problem-solving for the ESL learner in the mathematics classroom. Teachers of ESLs must be cognizant of the fact that their instructional style and delivery are different from that used in teaching non-ESL students. The ESL math teacher must create a classroom culture that focuses on the students' ability to increase mathematical comprehension through organizational routines, student-led self-discovery, and the use of prior knowledge of mathematics and real-world connections. In addition, teachers must guide students in applying an individualized organizational routine to be used in everyday practice or when rigor in math increases.

Problem-solving strategies. To bridge the gap in academic success and math comprehension, researchers have declared that problem-solving instruction should allow ESLs to access multiple entry points to solve a problem through extension questions to stretch their mathematical mindsets into more advanced mathematics, exploring whether real-world experience, the math curriculum, and cross-curricular standards intersect within problem-solving (Appleton et al., 2017; Scherer & Beckmann, 2014). Problem-solving allows ESLs to develop their ability to focus on what the math question asks them to perform, which improves clarity of unfamiliar English vocabulary, useful for their independent work and test items (Beal & Galan, 2015). ESLs self-monitor how mathematical problem-solving is conceptualized into two categories: the everyday world of problems and the abstract world of mathematical concepts, symbols, and operations (Mwei, 2017). Problem-solving lessons develop ESLs' ability to maintain explicit expectations of skills, attitudes, and knowledge. When ESLs are shown how to use what they already know, it enables them to move to different levels of math (i.e., more challenging tasks), and it enhances the transfer of classroom terminology into everyday practice (Burt & Stringer, 2018). Hence, ESLs will reach mastery when they become proficient in the following four domains: labeling the main idea of the problem, devising a plan to solve the problem, implementing the selected method to answer the question, and reflecting on the question to see if it could potentially have been solved in a different way (Hinnant-Crawford, Faison, & Chang, 2016; Mwei, 2017; Orosco, 2013, 2014).

Current teachers and problem-solving. Current teachers understand that decoding a problem entails training middle school students to be aware of problem-solving and showing them how to recall previously learned math knowledge as a functioning ability (Krawec et al., 2012). Problem-solving connections assist teachers in presenting challenging math questions to assess students' ability to apply learned math standards at levels that do not include recreating algorithms or procedures practiced in current lessons, such as common mistakes, relativity, or debating mathematical hypotheses (Bishara, 2016). In improving metacognitive skills in ESLs, researchers have provided trainings for teachers to apply various methods to assist ESLs when extracting relevant information, when they are unaware that an answer is incorrect because they do not understand the mathematical process, or when they need encouragement through motivational instruction. Such trainings are offered through the PACE method, conceptual models, coaching and mentoring, annotating, developmental patterns reference numbers, mathematic dialogue, and the IMPROVE method (Aisha et al., 2017; Bishara, 2016; Burt & Stringer, 2018; Cave et al., 2018; Ganor-Stern, 2016; Hansen-Thomas & Grosso Richins, 2015; Hojnoski et al., 2014). The aim is for ESL teachers to create an optimal learning environment that provides support for ESLs within linguistic and cultural complexities to give these students a better chance of increasing mathematical comprehension through organizational routines, student-led self-discovery, and use of prior knowledge (Cardimona, 2016; Krawec & Montague, 2014).

Furthermore, the teacher must be aware that the Texas Essential Knowledge and Skills (TEKS) standards or the Common Core Framework (pacing guide and standards employed in other states) for mathematics are implemented to build upon students' prior knowledge, but problem-solving offers particularly useful opportunities that target the *how* in instruction. This illustrates what techniques will be required to lead to mastery during instruction of complex content and ambitious mathematical practices over a sustained period (Jitendra, Harwell, Dupuis, & Karl, 2017). ESL teachers must construct a systematic approach to allow students to make judgments not directly covered in class to arrive at various ways to solve or analyze all available options in all math representations (Bishara, 2016). For instance, visual arts such as manipulatives, other tangible materials, and color coding in geometry develop the ESLs' reasoning while problem-solving (Gerlings, 2018). Then, the solution is presented in a familiar model, that is, with the use of formulas and routines when annotating word problems.

To reach this goal, lessons must cater to and require creativity in math problem-solving to enhance divergent thinking or knowledge and skills in math (Lin & Cho, 2011). Lin and Cho (2011) concluded that problem-solving will allow students to reach mastery of concepts and skills and a fundamental understanding of mathematical concepts, risk taking, motivation, usage of time, and prior experience. Practices, methods, and activities to boost engagement and accountability through problem-solving assort from thinking maps (predominantly flow charts to display sequencing); math discourse to heighten academic conversation, knowledge, and reasoning; differentiated problem-based projects; and constructive feedback through failure (Gerlings, 2018; Kapur, 2014; Krawec & Montague, 2014; Master et al., 2016; Norquay &

Rapke, 2018; Orosco, 2014; Pourmohamadreza-Tajrishi, Ashori, & Jalil-Abkenar, 2015; Rosales, Vicente, Chamoso, Munez, & Orrantia, 2012; Scherer & Beckmann, 2014; Thai, Son, Hoffman, Devers, & Kellman, 2014; Turkan & de Jong, 2018).

Assessing developmental levels to aid in problem-solving. Analyzing ESLs' developmental levels to determine how they can learn to solve math problems independently is an important step in a teacher's professional growth. Teachers determine ESLs' placement or grouping according to their developmental levels with respect to problem-solving through observation, student feedback, and physical work provided by the students. Evaluations such as the Math Problem Insight (MPI) by Thai, Son, Hoffman, Devers, and Kellman (2014) guide teachers to decipher the highest level of potential development, achieved through teacher assistance or collaboration with more capable peers (Orosco, 2014). The teachers' knowledge of ESLs' developmental levels will not only showcase how they learn procedures, but also indicate their awareness of an ESL's having trouble and knowing when to apply learned procedures accurately to a problem. When teachers are correctly applying their new knowledge, the ESLs rely on the psychological mechanism of perceptual learning and the natural ability to extract invariant information across multiple learning experiences (Cafarella, 2014; Ganor-Stern, 2016; Thai et al., 2014). For instance, the conceptual model, practiced by Aisha et al. (2017), allows teachers to evaluate the developmental levels of students, based on five dimensions on a scale that measures duration of the problem, steps, word problems, time, and effort. Aisha et al. (2017) categorized and aligned measures with phrasing, based on cognitive and problem-solving ability, giving teachers a baseline for securing that ESLs self-regulate (Aisha et al., 2017; Cardimona, 2016).

Hence, self-regulation for ESLs is not merely a skill but a sequential process that entails incorporating forethought, performance, and reflection, making it essential to academic success (Hinnant-Crawford et al., 2016). In order to transition through each problem-solving domain and be promoted to a higher placement, ESLs must perform these eight actions: setting, adopting, attaining, monitoring, restructuring, managing, self-evaluating, and attributing their physical and social context to make it compatible with the math problem-solving goals (Cafarella, 2014; Hinnant-Crawford et al., 2016; Thai et al., 2014). Cafarella (2014) noted that when students in secondary mathematics courses fall into the “low math development” bracket, there is a higher probability of being one of the 81.5% of students who attempt developmental math postsecondary courses. These students typically have a higher chance of not completing their degree plan or of transferring to another institution (Cafarella, 2014). It is vital for teachers to gain insight and an in-depth understanding of the developmental levels of ESLs in order to snowball the best practices of problem-solving and elevate the students to higher cognitive levels.

Prior knowledge and problem-solving. Openness to prior knowledge helps ESLs to achieve deeper levels of processing when encoding, which benefits the performance of their working memory to the extent that active maintenance processes are halted and eventually enhanced, as items such as standards, math tasks, or connections made in earlier grade levels are retrieved from long-term memory (Rose, Buchsbaum, & Craik, 2014). When teachers go forward with deciphering ESLs’ developmental placement, assessing prior knowledge keeps the learning process continuous from short-term memory to working memory with the aim of reaching long-term memory. Fung and Swanson (2017) have narrowed down the domains for differentiating students’ working memory, with one focusing on fluid intelligence, or an ESL student’s knowledge base and its relationship with reading processes; thus, one can channel the ESL's experiences into randomized activation and build understanding.

Children tend to use the sense of magnitude strategy, which does not involve math calculations but relies on the coarse, intuitive sense of magnitude, whereas adults use the approximated calculation strategy. The latter involves rounding and multiplication procedures and relies on calculation skills and working memory resources (Ganor-Stern, 2016). Channeling the working memory assists the problem-solving process because ESLs will recall from their temporary storage rehearsal, maintenance, processing, updating, and manipulation of internally held information (Friedman et al., 2018). Fung and Swanson (2017) and Wu et al. (2017) attested to the fact that the working memory and problem-solving, particularly with word problems, have a relationship that mediates individual differences in ESLs' skills in reading and math and intelligence. This claim allows differentiation among students' cognitive ability to problem solve, dependent on their ability to focus and to minimize interference (i.e., the ability to inhibit irrelevant information from competing with information held or processed in memory). This strengthens the ability to apply multiple algorithms and oversees both phonological short-term memory and visuospatial short-term memory, which upload information (Friedman et al., 2018).

Furthermore, prior knowledge provides a baseline for students to solve problems by recalling learned acquisition strategies or revisiting previously learned techniques in earlier grade levels (Sherman & Gabriel, 2017). For students to remember what type of action a word problem is asking for, they must somewhat automatically place known and unknown numbers and situation in the correct number-sentence arrangement, including the operation type (Mwei, 2017; Sherman & Gabriel, 2017). Transforming an everyday world problem into a mathematical problem increases the probability correctly to devise a plan, which can only occur in solutions directly emanating from Domain 1 (i.e., labeling the main idea of the problem), meaning that students create realistic situations for numerical representations to establish a deeper connection (Mwei, 2017). Analyzing all depictions of math problems will then create scaffolding between how ESLs comprehend what is relevant within the problem and how this can easily be connected to personal experiences relevant to the topic or lesson (Orosco, 2014).

Finding the variety in literacy. Literacy gives ESLs the capability to elaborate on their thinking when problem-solving. It assists ESLs with their English language proficiency to mold a common language and a way of thinking, talking, and writing about their math processes (Coppens, 2018; Sherman & Gabriel, 2017). This proves to be the case because of the correlation that exists between a student's reading comprehension and his or her academic success in all content areas (Coppens, 2018). Cross-curricular applications can present a broader range of teaching styles to align the awareness of referring words with the systematic concepts of math. Simple attributes from each content's curriculum can manifest more strategies to supply realistic inferences. Swanson, Moran, Lussier, and Fung (2014) explained how reading comprehension has been found to be highly predictive of solution accuracy: When a person has to decode what exists within a problem, he or she must recall literature relations toward text comprehension tactics.

Researchers indicated that basic math skills (i.e., one-step equations or computations) are taught well enough so that ESLs can solve them as well as their native English-speaking peers, but the mastery in literacy ability holds at 95% for English-speakers, whereas ESLs perform 30% to 40% lower (Cardimona, 2016; Coppens, 2018; Orosco, 2014; Sherman & Gabriel, 2017). Once the student, whether a native English speaker or an ESL, skips or misreads a character in any part of the problem, he or she may have to deal with an altered meaning in oral language development (i.e., math vocabulary and concepts), which impacts word problem-solving comprehension (Orosco, 2014; Sherman & Gabriel, 2017; Taylor, 2018). ESLs must convey and manage every increment of the problem most directly and efficiently, making every symbol hold meaning (Sherman & Gabriel, 2017). For instance, Sherman and Gabriel (2017) proclaimed the importance of transferring numerical representations into written descriptions. This numerical statement, $1(3x+2) = 2(x-7)$, uses 12 symbols and six algorithms before reaching a solution. When the numerical representation is presented in a written format, it requires 17 words: “One distributed to three times a number and two equals two distributed to a number minus seven” (Sherman & Gabriel, 2017, p. 473). Techniques connecting all representations of math problems increase the multimodal structure for students to provide “proof” (when reflecting in Domain 4 of the problem-solving structure) and for ESLs purposefully to comprehend the mathematical concepts behind them (Taylor, 2018). When ESLs can see these connections as they examine problems in the problem-solving process, it becomes easier for them to read, visualize, identify, and categorize scenarios and relationships for long-term benefits (Jõgi & Kikas, 2016; Sherman & Gabriel, 2017).

Thus, teachers must provide and insist on the use of explicit instructions to teach students skills and strategies, a problem-solving process (Kingsdorf & Krawec, 2016). Comparing and contrasting different types of words, picture analysis, and numerical problems make the associations and connections that students create stronger than if they had learned each problem type in isolation (Kingsdorf & Krawec, 2016; Sherman & Gabriel, 2017). In doing math, ESLs consistently use language, connecting written, oral, and numerical illustrations accurately in order to know which algorithms apply (Newkirk-Turner & Johnson, 2018). For instance, test-taking strategies for math push skimming for the keywords in solving the problem, but students must be able to visualize the relationships and actions being described in a question to determine which information is vital versus not vital (Sherman & Gabriel, 2017).

Written language and computations. A challenge students must face is referring to junctures, and this challenge is not unlike the challenges they face in comprehending literature (Sherman & Gabriel, 2017). There must be a cycle in which ESL students' interests or strengths, whether in math or reading, support moving from numbers or words to the ideas and relationships they represent (Sherman & Gabriel, 2017). Using a limited or an unsustainable span of time to solve problems for specific math standards limits mathematical relations among vital elements in the problem (Jitendra et al., 2017). ESLs must be given the time to monitor and reflect on the problem-solving process. It is imperative for students to recall an assortment of meanings of keywords in a problem (the context) to devise a plan to illustrate how to solve the problem through an individualized approach (Mwei, 2017).

A major question regarding mastery among ESLs is whether tracking for ESLs operates in ways that are distinct from tracking among non-ESLs when analyzing students' interpretations of words to direct solving (Thompson, 2017). Again, comparing and contrasting different types of word problems does not occur through isolation (Sherman & Gabriel, 2017). For instance, the word *strike* can have multiple meanings: It can be a term in bowling, a term in baseball, a term that indicates grasping someone's attention; it can mean to light a match, to hit or kick another person, or refer to a rally on an opposing view. A multitude of meanings can also be found in math, in terms such as *proportionality*. Proportionality can be categorized as unit rate, direct variation, constant rate of proportionality, and a rate that begins with zero. These types of problems allow ESLs to decipher specific genres of knowledge that offer narrative text on the *how* of problem-solving to articulate their thinking (Mwei, 2017; Sherman & Gabriel, 2017).

This strategy loosens the mindset and permits going beyond using only verbal articulations; it allows the teacher to lead students toward writing down their reasoning in order better to comprehend their independent thought processes. This will cater to labeling the main idea of the problem (Domain 1) and devising a plan to solve the problem (Domain 2) in the problem-solving process (Hinnant-Crawford et al., 2016; Mwei, 2017; Orosco, 2013, 2014). This should allow teachers to assess how each student solves problems and what choices are made to reach a solution for validation. Eventually, the teacher can see the patterns of each student's strengths and weaknesses regarding problem-solving. Success or failure in problem-solving depends essentially on the choices the solver makes within each domain, determining the probability of success (Mwei, 2017).

Communication and conceptual skills. While some researchers have depicted problem-solving solely through self-regulation (Bishara, 2017), there are reliable indicators that communication enhances the role of effort to increase mathematical ability (Aisha et al., 2017; Beal & Galan, 2015; Brown et al., 2016; Burt & Stringer, 2018). The disciplinary literacy practices of mathematics and processing are essential for conceptualizing the relevance to the discourse, but once ESLs have the capability to explain their thinking, they can work within a common language and through a mathematical way of thinking, talking, and writing (Cafarella, 2014; Sherman & Gabriel, 2017; Taylor, 2018). Collaborative dialogue promotes effective strategies that encourage problem-solving and knowledge building to repair communication breakdowns and negotiate mathematical meaning, attitude, interest, and self-efficacy as key factors that affect educational pursuits of STEM (Cardimona, 2016; Rice et al., 2013). Collaborative learning benefits ESLs, but teachers must take into account the layout of the class and its comfort level to produce a collaborative learning environment (Cafarella, 2014). The objective is to shift away from the one-dimensional approach of individualized (one-to-one) teaching because it limits deeper comprehension (Bishara, 2016). Aisha et al. (2017) reported that mathematical discourse allowed ESLs to portray a shift from the third-person to the first-person perception in such a manner as to represent changes in ESLs' beliefs.

The social interaction helps ESLs' development because it allows time for capable students to assist those in need of assistance through peer instruction. Problem-solving and peer guidance can easily be applied to various math skills such as numerical skills and word problems. The variation in problems must rely on several antecedents, namely, language skills, processing speed, working memory, and attentive behavior to predict word problem-solving success, but this is not so for procedural calculation (Jõgi & Kikas, 2016). Social interaction allows the novice student (one who needs assistance) to become drawn into the space of the expert student (one who has mastered content standards) to problem solve and communicate in multiple social and cultural-site practices (Cardimona, 2016; Taylor, 2018). The expert and novice are accountable to guide, support, and shape the actions and behaviors of one another. The opportunity for language learning and use becomes internalized, prompting key markers that indicate to what else an area is related with respect to calculations (+, −, ×, etc.) or dialogue reading (Burt & Stringer, 2018; Cardimona, 2016; Hojnoski et al., 2014; Newkirk-Turner & Johnson, 2018).

Teachers communicating. Texas houses the second largest ESL-student population in the United States, and 7% of this population attends schools in rural areas, where teachers must become professional learners, making the learning process a two-way experience (Hansen-Thomas & Grosso Richins, 2015). Both rural and urban teachers need adequate training to implement positive collaborative techniques to help in narrative approaches to questioning. The behavior of mainstream teachers depends on the kind of problem to be solved. If teachers use explicit hints in the text for mathematical reasoning and focus the situational processing on the most relevant aspects of the situational content, they will involve their students (Rosales et al., 2012; Turkan & de Jong, 2018). Just as ESLs must consistently learn English alongside math instruction, the teacher must condition his or her teaching framework and reflect on communication as colearning, willingness to learn, practicing taught instruction, and equality (Hansen-Thomas & Grosso Richins, 2015). Communicative aspects range from asking learners how they want to learn, having the students teach the teacher, comentoring, to cocoaching. Teachers will then provide nonjudgmental support based on evidence from their practice that emerges as the dominant model of collaboration as teachers work together (Hansen-Thomas & Grosso Richins, 2015; Rosales et al., 2012; Turkan & de Jong, 2018).

Teachers must realize that students cannot accomplish problem-solving on their own. It is best for the teacher to guide students with questions toward explaining, justifying, and defending their independent and collaborative problem-solving processes (Cardimona, 2016; Turkan & de Jong, 2018). In communicating and problem-solving, the teacher must become accustomed to unpacking language demands, specifically to rephrasing the student's language or a linguistically challenging sentence, and resorting to the use of pictures or manipulatives (Aisha et al., 2017; Turkan & de Jong, 2018). Students' beliefs must transform to be dependent on the classroom culture. Comparing and contrasting the use of cooperative learning and traditional lecture-style teaching involves analyzing if concepts are translated to exhibit the trained contexts into realistic situations (Kuntz, McLaughlin, & Howard, 2001). Pictures and manipulatives are mirrored as nonverbal replacements of what was perceived as difficult vocabulary, communicating to form a lasting connection for ESLs. In the words of Turkan and de Jong (2018), "This might make the

ESL teaching 'othered' from non-ESL teaching, and therefore ESL teaching might be distinct from non-ESL teaching" (p. 42). This can grant teachers ongoing feedback. This feedback, via conversation or nonverbal cues, can direct the teacher to either intervene or not to enter the process. Gateways toward mathematical communication can be derived from Jigsaw activities, student team-achievement divisions (STAD), team assisted individualization (TAI), and group investigations (Kuntz et al., 2001).

Furthermore, this practice can enhance teacher-to-student rapport despite the use of noncommunicative strategies provided by more traditional teaching. The traditional teaching formation, also known as the baseline approach, is giving the lesson in a lecture environment (Kuntz et al., 2001). The baseline approach can reduce student engagement, lowering the chance of ongoing mathematical discussions to break through various strategies and additional observation. Communication not only facilitates construction and transfer of knowledge, but also can develop skills of cooperation, problem-solving, and thinking in order for students to set their own goals, appreciate others' input, and self-regulate (Kantar, 2014). Kuntz, McLaughlin, and Howard (2001) found that small-group instruction achieved better results than individualized instruction because the lesson and activities aligned with cooperative learning strategies. ESLs, once in the routine of small group instruction, will embrace the importance of living through learning mathematics.

Emotions and self-concept. Researchers have observed that ESLs experience various emotions in and out of the classroom that make it difficult for them to maintain the positive cognitive state needed to achieve their desired learning objective (e.g., problem-solving); these emotions include happiness, worry, relief, frustration and anger, nervousness, and pride (Aisha et al., 2017; Cave et al., 2018; Tornare, Czajkowski, & Pons, 2015). Math teachers must realize that instructional components in lessons showcase ESLs' math beliefs. Teachers must alleviate students' anxiety about classmates seeing their work or hearing their oral participation (Aisha et al., 2017; Norquay & Rapke, 2018). The ESL population must work harder than native English speakers when going through the problem-solving process. Thus, there must be an awareness that the beliefs ESLs hold about math and mathematical performance can enhance or weaken their mathematical problem-solving ability (Aisha et al., 2017). As noted by Aisha et al. (2017), the usefulness of mathematics strongly affects math problem-solving and increases motivations to define the context for learning mathematics in general.

The student must comprehend the English dialogue or text while attempting to master the problem-solving process within each math standard. Regardless of the student's ability, this tactic often results in ESLs' establishing greater self-efficacy and connection to their previous experiences in problem-solving (Cave et al., 2018). Teachers must remain consistent in applying the methods to problem-solving in various ways over a more substantial time interval to challenge the ESLs' self-efficacy (Cave et al., 2018; Tornare et al., 2015). Tornare, Czajkowski, and Pons (2015) reported that the combination of emotional experiences and the ability to access prior knowledge during a problem-solving task raises vital questions for teachers, namely, how to direct the flow of problem-solving without disrupting or influencing the students' self-efficacy and with what frequency they might appropriately try to detect their emotional responses. Both questions stem from the need in the classroom culture to create a social system that will allow the group of students to achieve more than each could achieve alone (Cave et al., 2018). Thus, the staff's objective is to realize that reflective and global self-report measures should be interpreted with caution and that more proximal indexes of anxiety would be desirable (i.e., assessing anxiety while solving math problems; Trezise & Reeve, 2014). Self-efficacy allows

ESLs to experience success personally through mastery and attain success through mirroring peer and teacher behavior (modeling), following verbal math direction, and allowing the enhancement of physiological states (Cave et al., 2018). By contrast, if the ESL student has anxiety, more than likely, he or she will avoid math tasks and show less persistence when it comes to math-related work (Justicia-Galiano, Martín-Puga, Linares, & Pelegrina, 2017).

Lastly, the emotions are not always related to math ability; rather, the anxiety can occur while having to solve a math problem (McFarland, Primosch, Maxson, & Stewart, 2017; Trezise & Reeve, 2014). The ESL student's objective is to believe in his or her capabilities to perform the specific tasks required to produce and reach problem-solving mastery (Cave et al., 2018). For the teacher, the process should become a combination of assessing students' perceptions of competence that is open to influence and distinguishing test anxiety from pure math anxiety. Increasing the complexity of math problems will not showcase a student's math ability. The focus should be on transitioning the student's mindset and have him or her persevere in spite of math anxiety and not dwell on it; it must also be distinguished from enduring anxiety (i.e., trait anxiety; Trezise & Reeve, 2014). The motivational input will develop and offer learning opportunities for both teachers and students through instructive feedback and observational learning (Aldemir & Gursel, 2014).

Improved problem-solving ability through failure. Failure and errors can become a problem-solving method for students to generate or discover the correct solutions by themselves and for the teacher to capture and define error types observed in students' work (Brown et al., 2016; Burt & Stringer, 2018; Kapur, 2014). As self-regulation is demonstrated by ESLs, the teacher can decipher whether a student's error occurs with processing or interaction. Processing errors are student errors in any one of these three processes: misinterpreting some mathematical notion, incorrectly performing some task, or incorrectly evaluating results with respect to an anticipated outcome (Brown et al., 2016; Kapur, 2014). The processing-error domain contains the following subsets: interpretation, activity, and evaluation. As Brown, Bossé, and Chandler (2016) explained, interpretation errors occur when students incompletely solve or misinterpret the problem, the mathematics, or the available technology tools. Activity errors happen when there is a barrier for students as they translate mathematical representations after the source representation is misinterpreted and during the actual act of producing the target representation (Brown et al., 2016; Kapur, 2014; Lee, 2016). Evaluation errors occur when students either do not attempt appropriately to assess their work performance as tasked, or the assessment is incomplete (Brown et al., 2016). Interaction errors occur when students work with precise content attributes, but misinterpret global concepts (syntactic error), or when they understand universal content concepts, but misinterpret or are unable to convert characteristics of math problems (semantic error; Brown et al., 2016; Lee, 2016).

An error can be the outcome of a lack of prior knowledge; yet, the problem-solving methods employed can be productive in preparing students to learn better from subsequent instruction (Kapur, 2014). The ESL learner can become accustomed to the routine of fixing the error, rather than dwelling on it. Allotting time for ESLs to learn from their mistakes reduces the probability of their working the same standard repeatedly incorrectly. As Kapur noted, students must have the opportunity to

> attend to and acquire the correct procedures and knowledge, while concomitantly reducing the probability of encoding errors and misconceptions when students do not have the expertise to solve a problem, they often search the problem space for solutions

> by engaging in resource-intensive processes such as trial and error or means-ends analysis, which burden the limited working memory capacity. (Kapur, 2014, p. 1009)

Trial and error let ESL students learn from their mistakes. Those moments of error can now become the result of prior knowledge activation for ESL students. Students can differentiate between thinking that compares student-generated solutions and thinking about correct solutions, marking the constructive nature of learning (Kantar, 2014; Kapur, 2014). Learners can direct individualized error in the meaning-making process and the formation of schematic representation of the knowledge to assist the development of a knowledge repertoire (Kantar, 2014). Comparing and contrasting errors in problem-solving through self-discovery assists students when deciphering critical features of mathematical standards while differentiation is employed throughout the lesson (Kapur, 2014).

Teachers and self-regulation. In order to promote problem-solving, teachers must set a classroom culture that enhances learning communities (Appleton et al., 2017). As these learning communities are constructed, teachers can focus on these two aspects of teaching and learning mathematics: problem posing and problem-solving. Both components make it easier to conduct content exploration and connect to pedagogical conversations (Appleton et al., 2017; Hinnant-Crawford et al., 2016). Teachers guide the process of problem-solving for tasks not "prescribed or [contained in] memorized rules or methods, nor is there a perception by students that there is a specific 'correct' solution method" (Appleton et al., 2017, p. 34). Because knowing appropriate algorithms, facts, and procedures is not sufficient, teachers must adhere to problem-solving with the idea that more straightforward calculation skills, more complex word problem-solving skills, and task-persistent behavior as an expression of self-regulation depend on previously-achieved cognitive abilities, nonverbal intelligence, linguistic skills, and executive functioning (Aisha et al., 2017; Appleton et al., 2017; Jõgi & Kikas, 2016).

To fulfill the set objectives, teachers must extend their varied mathematical content knowledge and teaching experience from content-based professional development, rooted in active learning and ongoing collaboration, to the collaborative professional-development structure of CAMI or LAST (Appleton et al., 2017; Master et al., 2016). Teachers collaborating for the students' benefit will help staff become aware of their own problem-solving, which promotes the use of problem-solving as an approach to teaching mathematics and even changing teachers' views of mathematics. Questions mentioned by Appleton, Farina, Holzer, Kotelawala, and Trushkowsky (2017) ranged from "How can we give our students more time and space to engage with each other's thinking?" to "How can we help our students adjust to the discomfort of nonroutine problems?" (p. 37). Teachers must ask themselves these questions to push the boundaries from general teaching experiences to reaching similar math achievement gains for ESLs and non-ESLs alike (Master et al., 2016). Collaboration between teachers can be crucial when teachers who have experience with teaching ESLs start to work with and mentor novice teachers (Master et al., 2016). The novice teachers' practices are influenced by a range of factors, including coursework, personal experiences and beliefs, recommendations or feedback from their mentor teacher or supervisor, and contextual constraints such as curriculum or assessment mandates (Turkan & de Jong, 2018).

For students to be able to problem solve rather than solve problems, teachers must incorporate communication in their lessons and consistently strive to create a motivational classroom culture to grow the students' self-efficacy when handling problem-solving strategies. Motivational factors of choice foster an engaged performance as the perception of one's capacity to complete a given task benefits self-regulation in order to gain domain-specific, complex skill achievement (Boonen, de Koning, Jolles, & van der Schoot, 2016; Boonen, Reed, Schoonenboom, & Jolles, 2016; Gasco & Villarroel, 2014; Jõgi & Kikas, 2016). Individuals locate personal levels and expectations of their achievement as they reveal individual beliefs concerning each concept (Gasco & Villarroel, 2014). When motivation is partnered with various types of teaching strategies and the collaborative efforts of cooperative learning, the transmission of problem-solving strategies leads to their proper application and individualized problem-solving action without encountering resistance or anxiety.

Review of Methodological Issues

Researchers have studied problem-solving, literacy, communication related to problem-solving, and teacher-to-student regulation through both qualitative and quantitative approaches. Researchers have analyzed calculation and problem-solving skills, teacher-rated task-persistent behavior, nonverbal intelligence, linguistic abilities, and executive functioning (Beal & Galan, 2015; Boonen, de Koning et al., 2016; Decker & Roberts, 2015; Friedman et al., 2018; Graziano & Hall, 2017; Kapur, 2014; Lee, 2016; Pourmohamadreza-Tajrishi et al., 2015). Researchers who have quantitatively analyzed responses from pre- and postassessments, whether written or oral, and discussed the statistical results are cited in this literature review; their studies comprised 16 of the 54 articles covered in this chapter.

Qualitative data collection was evident in 34 of the 54 articles reviewed. The analysis of literature, questionnaires, professional development or training, observations, interviews, and teaching interventions comprised the content of these qualitative studies. In the qualitative articles, the main sources for data collection were structured professional development and teacher training (Appleton et al., 2017; Boonen, Reed, et al., 2016; Brown et al., 2016; Burt &

Stringer, 2018; Ganor-Stern, 2016; Hansen-Thomas & Grosso Richins, 2015; Jitendra et al., 2017; Krawec & Montague, 2014; Orosco, 2013, 2014). The results of professional development and interventions, reported in these studies, provided clear insights that can be applied in appropriate ways and through efficient methods by math ESL teachers cooperatively to achieve clarity about the importance of students' mirroring problem-solving behaviors and attitudes modeled by their teachers. These results were put to use and tested in this study.

Furthermore, authors of four of the 54 reviewed articles employed a mixed-methods approach (Bishara, 2016; DelliCarpini & Alonso, 2014; Thompson, 2017; Wu et al., 2017). Mixed methods would have been difficult to employ and align with the focus of and the questions posed in this study. The four domains of problem-solving—retrieving the main idea, devising a plan to solve the problem, implementing the selected methods, and reflecting on the question to see if it could potentially have been solved it in a different way through a different algorithm or connectivity to real-world analysis—can best be demonstrated through a qualitative approach to exhibit the value of tapping into prior knowledge in problem-solving, collaboration between teachers, collaboration between students, teacher-to-student efforts, and self-regulation through discovery.

Synthesis of Research Findings

In this review of the literature, I sought to show how developmental levels help to format instruction and learning, literacy and math discourse, emotional levels, and error analysis to benefit the ESL student in problem-solving beyond merely solving a problem at hand. In addition, it became evident that teachers must be trained to make collaborative efforts with their colleagues to improve both their professional growth and the instruction of ESLs by presenting the most thought-provoking questions to maintain engagement and transfer learning experiences from teacher training and professional development to the classroom culture. The following sections provide detailed information about each of the themes chosen for the literature review and described at the beginning of this chapter.

The cross-curricular direction in instruction has heightened awareness of the fact that ESLs underperform compared to their native English-speaking peers in math, science, and literacy areas (Bachman et al., 2015; Beal & Galan, 2015; Bishara, 2016; Scherer & Beckmann, 2014). Stakeholders must understand that math skills will allow ESLs to access opportunities later in life and that their delay is not based on academic failure (Aisha et al., 2017; Bachman et al., 2015; Burt & Stringer, 2018; Cardimona, 2016; Master et al., 2016). Researchers have argued that problem-solving is strongly influenced by the learning environment, which can thus be constructed to support ESLs in acquisition, working memory, and task application (Friedman et al., 2018; Ganor-Stern, 2016; Jõgi & Kikas, 2016). Problem-solving allows ESLs to seek multiple entry points to solve problems, while improving clarity of unfamiliar English vocabulary, and reach mastery in these four domains: annotating the main idea, devising a plan, implementing the plan, and reflection upon the result (Appleton et al., 2017; Beal & Galan, 2015; Hinnant-Crawford et al., 2016; Mwei, 2017; Orosco, 2013, 2014; Scherer & Beckmann, 2014).

Current teachers understand that decoding a problem requires the training of middle school students in recalling prior knowledge as a functioning ability that is not limited to recreating algorithms or procedures (Bishara. 2016; Krawec et al., 2012). Furthermore, a teacher’s professional growth is enhanced when he or she analyzes ESLs’ developmental levels and ability to solve problems independently through observations, student feedback, and physical work provided by the students (Aisha et al., 2017; Orosco, 2014; Thai et al., 2014). A teacher’s knowledge of ESLs' developmental levels shows how he or she learns procedures while helping students to access prior knowledge that allows them to self-regulate and incorporate forethought, performance, and reflection (Cafarella, 2014; Hinnant-Crawford et al., 2016; Rose et al., 2014, Thai et al., 2014). Thus, teachers must provide explicit instruction and insist that it be followed when they teach their students skills, strategies, or a problem-solving process (Kingsdorf & Krawec, 2016).

Researchers have noted that teachers must be trained to apply various problem-solving methods to assist ESLs in extracting relevant information (Aisha et al., 2017; Burt & Stringer, 2018; Cave et al., 2018; Ganor-Stern, 2016; Hansen-Thomas & Grosso Richins, 2015; Hojnoski et al., 2014; Rosales et al., 2012; Turkan & de Jong, 2018). Teachers must also realize that students cannot accomplish problem-solving entirely on their own. It is best for the teacher to guide students with questions toward explaining, justifying, and defending their independent and collaborative problem-solving processes (Cardimona, 2016; Turkan & de Jong, 2018). In communicating as well as in problem-solving, the teacher must be accustomed to unpacking language demands, specifically rephrasing the student's language or linguistically challenging sentences, by referring to or using pictures and manipulatives (Aisha et al., 2017; Turkan & de Jong, 2018). The aim is for ESL teachers to collaborate to create an optimal learning environment that draws support for ESLs from linguistic knowledge and cultural situations to target the *how* in instruction (Bishara; 2016; Cardimona, 2016; Gerlings, 2018; Jitendra et al., 2017; Krawec et al., 2012).

To promote problem-solving, teachers must set a classroom culture that creates and enhances the learning community (Appleton et al., 2017). Teachers can focus on problem posing and problem-solving. They must adhere to problem-solving through straightforward calculation skills and more complex word-problem-solving skills. They must model task-persistent behavior as an expression of self-regulation, based on previous cognitive abilities, nonverbal intelligence, linguistic skills, and executive functioning (Aisha et al., 2017; Appleton et al., 2017; Jõgi & Kikas, 2016; Master et al., 2016; Turkan & de Jong, 2018).

Literacy mediates ESLs' capabilities to elaborate on their thinking when engaged in problem-solving (Fung & Swanson, 2017; Wu et al., 2017). Literacy skills assist ESLs with their English language proficiency to mold a common language and a way of thinking, talking, and writing about their math processes (Coppens, 2018; Sherman & Gabriel, 2017). When ESLs skip or misread a character in any part of the problem, it alters the meaning in oral language development (Orosco, 2014; Sherman & Gabriel, 2017; Taylor, 2018). ESLs must have time to comprehend that every symbol holds meaning and bestows the ability to provide proof behind answers (Jitendra et al., 2017; Jogi & Kikas, 2016; Kingsdorf & Krawec, 2016; Sherman & Gabriel, 2017; Taylor, 2018).

While specific research depicts problem-solving solely through self-regulation (Bishara, 2017), some indicators exist that communication enhances the role of effort in increasing mathematical ability (Aisha et al., 2017; Beal & Galan, 2015; Brown et al., 2016; Burt & Stringer, 2018). When ESLs explain their thinking, they can work within a common language and in a mathematical way of thinking, talking, and writing (Cafarella, 2014; Sherman & Gabriel, 2017; Taylor, 2018). Collaborative dialogue repairs communication breakdowns and negotiates mathematical meaning, attitude, interest, and self-efficacy as key factors affecting educational pursuit in STEM (Cardimona, 2016; Rice et al., 2013). The objective is to shift away from individualized (one-to-one) teaching and allow ESLs to portray a shift from third-person to first-person perception in such a manner as to represent a change in their beliefs about math

(Aisha et al., 2017; Bishara, 2016). This allows the novice student (one who needs assistance) to become drawn into the space of the expert student (who has mastered content standards) to solve problems, communicate, guide, support, and shape the actions and behaviors in multiple social and cultural site practices (Burt & Stringer, 2018; Cardimona, 2016; Hojnoski et al., 2014; Newkirk-Turner & Johnson, 2018; Taylor, 2018).

Researchers have noted that ESLs experience various emotions, in and out of the classroom, that can make it difficult for them to maintain the positive cognitive state needed to achieve their desired learning objectives (e.g., problem-solving); these emotions include happiness, worry, relief, frustration and anger, nervousness, and pride (Aisha et al., 2017; Cave et al., 2018; Tornare et al., 2015). If the ESL student experiences anxiety, he or she is likely to try to avoid math tasks and show less persistence when it comes to math-related work (Justicia-Galiano et al., 2017; Trezise & Reeve, 2014). Teachers must alleviate students' anxiety about classmates' seeing their work or hearing oral participation and encourage their beliefs in their abilities (Aisha et al., 2017; Cave et al., 2018; Norquay & Rapke, 2018). For instance, failures and errors can themselves become a problem-solving method for students if the latter generate or discover the correct solutions by themselves and for the teacher if he or she captures and defines error types observed through student work (Brown et al., 2016; Kapur, 2014; Lee, 2016). Teachers must remain consistent in applying the method of problem-solving in various ways over a more substantial time interval to challenge the ESLs' self-efficacy (Cave et al., 2018; McFarland et al., 2017; Tornare et al., 2015; Trezise & Reeve, 2014). This motivational input will develop and offer learning opportunities through instructive feedback and observational learning (Aldemir & Gursel, 2014).

Critique of Previous Research

The reviewed literature depicts the advantages of problem-solving as a gateway for ESL students toward understanding various methods of problem-solving versus merely solving a problem at hand (Appleton et al., 2014; Beal & Galan, 2015; Burt & Stringer, 2018; Hinnant-Crawford et al., 2016; Mwei, 2017; Orosco, 2013, 2014). This review can provide valuable insights for ESL math teachers who want to create a classroom culture that focuses on the students' abilities to increase their mathematical comprehension through organizational routines, student-led self-discovery, and the utilization of prior knowledge of mathematics and real-world connections, as the rigor of the math curriculum increases. A drawback with specific findings might be that they are based solely on assessment scores, tests, and quizzes (i.e., a purely quantitative approach), thus offering short-term results that do not provide long-term usefulness (Beal & Galan, 2015; Boonen, de Koning, et al., 2016; Decker & Roberts, 2015; Friedman et al., 2018; Graziano & Hall, 2017; Kapur, 2014; Krawec et al., 2012; Lee, 2016; Pourmohamadreza-Tajrishi et al., 2015). What the literature does indicate, however, is that educators who also adopt such a fixed mindset will experience difficulty with ESL students completing an academic task or accepting negative feedback about their performance. The latter difficulty arises from the students' interpretation that the critique of their work indicates a lack of intelligence on their part or an inadequate ability to be successful at math (Aisha et al., 2017; Justicia-Galiano et al., 2017; Rice et al., 2013; Shen, Miele, & Vasilyeva, 2016; Wu et al., 2017).

Improvements in literacy and communication skills is vital in today's math classroom because both support the problem-solving process, as the literature makes very clear (Fung & Swanson, 2017; Hojnoski et al., 2014; Sherman &Gabriel, 2017; Swanson, Olide, & Kong, 2018; Wu et al., 2017). This review of the literature is thought to be useful for both ESL students and their teachers because it furthers the understanding that, despite current limitations, efficacious learning of problem-solving strategies will lead to greatly improved content knowledge. ESLs' outcomes, when they are taught not just through the traditional lecture style but also through shaping of the classroom environment, far exceed mere computational skills (i.e., +, -, x, and ÷; Beal & Galan, 2015; Friedman et al., 2018; Jitendra et al., 2017; Jogi & Kikas, 2016; Lin & Cho, 2018; Mwei, 2017). The authors of the reviewed studies supported the idea that students should be encouraged to recall previous experiences as a starting point when the rigor of math increases (Burt & Stringer, 2018; Hansen-Thomas & Grosso Richins, 2015; Turkan & Jong, 2018). Overall, teachers are prompted to think differently and are challenged to collaborate on questioning strategies that engage ESL learners' interests and stimulate their independent problem-solving, so that they can succeed in all subjects, not merely in their computational skills (Cardimona, 2016; Cave et al., 2018; Gerlings, 2018; Krawec & Montague, 2014; Orosco, 2013).

Chapter Summary

In this chapter, I summarized the perspectives of previous researchers regarding the importance of problem-solving versus merely solving the problems at hand for ESL students. Problem-solving skills can be developed and enhanced by accessing prior knowledge and improving literacy and communicative awareness. The importance of the teacher's role and methods to create a problem-solving culture in the classroom should not be underestimated. Its various characteristics are based on the literature review and described based on the theory of social constructivism as the conceptual framework of the study. ESL students reach mastery when they become proficient in the four domains: labeling the main idea of the problem, devising a plan to solve the problem, implementing the selected method to answer the question, and reflecting on the solution to see if it could have potentially been achieved in a different way (Hinnant-Crawford et al., 2016; Kingsdorf & Krawec, 2016; Mwei, 2017; Orosco, 2013, 2014).

Attention to prior knowledge aids in problem-solving and ESL students gain a deeper level of processing when encoding math. Literacy gives ESL students the capability to elaborate on their thinking. An optimal learning environment helps teachers provide support for ESL students through cultural complexities and monitor emotions of fear and frustration (Aisha et al., 2017; Cardimona, 2016; Cave et al., 2018; Tornare et al., 2015).

Chapter 3 details the research methods used in the case study. The research question and purpose for the case study are restated. Chapter 3 will also address the site description, research population, and sampling method. In addition, validation, expected findings, and ethical issues are explained.

Chapter 3: Methodology

A qualitative case study is an effective method to explore and discover the experiences of ESL math teachers' with one another regarding problem-solving, before transitioning learned strategies and methods into classroom instruction (Hansen-Thomas & Grosso Richins, 2015; Hatch, 2002; Stake, 1995). The case study grants the capability to catch the complexity of a single case, program, or event in a person (Hatch, 2002; Sake, 1995). I was not interested in learning about general problems in teachers' efforts to problem solve, but rather about the case of middle school ESL math teachers teaching math through problem-solving to benefit ESLs' learning experiences in the classroom (Stake, 1995).

I was the primary instrument for collecting and analyzing the data (Hatch, 2002; Sake, 1995). In this study, I used an initial interview, second interview, and member checking after each interview. In addition, I provided my own personal narratives as a means of data collection. The interviewing process allowed me to fully understand ESL math teachers' points of view, as they too were coconstructors of the case study (Hatch, 2002). Providing my own narratives allowed me to explain my interpretations of similarities and differences in the ESL math teachers' responses.

The study did not seek language or cultural concerns (ethnography), nor did it involve developing an abstract theory of a process or action (grounded theory; Creswell, 2007; Stake, 1995). Problem-solving, rather than solving problems, for the ESL teacher or student is not a phenomenon but an aspect of lesson preparation and learning during instruction. Therefore, a qualitative case study was best suited for this study. Communicative strides were taken to improve educational instruction for ESLs by all stakeholders and to see and seek patterns of the unanticipated as well as expected relationships among teacher-to-teacher, teacher-to-student, and student-to-student problem-solving efforts (Stake, 1995).

Research Question

Setting up a research question ensured that the question clearly directed the study (Stake, 1995). I remained cognizant that the research question provided a logical device for an evaluation process and satisfactory completion, while still keeping a clear understanding of interests and intentions open for further inquiry (Stake, 1995; Yin, 2012). The objective was to create a concise question to embody both: substance (or what the study is designed to answer) and focus (or the who, what, where, and why) to ensure that the most appropriate methods would be used in the embeddedness and interaction with the study (Hatch, 2002; Yin, 2012). Understanding the objective helped to delimit the scope of investigation, which was problem-solving within the teaching style of ESL math teachers to benefit ESL learners in a well-rounded manner (Hatch, 2002; Stake, 1995). Therefore, I sought a deeper understanding of the experiences of middle school ESL math teachers who use problem-solving as a teaching style beyond merely solving a math problem at hand because math mastery levels are lower for ESLs than non-ESL students due to their needs in the area of language and literature. The research question for this study asked: What are the experiences of ESL math teachers who are embedding a problem-solving structure in the middle school bracket?

Purpose and Design of the Study

The purpose of this study was to gain a deeper understanding of the experiences of ESL teachers regarding math problem-solving through the middle school bracket. This intrinsic case study was an examination of the experiences of teachers voicing their experiences through mathematical problem-solving, resulting in how these experiences occur in classroom instruction to bridge the gap of mathematical operations and literacy comprehension for ESL students. An intrinsic case study was beneficial because it allowed me to be descriptive not about a problem but about a particular case of problem-solving (Stake, 1995). Discovering a singular instance of problem-solving, while aligning with what ESL teachers' instruction and ESL students' learning are like, helped me extensively comprehend the participants' personal experiences (Hatch, 2002; Stake, 1995). Therefore, an intrinsic case study was appropriate; it bought familiarity to what was unfamiliar in a common language about the research question. The outcome could create vicarious experiences for the reader to gain a sense of "being there" through my descriptions, processes, and methods (i.e., interviews, member checks, and narratives) performed within the study (Stake, 1995). Interviews and narratives provided a chance to comprehend the experiences teachers have had with mathematical problem-solving and interpreting how well ESLs apply their problem-solving skills through each standard with cross-curricular strategies or content in mind.

Site Description, Research Population, and Sampling Method

Site Description

The school district is in a suburban community on the southwestern Gulf coastal portion of Texas. The total number of students is approximately 46,000. Through this melting pot of cultural diversity between staff and students, there is a 14:1 student-to-teacher ratio. Table 1 shows teacher and student demographics:

Table 1

Teacher and Student Demographics

Demographics	Teachers	Students
African American/ Black	39%	29%
Caucasian/ White	28%	4%
Hispanic	25%	53%
Asian	6%	12%
Biracial	2%	1%
American Indian	0%	1%
Additional Information	• Bachelor's degree 70% • Master's degree 28% • Doctorate 1% • no degree 1%	• students at-risk 75% • economically disadvantaged 83% • enrolled in the ESL 43% • Limited English Proficient 43%

Note. Teacher-to-student ratio 1:14.

The mission of the district references collaboration among all stakeholders to provide an exemplary education for all students through safety and civility. The district strives for all educators to work together to prepare students for success in the future while being caring, committed, competent, and culturally responsive. In doing so, the district aims to increase student achievement and development, meaningful relationships (between all stakeholders), and meaningful work to create qualified and effective personnel to benefit the district's learning culture. All of these aspects align with the focus of this intrinsic case study because the district wants to close the achievement gap between ESL students and native speakers of English. I was able to gain a deeper understanding of ESL teachers' experiences regarding closing the gap in middle schools through embedding problem-solving into their teaching of math.

Research Population

Teachers in the district. The teachers in the district create lessons to develop language and mathematic content in both English and other languages through strong programs and research-based pedagogy. Teachers in the district know that ESL students were administered a Home Language Survey to determine language proficiency in English. Once the students are classified as Limited English Proficient (LEP) or English Language Learners (ELL), the student's guardian is offered for his or her acceptance the English as a Second Language (ESL) program for stakeholders to ensure equal access to meaningful implementation of research-based best practices and work collaboratively to develop highly trained staff to move ESLs along the continuum of language and math content to provide an exemplary education. Teachers in the district who teach math as a content area are provided with multiple professional development opportunities on various ways to problem solve and techniques for the ESL learner.

Participants in the study. All participants in the study were middle school ESL math teachers from the same district. All participants had either passed their teaching certification program or earned a bachelor degree or higher in education, and they have passed both Mathematics 4–8 and Pedagogy and Professional Responsibilities tests, required by the state of Texas. The participants (i.e., ESL math teachers) varied by race, but all had trained to complete or have passed their English as a Second Language Certification test. Lastly, participants attended professional development courses annually to ensure that their teaching certification remained valid and up to date.

Sampling Method

Based on the purpose of the study, a homogeneous sample was useful. Selecting a purposive sample of ESL math teachers from each middle school, ensured that they shared common characteristics (Hatch, 2002). Purposeful sampling was used to identify and select information-rich cases for effective use of limited resources (Hatch, 2002; Stake, 1995). This involved selecting middle school ESL math teachers from each of the six middle schools in the district (totaling $N = 9$ participants). The case study benefited from the small homogenous sample size because these teachers were knowledgeable and had experiences for answering the question of interest, which involved problem-solving for ESL students in the middle school bracket (Hatch, 2002; Stake, 1995). In addition, I was able to study this small subgroup of teachers in depth with respect to their experiences of problem-solving, mathematics, and teaching ESL learners. The sample provided answers to the research question, as well as the opportunity to learn about the particular case of problem-solving from the ESL teacher's stance in order to seek patterns of unanticipated as well as expected relationships (Hatch, 2002; Stake, 1995). Therefore, the aim was to understand the complex interrelationships among the participants' experiences through the instrumentation of interviews, member checking, and personal narratives (Stake, 1995).

Criteria for sample election were as follows:

- Are you currently a middle school teacher within the district?
- Are you certified for Math 4–8 and PPR in the state of Texas?
- Within previous years and up until now, have you taught the ESL population at your school within this district?

Instrumentation

Different instrumentations were used within the study to include initial interviews, second interviews, my own personal narratives after each interview, and member checking after each interview had been transcribed. Using an initial interview, second interview, and member checking stimulated one another. Incorporating my own narratives allowed me to be descriptive in my interpretations of each interview, elaborate on my experience teaching ESLs, and incorporate problem-solving in my instruction.

Interviews

Initial interview. The initial interview targeted the ESL teacher-to-student relationship regarding problem-solving within the classroom culture to reach mathematical mastery. It is imperative for students to recall meanings of keywords in a problem (the context) to devise a plan to illustrate how to attack a problem through an individualized approach (Bishara, 2016; Mwei, 2017). This can be detailed either through isolation or mathematical discourse to repair communication breakdown and connectivity through all mathematical representations. For instance, collaborative dialogue promotes effective strategies that encourage problem-solving, direct individualized error in the meaning-making process, and the formation of schematic representation of the knowledge to assist in the development of a knowledge repertoire and negotiate mathematical meaning and self-efficacy as key factors to understand math as it relates to other subject matter (i.e., STEM or STEAM; Carafella, 2014; Cardimona, 2016; Kantar, 2014; Rice et al., 2013). I wanted the initial interview to maintain the idea, in alignment with the literature review, of what kind of experiences ESL math teachers were having when shifting away from the one-dimensional approach of individualized (one-to-one) teaching to first-person perception in such a manner as to represent changes because limited methods limit deeper comprehension (Aisha et al., 2017; Bishara, 2016).

A formal face-to-face initial interview was conducted to ensure that the participants and I both understood that we were to generate data from their expertise and experience with teaching ESLs (Hatch, 2002). I used the following questions for the initial interview (see Appendix A):

1. What is your experience in education and teaching ESL students?
2. How has your experience been teaching the ESL population?
3. What are the benefits for ESLs when establishing an individualized organizational

approach in math problem-solving while emphasizing mastery in all four categories (i.e., labeling the main idea of the problem, devising a plan to solve the problem, implementing the selected method, and reflecting on the question to see if it could potentially have been solved it in a different way?).

4. What experiences in mathematics (i.e., prior knowledge in algorithms or real-world experiences) can assist the problem-solving process when ESLs are learning new concepts?
5. How does the variation between isolation and communicative techniques in problem-solving heighten literacy in all mathematical representations for ESLs?
6. What are your experiences in recalling or attended trainings to properly model the problem-solving process for ESLs?
7. In what ways do you align self-discovery and ESLs' math readiness standards in your learning environment?
8. In what ways do cross-curricular techniques assist the learning culture within your ESL classroom, and how does that affect students' problem-solving?

Second interview. The second set of interview questions was based on the findings of the initial interview, initial personal narratives, and initial interview member checking. In addition, I assessed how teacher preparation and collaborative efforts to problem solve prepare long-lasting lessons for ESLs. Through my experience teaching ESLs, I understand that students cannot accomplish problem-solving on their own. Teachers must guide students with questions toward explaining, justifying, and defending their independent and collaborative problem-solving processes (Cardimona, 2016; Turkan & de Jong, 2018).

Again, the second interview questions were based on the findings of the initial interviews, personal narratives, and member checking to extend the initial responses and narrow the common themes from the participants' responses as a whole. The same steps were followed as in the initial interview. Second-interview questions were as follows (see Appendix B):

1. What kind of experiences are a vital factor in math problem-solving to close the developmental gaps between ESL and non-ESL students in acquisition, working memory, and mathematical tasks?
2. With ESLs, what are common mistakes the students make when solving math problems whether in numerical, verbal, or pictorial renditions?
3. What have been difficulties for you as the ESL math teacher when applying problem-solving in math as English is not their first language (possible answers based on my own experience could be lack of motivation or not being connected to the lesson due to lack of experience)?
4. From your experiences as ESL math teacher, what alterations do you make during instruction when embedding problem-solving to benefit student math practices?
5. With ESLs, what are common mistakes the students make when solving math problems whether in numerical, verbal, or pictorial renditions?
6. How did you apply learned strategies, techniques, and behaviors from professional development courses and experiences to lower error rates when similar math problems are given in the future?
7. During instruction, how do you apply individualized relativity to individualize the lesson to benefit each ESL student?

Member Checking

The instrumentation of the member checks was the last method used to verify and confirm responses based on the initial and second interviews. The aim was to verify the information that I would further develop (Hatch, 2002). I provided the opportunity for participants to consider and give their reactions to my interpretations in the summary I wrote (Hatch, 2002). I allowed time for the participants to agree or clarify to ensure that their responses were fully conveyed within the study before going forward with data analysis. I conducted the first member check after the initial interview. Once confirmed by participants and the initial analysis completed, I formulated the second interview questions, conducted the interview, and went on to the second member checking. The form used can be seen in Appendix C.

Personal Narratives

My personal narratives expounded on my experiences regarding the ESL mathematics classroom and problem-solving as a means of instruction to generate connectivity between mathematics, literacy, and comprehension levels for ESL students. My professional experiences in teaching middle school ESLs, coordinating summer school intervention programs for state standardized testing, attending extensive problem-solving professional development sessions, and using problem-solving structures contributed to analyzing the information gained from all interviews. The 30-minutes interval after each interview gave me the chance to reflect and write down my thoughts. Personal narratives added depth in problem-solving for ESLs.

Personal narratives were produced in the first 30 minutes after each interview. I anticipated discovering commonalties in themes of ESL math teachers' experiences in learning and teaching math through problem-solving to benefit ESL students' learning experience. The reflective questions that I used were as follows (see Appendix D):

1. What did I observe that I noted during the interview and what are my personal thoughts?
2. What I noticed that is similar to my own experience in teaching ESLs was . . .
3. What skills did I discover that are different from my own experience in teaching ESLs?
4. Based on commonalties, what steps am I gaining to improve the problem-solving process for ESLs?
5. What extension questions could I have asked in going deeper in understanding the participants' experiences?
6. What mattered most in this interview, and what distinguishes this participant from the others?

Data Collection

Four types of data were collected through initial interviews, second interviews, member checking interviews, and personal narratives.

Interviews

Initial interview. The initial interviews were face-to-face meetings, but the sites varied based on the participant's assigned middle school within the school district. When scheduled, times were set at the various middle schools in the district. I ensured that the names of the interviewees, their school sites, and district would not be disclosed. Each participant had the opportunity to accept or decline being recorded, but scripts were made in each interview, regardless of the outcome. Each participant was free to decline the offer of participation or stop participation in the study at any moment during the case study process. Each interview had a time frame of 45 minutes. I elaborated on the main idea and objective of the interview to ensure that the participants comprehended what was being studied. The outline of the initial interview process was as follows (see Appendix E):

1. Recruit participants.
2. Schedule times with each participant at his or her school site.
3. Inform each participant that their identity, their school, and name of the district would be strictly confidential.
4. Inform each participant that he or she can decline continuing with the study at any time during the case study process.
5. Inform each participant of the objective, purpose, the research question, and how their participation will help me create answers to the research question.
6. Use a hard copy of interview questions to take notes and set recorder (Rev.com) to record the interview (upon written permission by the participant).
7. Read questions in the same way to each participant and clarity the question if necessary.
8. After questions have been answered and responses have been written down, I scheduled the second interview, based on the participant's availability and after confirmation of the member checking from the initial interview transcript.

Second interview. The second interview was also a face-to-face meeting and scheduled based on the availability of each participant. Second interview questions were developed after data analysis of the initial interviews, personal narratives, and member checking (chart depiction is further explained in Chapter 4). Each participant had the opportunity to accept or decline being recorded, but scripts were made in each, regardless the outcome. The objective of the study was presented again to ensure that each participant understood the focus of this research. In addition, I reassured the participants that their identity, school, and district would remain confidential. Each participant had the opportunity to decline to participate or cease participation at any time during the case study. Each question was read in the same way to each participant, and the same time span was provided for his or her answers (i.e., 45 minutes).

The outline of the second interview process was as follows (see Appendix E):

1. Schedule second interview with each participant, based on school site.
2. Inform each participant that his or her identity, school, and information about the district would remain strictly confidential.
3. Inform each participant that he or she can decline to continue with the study at any time.
4. Inform each participant of the objective, purpose, the research question, and how their participation will help to create answers to the research question.
5. Use a hard copy of interview questions to take notes and set recorder to conduct the recording (upon written permission by the participant).
6. Read questions in the same way to each participant, and provide clarification for any question is necessary.
7. The member checking interview is to be planned based on the participant's availability.

Member Checking

Member checking occurred over the phone and personalized district e-mails. I sent the initial interview transcripts through individualized personal e-mail. If participants wished to receive a hard copy of the transcript that was provided upon request through interoffice mail. The participants reviewed and ensured that the transcripts correctly mirrored their responses. When confirmed, the participant sent the transcript back to me and stated he or she approved the quality and data presented in the transcript. The same steps were taken with the second interview, which also included the transcript check.

This time, participants had the opportunity to review what they had stated during the interview process; explore the experiences, meanings, data gathered from initial and second interview further; and explain other patterns that they have experienced in problem-solving and teaching ESLs. Each member checking took approximately 30 minutes. The outline of the member checking interview process was as follows (see Appendix E):

1. Schedule next meeting times with each participant during this phone conference.
2. Over the phone or via e-mail dialogue, I informed each participant that their identity, their school, and information regarding the district would remain strictly confidential.
3. Inform each participant that he or she may decline at any time to continue with the study.
4. Remind each participant of the objective, purpose, and research question and how their participation will help to create answers to the research question.
5. Send a hard copy of the interview transcript via interoffice mail, or e-mail a copy of his or her transcript to each participant.
6. Participants reviewed their interview transcript, and if clarification was needed, they noted so on the transcript and sent it back to me to make further changes.
7. If changes or additions needed to be made, I repeated the same steps to ensure that the respondent’s point of view and responses were truthful and ethically sound.
8. Delete recordings from Rev.com application when confirmed within 24–48 hours.

Personal Narratives

After each interview, I reflected on the interview process and took 30 minutes to compose a personal narrative. This follows the intrinsic qualitative approach to connect the researcher-created data with the participant-provided data (Hatch, 2002; Kwasnicka, Dombrowski, White, & Sniehotta, 2015). Furthermore, the personal narrative helped to produce a deeper understanding of data gathered in the initial interviews, second interviews, and member checks to create coding themes when beginning the analysis process.

The outline for personal narratives was as follows (see Appendix E):

1. Directly after conducting each initial and second interview, I located an isolated space, away from the participant's school, to ensure that information gathered was fresh in my mind and could be quietly reflected upon.
2. I designated 30 minutes for answering my self-created reflection form.
3. Based on the responses, I reflected on how each participant differed from the others.
4. I applied my own experience in teaching ESL students and from other positions in the field of education to compare and contrast my experiences with those of the participant.

Identification of Attributes

Problem-solving continues to allow ESLs to access multiple entry points to solve a problem through extension questions to stretch their mathematical mindset into more advanced mathematics, exploring real-world experiences, the math curriculum, and cross-curricular standards that intersect within problem-solving (Appleton et al., 2017; Burt & Stringer, 2018; Scherer & Beckmann, 2014). Embedding problem-solving focuses on what the math question asks the student to perform to improve clarity of unfamiliar English vocabulary and accountability in how mathematical problem-solving is conceptualized into two categories: the everyday world of problems and the abstract world of mathematical concepts, symbols, and operations (Beal & Galan, 2015; Hinnant-Crawford et al., 2016; Mwei, 2017; Orosco, 2013, 2014).

Krulik and Rudnick (1996) defined problem-solving in the early 1990s, explaining how mathematical tasks contained the potential to provide intellectual challenges to enhance the mathematical mindset and its development. ESL math teachers must be aware that the problem-solving approach contributes to the practical use of mathematics and employ these skills to become adaptable when transferring them to new mathematics courses or attempting to discover solutions when problems arise. For ESL teachers to confirm that mastery has been achieved requires examination of *understanding* (i.e., how to solve and make real-world connections) and *development* (i.e., how people build upon learned behavior and apply rigor to future math concepts). The goal is for teachers and students to become continuous learners, reinforce learning, and understand how to tackle everyday challenges.

Data Analysis Procedures

The literature review was the starting point, showing how to conduct the data analysis. The inductive approach was suitable for a case study because it guided the deeper understanding of specific elements in the experiences of ESL math teachers and the connections within them (Hatch, 2002). The inductive analysis was used to develop and organize raw data from recordings and participants' responses. Each participant had personal experiences with problem-solving and ESL learners. Therefore, inductive analysis was best suited to assist the instrumentation of interviews, creating initial codes based on semantic relationships I discovered from ESL math teachers' recalling, explaining, and recognizing what they personally felt was best in their style of teaching as well as in trial and error to benefit the ESL learner with problem-solving (Hatch, 2002; Stake 1995). This was when I understood how purposefully to code common items or themes that were directly related to one another through each participant's responses.

Interviews

I followed the process of inductive analysis, using Hatch's (2002) nine steps and Saldaña's (2016) initial coding for the interview data of the case study. I actively stimulated and guided the discussions using data-driven prompts; explored, integrated, and contrasted interpretations derived from data with participants' experiences and narratives; and discussed and evaluated participants' views regarding the personal data presented (Hatch, 2002; Kwasnicka et al., 2015). Through revision of the primary qualitative data gathered, inductive analysis allowed me to reflect on key themes, enhancing the themes in detail, and reformulating the responses that each participant had given during the interview, describing different contexts and based on their different experiences (Hatch, 2002).

I applied initial coding as a technique for the interviews. The outline of the inductive process was as follows:

1. I read the data and identified frames of analysis.
2. I created codes based on relationships that I discovered within the levels of specificity within the data examined.
3. I began the initial coding process. I created an organized outline that was transferred through initial coding to code the gathered data. At this stage, I listed themes and relationships to describe the problem-solving process for ESLs, based on the ESL teachers' experiences:

a. I reviewed interview transcripts and responses provided by each participant.
b. I highlighted salient features of data within the transcript. As I read the transcript, I highlighted or labeled the information that was germane to the research question.
c. I reread information within the text that was either highlighted or labeled. Next to it, in the margins of the transcript, I wrote down a code that represented the meaning or main idea within the highlighted or labeled texts.
d. I created codes (words or phrases) that were brief and represented the main idea of the overall responses.
e. From highlighting and creating codes from each interview transcript, I had a list of codes to represent features, meanings, and data from each interview.
f. Within these codes, based on the experiences of each participant, I was able to group them together to create themes.
g. After interviews were conducted, I reflected on data to form a personal narrative to expound on meanings of common and uncommon themes.

4. I identified and assigned codes. Once completed, I put codes that were least common among all participants aside.
5. I reread data, refined salient codes, and kept a record of relationships found in the data.
6. I examined if the codes were supported by the data and searched the data for examples that did not fit or align with the relationships among codes.
7. I completed analysis within the codes.
8. I searched for themes across all codes.

9. I created an outline expressing relationships within and among codes.
10. I selected data excerpts to support the elements of codes and themes created.

Initial interview. I used inductive analysis for the initial interviews. The initial interviews were transcribed based on notetaking and recordings (with Rev.com). I began with a frame of background questions so that participants could talk about what was familiar to them, to create a sense of comfort and ease concerns about the interview process (Hatch, 2002). This allowed each participant to include information (e.g., demographics) that was beneficial during data analysis and also helped to distinguish one participant from another (Hatch, 2002). Thereafter, data were analyzed, outlined, and then coded, based on commonalities of themes among all participants.

The initial interview required initial coding. The initial coding broke down qualitative data into discrete parts; I closely examined them and compared them for similarities and differences (Saldaña, 2016). When interviews were completed, I highlighted salient information within the transcript with a code to represent features and meaning common among all interviews. I labeled sections using code words or phrases in order to have a list of codes that could be placed in order and also furnished with subgroupings. This process allowed me to see how the codes interrelated or differed.

Through the inductive process, I created codes related to participants' experiences and grouped together codes based on similarities to form themes (Saldaña, 2016). The coding process is mentioned in Step 3 of the inductive process, which was as follows:

1. I created an organized outline that was transferred through initial coding to code the gathered data. At this stage, I listed themes and relationships to describe the problem-solving process for ESLs, based on the ESL teachers' experiences:

a. I reviewed initial interview transcripts and responses provided by each participant.
b. I highlighted salient features of data within the transcript. As I read the transcript, I highlighted or labeled the information that was of interest to answer the research question.
c. I reread information within the text that was either highlighted or labeled. I wrote on the side, in the margins of the transcript, a code that represented the meaning or main idea within the highlighted or labeled texts.
d. I created codes (words or phrases) that were brief and represented the main idea of the overall responses.
e. Through highlighting and creating codes from each initial interview transcript, I had a list of codes to represent features, meaning, and data from each interview.
f. Thereafter, I reviewed created codes from all the interviews (code words or phrases) in order to have a list of codes.
g. Within these codes, based upon the experiences of each participant, I was able to form groupings to create themes.

2. After initial interviews were conducted, I reflected on data to form personal narratives to expound on meanings of common and uncommon themes.
3. In the next steps of this research, I further detail and elaborate on codes, relationships, and common phrasings.

Second interview. Inductive analysis was used for the second interviews. Each second interview, just as each initial interview, was transcribed based on notetaking and recordings (with Rev.com). The second interview questions were formulated based on the responses and analyses of the initial interviews, initial personal narratives, and member checking (Hatch, 2002). Again, as interview questions continued, each participant was able to include familiar and comfortable information (e.g., demographics), which was beneficial during data analysis and helped to distinguish one participant from another (Hatch, 2002). Data were analyzed, outlined, and then coded, based on commonalities of themes among all the participants' feedback.

The second interview required initial coding. When interviews were completed, I highlighted salient information within the transcript and marked it with a code to represent features and meanings common among all interviews; I outlined them into discrete parts, closely examined them, and compared them for similarities and differences (Saldaña, 2016). I labeled sections through code words or phrases in order to have a list of codes that was placed in order and also contained subgroupings. This process allowed me to see how codes interrelated or differed.

The inductive data analysis process for the second interview followed the initial coding technique as stated in Step 3 (inductive process) and outlined as follows:

1. Reviewed common codes and outline from initial interview to form questions for second interview.
2. When second interviews were complete, I reflected on the data gathered to form personal narratives to expound on meanings of common and differing themes.
3. I followed the same steps for coding as in the initial interview. I created an organized outline that was transferred through initial coding to code data. At this stage, I listed themes and relationships to describe the problem-solving process for ESLs, based on the ESL teachers' experiences:

a. I reviewed second interview transcripts and responses provided by each participant.
b. I highlighted salient features of the data within the transcript. I read the transcript, I highlighted or labeled the information that was of interest to answer the research question.
c. I reread information within the text that was either highlighted or labeled. I wrote on the side, in the margins of the transcript, a code that represented the meaning or main idea within the highlighted or labeled text.
d. I created codes (words or phrases) that were brief and represented the main idea of the overall responses.
e. Through highlighting and creating codes for each second-interview transcript, I had a list of codes to represent features, meaning, and data of each interview.
f. Thereafter, I reviewed the created codes from all the interviews (code words or phrases) in order to have a list of codes.
g. I was able to group these codes, which were based upon the experiences of each participant, into thematic categories.

4. After the second interviews had been conducted, I reflected on the data to form personal narratives to expound on meanings of common and differing themes.
5. I further detailed and elaborated on codes, relationships, and common phrasings.

Member Checking

Member checking provided the opportunity to verify, clarify, and extend information that I had developed from the initial and second interviews (Hatch, 2002). Inductively, the same steps were taken, just as in the initial and second interviews. I read and identified frames of analysis to create codes, based on themes from the semantic relationships discovered to exist among all participants, and code common themes. I aligned attributes from the gathered data in comparison to the literature review. The themes were configured, and the member checks were analyzed and compared to the first two interviews. Thereafter, I identified common codes and assigned codes to organize a record of relationships within the data, making it easier to pinpoint supportive and nonsupportive data when creating an outline to express relationships.

The inductive data analysis process for the member checking interview supported the coding techniques used in the initial and second interviews. The outline is listed as follows:

1. I reviewed and analyzed codes from the initial and second interviews.
2. I reviewed the developed and organized outline that was transferred through an initial coding, which was performed on data gathered to construct a table. At this stage, I clarified the list of themes and relationships to describe the problem-solving process for ESLs, based on the ESL teachers' experiences
3. Lastly, I reinterpreted findings from each instrumentation to detail themes and concepts and describe how they align with the experiences of ESL teachers, modeling ESLs accountability to problem solve.

Personal Narratives

Inductive analysis was applied to my personal narratives through axial coding. After each interview, I used axial coding to break down core themes to elaborate on my experiences through each observation and my expertise in lesson preparation, teaching, and modeling the problem-solving process to ESLs. This second cycle of coding helped me further to explain my experiences to discover ideas through metaphors and concepts that linked me with the participants (Saldaña, 2016). The narratives were categorized and defined in order to connect the codes formulated during the initial interviews, second interviews, and member checks.

During the personal narrative analysis, I used axial coding to inductively locate linkages between data that were formulated (i.e., codes, relationships, and themes). The outline for personal narratives was as follows:

1. After the interviews had been conducted, outlined, and confirmed, I spent 30 minutes reflecting on my experience conducting the interview, utilizing problem-solving in lessons, and teaching ESLs.
2. When all narratives had been conducted, I used axial coding to identify the relationships among the initial codes that were outlined and formatted from the initial and second interviews, answering the question: What are the connections among the codes that I have created?
3. Then I looked for conditions or influences from the ESL math teacher, phenomena, strategies, and context of mathematics.
4. From the data, I pinpointed confirmations for the research question and listed exceptions in case they arose.
5. I understood what areas needed to be expanded or collapsed to comprehend patterns (similarities and differences).
6. I further detailed, through phrasing, how these codes were a commonality from participant to participant.

Limitations and Delimitations of the Research Design

Limitations

Limitations are defined as constraints that are beyond the researcher's control and could possibly affect the outcome of the study (Simon, 2011). I cannot rule out alternative explanations because the study is suggestive of what may be found in similar organizations and verified if findings of the study can be generalized (Simon, 2011). This qualitative case study will not make inferences and will not rule out alternative explanations. I was aware of the possibility that, in the future, similar points of view could be aired by middle school ESL math teachers of other schools in the district regarding problem-solving, prior to implementing data collection. Time was a possible limitation, depending on the availability of each participant. This availability determined when the interviews could be scheduled and how long they could last. Teachers at each middle school, including the sample of this study, have had extensive professional development regarding teaching ESL learners; they know how to implement problem-solving in lesson planning and real-time instruction. As an ESL math teacher and an instruction summer school coordinator who partnered with three schools (seventh and eighth graders only), I have had extensive training on how to implement problem-solving processes to increase communicative and literacy gains and know how to evaluate ESL teachers' instruction to ensure that problem-solving, math content, communication, and literacy are implemented. One limitation is that not all educators have as many years of experience as some of their colleagues; thus, campuswide practices in applying problem-solving with ESL learners will vary.

To address these limitations, multiple interviews (initial and second), personal narratives, and member checks were used to provide clarity in analyzing the data. The interviewing process was based on the availability of ESL math teachers. The number of participants was small ($N = 9$); thus, it was easy to inform all participants that their identity and the names of their school site and district would be kept confidential. The assurance of confidentiality was expected to encourage teachers to be honest and elaborate about their experiences as they related to the study. I used the same delivery reading the interview questions and allotted the same amount of time for each participant when going from site to site.

Delimitations

Delimitations are the characteristics that arise from limitations and result from choices made within the study (Simon, 2011). The experiences of ESL math teachers using problem-solving to benefit ESL learners' math experiences was a delimitation in the study. Participants (i.e., ESL math teachers) with experiences in problem-solving and math contributed to the important information gained during interviews and data analysis. All interviews (initial and second), member checks, and personal narratives were conducted in natural settings. Interview questions that I developed aligned with the literature review within the scope of research. Lastly, my personal narratives reinforced the validity and credibility of study.

Validation

To support trustworthiness of the case study, I addressed validity and reliability through the aspects of credibility, transferability, dependability, and confirmability (Shenton, 2004). Trustworthiness exhibited how truthful and applicable the research and methods were. The findings were based on participants' responses and were not driven by bias. Lastly, this case study can be replicated by other researchers and should yield similar results.

Credibility

Internal validity. Internal validity establishes credibility and shows that the research results are purposefully supported by data (Shenton, 2004). The strategies used for validity and credibility (congruence of findings and reality) were (a) familiarity with culture of each middle school within the district; (b) triangulation through the instrumentation, analyzing data from the experiences of each participant, member checking interviews, and personal narratives; (c) face-to-face interviews in private sites to ensure honesty; (d) debriefing participants to recognize my own biases and preferences; and (e) current literature to support the study (Shenton, 2004).

External validity. External validity refers to how well the outcome of the study can be expected to apply to other settings or situations (Shenton, 2004). I aimed to produce truly transferable results from ESL teachers' experiences with problem-solving with ESL learners in mind and did not disregard the importance of context, which is a key factor in qualitative research (Shenton, 2004).The district provided extensive professional development for ESL math teachers, including how to problem solve, making them knowledgeable about lesson preparation, modeling problem-solving, and ESL students' accountability. Results may not be valid in other surrounding districts, but if the same conditions apply, then transferability may be possible. This could vary case by case and the experiences of other ESL math teachers in other districts.

Dependability

To further ensure dependability I continued to describe the study plan, expounded on operational details of data gathering, and evaluated the effectiveness of the process of inquiry undertaken in detail to enable a future researcher to replicate the work (Shenton, 2004). This case study is dependable because it is consistent and repeatable through (a) descriptive reports of experiences of each participant by commonality of problem-solving and instructing ESLs, (b) triangulation through interviews, member checking, and personal narratives, and (c) reflective details of insight of each participant and my personal experiences with problem-solving and ESL students. Narratives allowed me to be open in interpreting and analyzing data from the research.

Expected Findings

Each phase of the study detailed the importance of ESL teachers' experiences in implementing problem-solving in math instruction. The initial interview, second interview, member checks, and my own personal narratives were used for an in-depth analysis of experiences from ESL math teachers' perspectives and experiences of problem-solving for ESLs. These steps uncovered how the teachers prepared lessons to instill how problem-solving can be communicated, applied, and implanted—but not only in math, also in other content areas and real-world experiences. Experiences, similarities, and differences from teacher to teacher uncovered the consistency in experiences. My personal narratives expanded upon the responses given by each participant and added onto their experiences in implementing problem-solving within ESL classrooms.

Ethical Issues

Conflict -of -Interest Assessment

This study was designed to detail current strategies used to problem solve to fill the developmental gap in math for ESL learners and seek improvements when teaching ESLs in the future. Problem-solving with the ESL learner in mind will improve the effectiveness of teachers' strategies for ESLs to communicate (socially) and solve (independently) when various types of mathematical representations are given. There could be conflict of interest in the study because I am an 8th grade ESL math teacher, but bias was mitigated. I ensured that I applied all aspects of trustworthiness and reassured that the participants could decline further participation in the study at any time and that they should be ethically truthful about the data being gathered.

Researcher's Position

Problem-solving is a process that keeps connectivity, engagement, and mastery levels in cross-curricular aspects for ESLs at a rise. The problem-solving process and delivery in the ESL classroom vary based on the teacher's content delivery, classroom culture, and management. My experience in teaching ESLs, learning and teaching problem-solving instruction through professional development, and embedding a problem-solving culture when acting as summer school administrator were vital in the instrumentation and delivery of this case study. Teachers should guide students with questions toward explaining, justifying, and defending their independent and collaborative problem-solving processes (Cardimona, 2016; Turkan & de Jong, 2018).

The literature suggested that discovering innovative strategies for literacy and communication skills is vital in today's math classroom because both support the problem-solving process (Fung & Swanson, 2017; Hojnoski et al., 2014; Sherman & Gabriel, 2017; Swanson et al., 2018; Wu et al., 2017). Teachers must also realize that students cannot accomplish problem-solving entirely on their own. Decoding a problem requires training middle school students in recalling prior knowledge as a functioning ability that is not limited to recreating algorithms or procedures (Bishara. 2016, Krawec et al., 2012). ESL math teachers must be trained and attend annual professional development sessions to apply explicit instruction and insist that it be followed when they teach their students skills, strategies, or problem-solving processes (e.g., extracting relevant information in math problems; Aisha et al., 2017; Burt & Stringer, 2018; Cave et al., 2018; Ganor-Stern, 2016; Hansen-Thomas & Grosso Richins, 2015; Hojnoski et al., 2014; Kingsdorf & Krawec, 2016; Rosales et al., 2012; Turkan & de Jong, 2018).

Ethical Issues in the Study

A district letter that had been approved by the superintendent's office was sent, and middle school building principals were informed that I was approved to conduct the study. The Institutional Review Board (IRB) of Concordia University–Portland provided approval to study human subjects. I asked and received the consent of participants before collecting data. Data were securely stored and locked in my personal computer in my home. Voice recordings that were used through Rev.com were deleted once converted into transcripts. The participants were teachers within the same district; each was given a consent form that detailed the guidelines, objectives, interview processes, and procedure of the study. I comprehended and applied the Belmont Report's respect for persons, beneficence, and justice. I had and showed respect for persons by ensuring that the ESL math teachers were treated as autonomous agents, making their own decision about participating in this case study. Beneficence was present within the case study because physical, behavioral, and mental harm did not occur, but the benefits of participation in comprehending each participant's expertise and experience was maximized. Justice existed within the study because I ensured that all participants were treated fairly and equally benefited from the case study.

Chapter Summary

In this chapter, I detailed the research methods and design of the qualitative case study. I examined the experiences of ESL math teachers using problem-solving to benefit ESL students. The research was conducted at six middle schools in one school district. I had participants from each school for a total of nine respondents. I gathered information at each interview and wrote personal narratives concerning ESL math teachers' guiding the problem-solving of ESL students with attention to attitudes and experiences. In addition, the literature review was relevant and current, but little evidence was found to showcase problem-solving with ESL learners in mind or how ESL teachers apply this strategy with students to ensure that its use will continue when rigor in math increases. Participants were informed about the procedures of data collection and analysis. The research question and interviews were aligned with the literature review. Consent from the district and participants was obtained, ethical concerns and approvals were provided to ensure trustworthiness through validity, credibility, and dependability. The methods described in this chapter were practiced and referenced with literature and previous practices (Hatch, 2002; Stake, 1995). In Chapter 4, I restate the research question and provide the data analysis and results of the study.

Chapter 4: Data Analysis and Results

Introduction

This case study was designed to explore the expertise and experiences of ESL math teachers regarding problem-solving versus solving problems at hand for the ESL learner in the middle school bracket. Within boundaries, case studies provide an opportunity to examine a contextualized contemporary phenomenon. In this chapter, I provide a description of the sample enlisted for this qualitative case study. The research methods are detailed; data collection and data analysis proceeded through means of organized interviews, personal narratives, and member checking.

Description of the Sample

I sent 13 invitations to participate in this qualitative case study to middle school ESL math teachers within the same district in the Gulf Coast region of Texas (see Appendix F). Nine of the teachers were able to participate in the study. Among the nine participants, six taught both ESL students and so-called on-level students at the same time throughout their years of teaching. Five coached sports at their campuses and have been sponsors of a club or organization. All participants have been trained in Sheltered Instruction Observation Protocol (SIOP), addressing the academic needs of English as a Second Language Learners (ELL). The SIOP model encompasses eight interrelated components: lesson preparation, building background, comprehensible input, strategies, interaction, practice/application, lesson delivery, and review/assessment. The highest academic degree that any participant held was a master’s degree in either Counseling or Educational Leadership. The experiences of participants ranged from one to eleven years of teaching. Pseudonymous were used for all participants to preserve their confidentiality.

Descriptions of Individual Participants

Paul. Paul (all names are pseudonymous) is in his 11th year of teaching in the district. He has experience in the community because he graduated within the district. Paul teaches seventh-grade mathematics and instructs the intermediate ESL population. He previously taught math with the on-level and special education population. Paul coaches multiple sports at his campus. He has been his content grade-level team lead, cross-curricular team lead, and has instructed for four years at his campus summer school bridge program. Paul is in his late 30s, an African-American male, and is fluent in English.

Paul believed that, being an ESL math teacher, one must build upon small successes to improve confidence as the math rigor intensifies. He believed that a consistent literacy strategy in problem-solving helps ESL students to become bilingual and ensures that an active mathematical struggle ("taking the floaties off") assists students to succeed intrinsically on their own.

Lisa. Lisa is a 29-year-old Hispanic female who is fluent in Spanish and English. Lisa has taught beginner, intermediate, and advanced-high ESL students. She is in her sixth year of education and has recently earned a master's degree in counseling. She has coached a sport for four years out of her six years of teaching and has worked one year in the summer school bridge program at her campus. Lisa has also been an active proponent in the Safety and Civility committee for three years.

Lisa's methodology in teaching the ESL population is to "read it, speak it, solve it, and explain it." She does not want the students to know only the What in math, but also the How. Her outlook on communicative and mathematical standards strives for ESLs to have to struggle for progress. ESLs must find an effective way to discover collaborative work and not "cheat to repeat," but "converse to immerse."

Elizabeth. Elizabeth is a Hispanic female in her mid-20s, going into her fifth year of teaching. Elizabeth is fluent in both English and Spanish. She has taught beginner seventh-grade ESL students and is currently teaching beginner and intermediate ESL students in both seventh and eighth grade. She has taught seventh-grade mathematics in the summer middle school bridge academy.

Elizabeth believes that encouraging creativity and skill sets by lesson preparation through problem-solving in small strides builds confidence in the ESL student. Perhaps because the majority of her learning population is of Hispanic decent, she has a multicultural perspective and approach. Through the problem-solving process, Elizabeth helps to develop English literacy in her students from a variety of backgrounds as well as to lead them to reach mathematical mastery. Elizabeth's classroom culture does not make one demographic (that is, ESLs) superior to any other.

Zachary. Zachary is in his first full year of teaching, coming into the classroom midyear in the previous term. Zachary is an African-American male in his 20s and fluent in English. Zachary instructed the beginner ESL population in eighth-grade mathematics. He had time allotted each day for assistance from a paraprofessional who worked in the ESL department. He also teaches on-level students and has instructed math in the summer bridge program in the district.

Zachary believes that teachers should discover the ESL students' "starting mindset." This helps teachers meet the students' interest to gain motivation by working at what they know. He believes that consistency is key. He is aware that comprehension does not happen on the first day, but when the teacher-to-student relationship is built up, the teacher can identify and address starting points individually even within whole-group instruction.

Melanie. Melanie is a Hispanic-American female, fluent in English and Spanish, and in her late 20s. This is her fifth year teaching seventh-grade beginner ESL students. She also teaches on-level students. Melanie has also served as her grade-level content team lead.

Melanie is aware that math lessons must be student-led for students to be involved in their learning versus getting information thrown at them. To assist the “teacher mindset,” educators must understand that any student coming from a different community or country will have a sense of culture shock, prompting fear and resistance and not feeling included. Melanie makes it known that a classroom culture that makes students aware that they are here for the same goal, equal opportunity, and fairness above all will boost their confidence.

Allen. Allen is a 30-year-old African-American male, who is fluent only in English. Allen has taught for two years in the southern region of Louisiana, teaching math and English. He has been within his current district for four years, teaching seventh-grade math to the intermediate ESL population. Allen has been his content grade-level team lead and cross-curricular team lead at his current campus. He is also an active member of the Black History program committee.

From his years in education, Allen consistently seeks out what is transferable, especially specific English words that have a double meaning (for sentence structure and math). Math discourse has been an ongoing method to provide moments for English literacy in the midst of learning mathematics. This gives him and his ESL students more explicit time, more one-on-one time, and independent awareness for applying the English language to mathematics.

Heather. Heather is a 30-year-old African-American female of East-African descent. She has been with the district for six years, teaching intermediate ESL students, but she also has experience with on-level, special needs students and pre-AP. Heather has had multiple roles at her campus: cross-curricular team lead, content grade-level team lead, coaching multiple sports, and supplying music entertainment for school functions and events. She has experience within the community because she attended and graduated in the district.

Heather believes in taking note of the “small wins” of ESL students to motivate them into reaching their English and mathematics goals. She is aware that ESL students are decoding and translating in real time during her lessons. She applies various strategies of writing and verbalizing to make it easier for them to connect words with the action.

Blake. Blake is a Hispanic male in his mid to late 20s. Blake teaches intermediate ESL students and has taught on-level as well. Blake has coached on his campus. He is fluent in both English and Spanish.

Blake is aware that ESL students may be on different levels, be it English fluency or mathematical mastery. This idea is laying the foundation for the students and gives Blake the freedom to go into more depth with harder, probing questions. To have ESLs succeed in both English literacy and mathematical problem-solving, the teachers must keep in mind how each student works.

Anissa. Anissa is a Hispanic female in her mid-30s. She teaches the beginner and intermediate ESL population and is fluent in English and Spanish. In addition, Anissa has taught on-level and special-needs students. She is familiar with the community because she has graduated in the same district. She has been in multiple positions within her campus: coaching multiple sports, cross-curricular team lead, 4 years as a math instructor for her campus summer bridge program, and content grade-level team lead.

Anissa has found certain moments in teaching the ESL population frustrating. She had a hard time making connections with the students because they knew that she could speak Spanish, while speaking in English was hard for them. In essence, the ESLs would use their language barrier not to speak or solve problems in English. Despite moments of disconnect, she understood despite the labeling of students (ESL, SPED, or on-level). She makes it clear that work or assessments do not see labels, and each child has the same learning opportunities to achieve and grow within his or her learning frame work.

Data Collection

I used a qualitative case study to understand the experiences of ESL middle school math teachers in a district in the Gulf Coast region of Texas. I was able to comprehend the experiences of middle school ESL teachers through their experiences of teaching this demographic, comparing methods, and incorporating real-life contexts (Yin, 2012). The research question guiding this study asked: What are the experiences of ESL math teachers who are embedding a problem-solving structure in the middle school bracket?

I used initial interviews, personal narratives, and member checking. Then I used second interviews, with new interview questions based on the combined data from all three data collection methods used. Another round of interviews, personal narratives, and member checking ensued (Hatch, 2002). This section details the coding steps used to analyze data. Once participants approved the first-interview transcription, I conducted 45-minute face-to-face interviews at the middle school site where the participants worked within the same district. During the interview process I used Rev.com to record the interviews (with the respondents' written permission). At the conclusion of each interview, I conducted an individual 30-minute personal narrative with the interviewee. When interview transcripts had been transcribed, I either had phone dialogue with the respondent or conducted an e-mail dialogue to review the transcript for accuracy and clarity. I also made sure that confidentiality was supported by the transcription. Within a 24-to-48-hour window after the interview, transcription was completed and the voice recording was deleted.

Data Collection

I collected data in two phases. In Phase 1, I conducted the initial interviews (face-to-face for 45 minutes), conducted personal narratives (30 minutes), and once completed, I followed up with member checking. A significant event took place after the fifth initial interview: I recognized that similarities occurred among the participants based on their responses. In addition, member checking was most beneficial through personalized e-mail interaction because participants could respond based on their availability. In Phase 2, I conducted a second interview. The second interview questions were based on the findings of all the initial interviews, personal narratives, and the confirmation of accuracy through the member checking process. After the second set of interviews, I conducted another round of personal narratives and member checking.

Initial interviews. Over a 3-week timespan, I conducted the first round of interviews with each of the nine participants. I collected data from each of the participants, based on a preplanned 45-minute interview sessions. Each interview suited each participant's needs and convenience, based on their availability regarding time and location. The location for each participant was at his or her home campus where each one worked and had privacy within the home classroom. I used the voice recording application Rev.com to record and transcribe the interview within real time. As each interview was being conducted, I took notes on a hard copy of the interview questions, making it easier to highlight main points and distinguish participants from one another. I reiterated responses to confirm that the recorded responses were factual and based on what they were stating in real time (as recorded on the hard copy). In addition, I asked clarifying questions and requested further explanations of each participant to grasp the full meaning of their responses.

Details of initial interview questions. In the initial interview, I asked eight prewritten questions that aligned with the literature review regarding problem-solving versus solving a problem at hand from the ESL math teachers' point of view. Questions 1 and 2 inquired on the What and the How of their personal experience in education and teaching of ESL students. Question 3 inquired about the benefits of establishing a problem-solving process for ESL students to fully comprehend what certain mathematical questions were asking them to do. Question 4 gave the participants the opportunity to express how they could apply prior knowledge and real-world experiences with the ESL students to problem solve and start mastering a new concept (or TEKS: Texas Essential Knowledge and Skills Mathematical Standards). Question 5 explained how the variation of isolation and communicative techniques can heighten literacy in all math representations for ESLs. Questions 6 and 7 detailed the trainings that the participants had attended in order to apply learned behavior, strategies, and opportunities of self-discovery with their ESLs to problem solve in their classrooms. Question 8 gave participants the opportunity to expound on how they utilized cross-curricular techniques to assist the learning culture within their ESL classrooms and how applying cross-curricular techniques can benefit the problem-solving process (refer back to Chapter 3 or Appendix A).

Initial personal narratives. Personal narratives were taking place after each initial interview for 30-minutes in an isolated environment. I anticipated discovering commonalties in the themes revealed by ESL math teacher's experiences in learning math through problem-solving to benefit the ESLs' total learning experience, once problem-solving was employed in the classroom. Personal narratives added depth to my own understanding of problem-solving for ESLs by bridging the experiences of participants to myself.

Initial member checks. For the initial interviews, I conducted member checking with each participant over a 3-week span. I sent a personalized e-mail of the transcript and offered to send the transcript by interoffice mail, based on the request of each participant. Within this dialogue (phone conference or personalized e-mail dialogue), I confirmed accuracy and legibility and removed any identifiers. I provided time for each participant to see if adjustments needed to be made. Each participant had the free will and obligation to accept or decline the transcript. All nine participants confirmed accuracy.

Second interviews. The second set of interviews occurred after I had collected and analyzed data from the initial interviews, personal narratives, and member checking process in order to formulate new prewritten questions. The second set of interviews took place within a 2-week timeframe. Just as with the initial interviews, there were 45-minute interview sessions. Each interview suited each participant's needs and convenience, based on their availability regarding time and location. The location for each participant was at his or her home campus, where each one worked; it was conducted in the privacy of their own classrooms. I used the voice recording application Rev.com to record and, then, transcribe the interviews within real time. As each interview was being conducted, I took notes on a hard copy of the prewritten questions, making it easier to highlight main points and distinguish participants from one another. I reiterated their responses to confirm that the responses given were factual and congruent with what they were stating in real time.

Details of second-interview questions. In the second interview, I asked seven prewritten questions, which had emerged from the findings of the initial interviews, personal narratives, and member checking, regarding problem-solving versus solving problems for the ESL learner from the ESL math teachers' point of view. Questions 1 and 2 gave participants the opportunity to expound on vital factors to help close the achievement gap between ESL and non-ESL students, regarding acquisition, working memory, mathematical depictions, and mathematical tasks. Questions 3 and 4 allowed participants to expound upon their personal difficulties in teaching the ESL population and how strategies were used to ensure growth and mastery among their ESL population. Question 5 and 6 allowed participants to share their experiences on common mistakes that ESLs make when problem-solving in numerical, verbal, and pictorial problems and how these teachers applied learned strategies, techniques, and behaviors from professional developments to lower the error rate when similar math problems will be given in the future. Question 7 allowed participants to expound upon individualized relativity to benefit students' learning and accountability (refer back to Chapter 3 or Appendix B).

Second personal narratives. The same steps were taken in the second round of personal narratives. Personal narratives occurred for 30 minutes after each participant's interview in an isolated environment. I anticipated discovering commonalties in themes of ESL math teacher's experiences in learning math through problem-solving to benefit ESLs learning experience, once this method was embedded in the classroom. Personal narratives added depth to my understanding problem-solving for ESLs, bridging the experiences from the participants to my own.

Second member checks. The same steps were taken after the second interview. Again, I conducted member checking with each participant over a 2-week span. I sent a personalized e-mail of the transcript and offered the transcript also by interoffice mail if requested. Within the dialogue, I confirmed accuracy, legibility, and the removal of any identifiers. I provided time for each participant to see if adjustments needed to be made. Each participant had the free will and obligation to accept or decline the acceptance of the transcript. All nine participants confirmed accuracy. Figure 1 shows the data collection process in the case study.

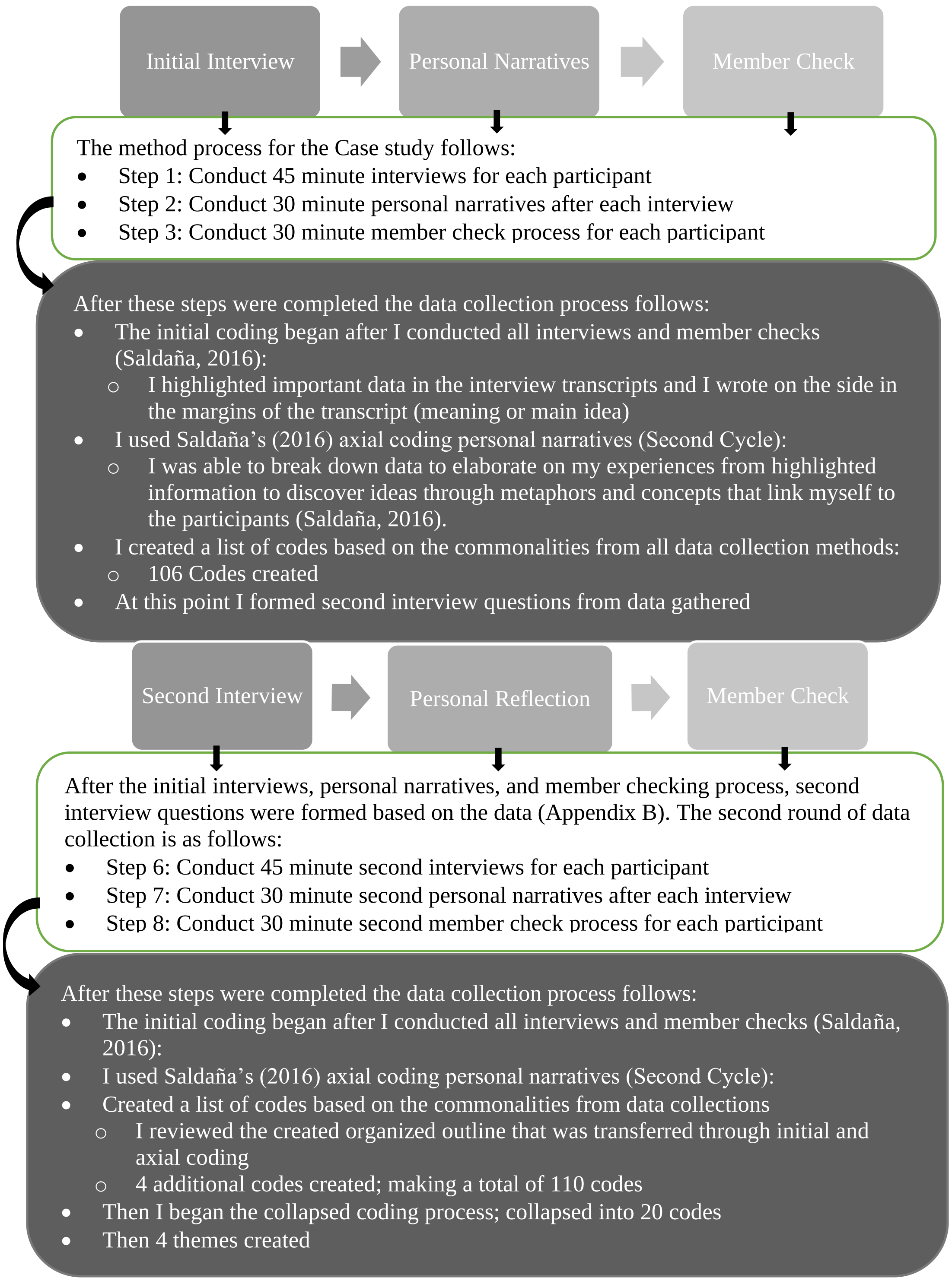

Figure 1. Process of data collection in the case study.

Data Analysis

Following the First Set of Three Data-Collection Processes

I used the inductive analysis process from Hatch's (2002) nine steps and Saldaña's (2016) initial coding (initial interviews and member checks), as well as axial coding (personal narratives) in this case study. The first round of coding occurred after the completion of the three data collection methods. I used the initial coding model (Saldaña, 2016). Going through all interviews and member checks, I compiled parts to discover similarities and differences among the participants. I read and identified frames of analysis to create codes based on the themes from the semantic relationships discovered among the participants and coded common themes. Lastly, I aligned attributes from the gathered data in comparison to the literature review, identified common codes, and assigned codes to organize a record of relationships within the data, making it easier to pinpoint supportive and nonsupportive data.

After the initial coding process, I used axial coding during my personal narratives (Saldaña, 2016). I used axial coding to break down core themes to elaborate on my experiences through each observation and my expertise teaching ESLs. The axial coding provided opportunities to linking myself to the participants (Saldaña, 2016). This was significant during the analysis process because I was able not only to analyze the differences and similarities among the participants, but also to discover similarities and differences in my own experience of teaching mathematics to middle school ESL students. This allowed me to reflect on lesson preparation, teaching, and modeling the problem-solving process to ESLs.

Following the Second Set of Three Data-Collection Processes

After the first round of coding, I used data gathered from the three data collections to create the second-interview questions. Then I conducted personal narratives and member checking. I repeated the same steps I had taken in the first round of coding. Coding took place after completion of the three data collection methods. I used the initial coding model again for interviews and member checking (Saldaña, 2016). Going through all interviews and member checks, I compiled parts to discover similarities and difference among the participants. I read and identified frames of analysis to create codes based on the themes from the semantic relationships discovered among the participants and code common themes. Lastly, I aligned attributes from the gathered data in comparison to the literature review, identified common codes, and assigned codes to organize a record of relationships within the data, making it easier to pinpoint supportive and nonsupportive data. After the initial coding process, I used axial coding during my personal narratives to elaborate on my own experiences through each observation and my expertise in lesson preparation, teaching, and modeling the problem-solving process to ESLs (Saldaña, 2016).

Coding

After reviewing Hatch's (2002) and Saldaña's (2016) work for coding processes, I read and reviewed the transcripts, personal narratives, and member checks with the research question in mind. The research question asked: What are the experiences of ESL math teachers who are embedding a problem-solving structure in the middle school bracket? This frame guided the initial review of interview transcripts, personal narratives, and member checks.

After coding the combined first three data collections, the second round of three data collections prompted two further inquiries:

- What strategies, application, and knowledge must ESL math teachers employ to instruct meaningful lessons for ESL students? and

- What behaviors are witnessed by participants about students to prompt application of motivational input for ESL students to succeed?

These questions were still in support of the main research question and helped to break down vital parts, phrasings, and key words for coding.

Saldaña (2016) stated that coding is an "interpretive act" (p. 4). Coding can sometimes summarize, distill, or condense data, not simply reduce the value that adds depth within the analysis process (Saldaña, 2016). In doing this, I began a color-coding process and noted details in the margins based on the frames when reviewing the transcripts. For instance, the peer-reviewed article by Turkan and de Jong (2018), "An Exploration of Preservice Teachers' Reasoning About Teaching Mathematics to English Language Learners," detailed one of their findings, namely, that students with English as a second language who are learning the language in real time often struggled with explaining their thinking in multiple deliveries, that is, in writing and speaking. In going forward with the coding process, I color-coded *academic struggle* in gray. So, when Paul stated, "I encourage active mathematical struggle in order to 'take the floaties off' for the [ESL] students intrinsically to succeed on their own," I color-coded gray. In addition, *strategies in problem-solving*, was color-coded in red, when Elizabeth stated, "Breaking the problem down line by line for pacing, based on the mathematical verbiage for ESLs to fully comprehend how to problem solve." Lastly, there were instances when phrases were double coded. For example, Allen stated,

> Problem-based learning is basically having those kids discover a certain skill through discovery, through trial and error, through collaboration. That was one way that I really got a hold to all of my students in the classroom, because they enjoyed it. They enjoy the

> problem. They enjoy actually figuring out a way to get to the solution. That was pretty much what I used.

This statement was coded in four areas: mathematical discourse, academic struggle, motivational input, and strategies to problem-solving. Mathematical discourse was color-coded green, academic struggle was gray, motivational input was purple, and strategies to problem solve was in red. The color coding was used to indicate commonalities and outliers between participants. This color coding helped me organize main ideas to easily discover phrases and words that were vital among the participants. The color coding assisted in grouping to form initial codes, collapsed codes, and themes. Figure 2 provides a coding process chart.

Initially, after completion of the first round of three data collection processes, I arrived at 106 codes. After the second round of three data collections, four additional codes emerged. With the additional codes added to the already existing 106 codes, I began the process of collapsing the initial codes and arrived at 20 collapsed codes. I reduced the number of codes based on commonality, or a shared main idea, among them. The 20 collapsed codes were used to support four themes: (a) demographic awareness, (b) math discourse and learning strategies, (c) connectivity through educational struggle, and (d) motivational input.

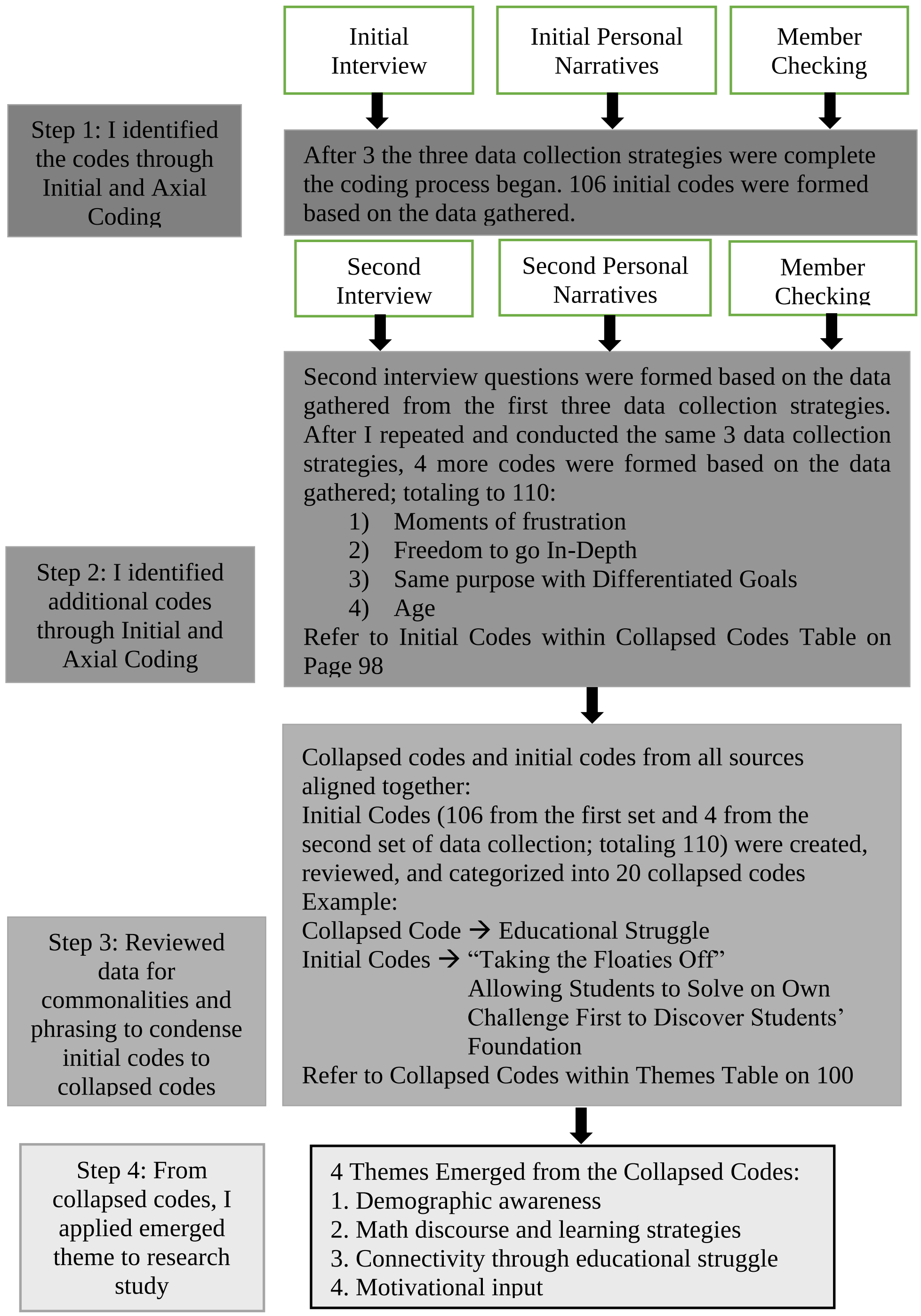

Figure 2. Coding process of the case study.

Interview data. After the first and second interviews, I analyzed each question put to the nine participants. The research question for the case study, together with my personal experience of teaching problem-solving to ESL students, helped me to formulate the interview questions. I asked additional questions to provide a rich and organic interview to expound on certain points each participant was making to ensure that clarity was being met. When transcribing the responses from the Rev.com recordings, I used a hard copy of the questions to write down notes; once transcribed, I used the margins of the transcript to detail vital characteristics of what type of ESL math teacher I was interviewing, which made it easier to distinguish each participant and his or her responses from all the others.

Personal narratives. In using Saldaña's (2016) axial coding, I was able to break down core themes to elaborate on my experiences through each observation, as well as my expertise in lesson preparation, teaching, and modeling the problem-solving process to ESLs. The axial coding helped me further to explain my experiences to discover ideas through metaphors and concepts that linked my experiences to those of the participants (Saldaña, 2016).

Member checking. After member checking sessions, I confirmed and analyzed coding responses that were aligned with the coding bank for all participants. I was able to see further the commonalities among participants and codes. I was able to form 20 collapsed codes and an explanation for the four emerging themes. Figure 3 shows the initial codes, collapsed codes, and the four themes.

Initial Codes (110 Codes)

******Are applied to Codes that were created from the analysis from the second round of the three data collections******

Fresh to the Country, Knowledge of English, Length of Time in Country, Beginner Students, Intermediate Students, Advanced High Students, Age ***, Target the Minority in the Majority, Find ways to Embrace All, Embrace all Culture, Coming from ICE Camps, Cultural Responsiveness, Culture Shock, Awareness of Socioeconomic Status, Merging Culture and Math, Assumptions Lead to Error, Learning may be Different, Different Levels to Lay the Foundation, Pacing for Deeper Comprehension, Slow it Down, Talk Instructions Slower, Tackle all Senses for the Students in Learning, Learning at Different Rates, Lesson Preparation, Building Background, Comprehensible Input, Strategies, Interaction, Practice/Application, Lesson Delivery, Review & Assessment, Break it Down, Line by Line, Dictionary in Reach, Understand Main Idea, Discover Unfamiliar Words, Understanding Transferable Words, Merge the Plan, Action, and Math Standards, Word Wall, Anchor Charts, Hand Gestures, Thinking Maps, "I do, We do, You Do," Change Seating for New Discovery and learning opportunities, Usage of Mathematical Verbiage, Build Trustworthiness, Discourse Helps with Exposure, Pair with English Comprehension Levels, Pair with Math Comprehension Levels, Pair for Peer Instruction, Pair for Self-Discovery, Moments to Use English Dialect, How did you get Answer?, Not Cheat to Repeat, Converse to Immerse, Read It, Speak It, Do It, Discussion Post (Technology), Annotating to Discover Main Idea, Underling/ Highlighting, Foreshadowing on How to Solve, Applying Science in Measurements, Applying History on Math Standards, Use Multiple Strategies, Apply Same Routine when Problem-Solving, Moments for Connection, Real- World Refer. (Students to Recall), Drills in Various Deliveries/ Methods, Student Accountability Formative Assessments, Informal Assessments, Teachers must be Aware in how Students, Comprehend "Starting Mindset, "Taking the Floaties Off", Allowing Students to Solve on Own, Discover Students' Foundation, Problem Based Learning Instruction, Specific Words-Native Language to English Dictionary Questionable, Real World What if Problem- Solving, Error Analysis, Read to Comprehend, Do not just look for Numbers, Understand to Distinguish and Decipher, Same Instructions as On-Level, Modifications, Goal Setting Classroom Culture, Same purpose with Differentiated Goals*** Freedom to go In-Depth***, Students to tack Accountability in Learning, Students to Create or Teach Problem-Solving Small Wins, Positive Reinforcement, "Have the big speech on overall goal," Politeness, Empathy, Reassurance, Teachers Motivating Themselves, During Frustration, Students Sense Frustration, Respectable Learning Environment, Problem-Solving in Math through Trust, Openness to Help Each Other, Accountability, Trust, Openness to Learn, Willing to Listen, Moments of Frustration***, Growing through Frustration, Empower Students to Succeed

↓

Initial Codes to Collapsed Codes (20 Collapsed Codes created from 110 Codes)

Awareness of Placement Level, Cross-Curricular Input in Instruction, Do Not Assume Students are Aware, Long Term Memory rather Short Term Results, Communication Delivery rather Product, Relationships Teacher to Student Relationships, Word Association, Visuals, Heterogeneous Grouping, Comprehension, Educational Struggle, Self-Discovery, Literacy, Equity for All Students, Motivational Input, Student to Student, Creativity, Pacing, Multicultural Perspective, SIOP Model

↓

4 Themes Emerged from the Collapsed Codes:

1. Demographic awareness
2. Math discourse and learning strategies
3. Connectivity through educational struggle
4. Motivational input

Figure 3. Initial codes, collapsed codes, and themes.

Coding method overview. Once the first set of interviews, personal narratives, and member checking had been completed, I began the coding process and discovered commonalities. I was able to formulate second-interview questions based on the gathered data, conduct personal narratives, and conduct another round of member checks. I also performed another round of coding for all three sets of data. Using Saldaña's (2016) initial and axial coding process, I color-coded and creating 110 codes based on the gathered data. I collapsed these codes into 20 collapsed codes from which four themes emerged.

Summary of Findings

The findings revealed that the participants understood that an effective ESL math teacher must encompass attributes of being culturally and demographically aware of the ESL students to whom they were catering, providing multiple learning strategies for all types of learners such as pacing, mathematical discourse, academic struggle, formative assessments, and motivational input, while being a caring, committed, competent, and culturally responsive individual. With this ambiance, the problem-solving structure is applied to create a successful and meaningful classroom culture. The participants taught at various middle school campuses within the same district and were well-aware that these characteristics were vital for an ESL student's learning experience when problem-solving in the hope that the same cultivated mindset would be applied again as rigor increased with the transition to higher mathematical courses. The participants were aware that this demographic was engaged in translating and processing verbal instructions, mathematical language, and mathematical computation all in one setting. Overall, four themes emerged from the research question regarding ESL math teachers' skill and input: demographics awareness, mathematical discourse (communication) and multiple learning strategies, educational struggle, and motivational input.

Presentation of Findings

This section contains the results of the analysis. I used Hatch's (2002) inductive analysis model and Saldaña's (2016) initial and axial coding models to analyze the initial interviews, second interviews, personal narratives, and member checking. Four themes emerged from the gathered data: (a) demographic awareness, (b) math discourse and learning strategies, (c) educational struggle, and (d) motivational input. Theme 1, demographic awareness, emerged from the collapsed codes awareness of placement levels, multicultural perspective, and do not assume students are aware. Theme 2, math discourse and learning strategies, emerged from the collapsed codes pacing, SIOP model, word association, visuals, cross-curricular input in instruction, and long-term memory rather than short-term results. Theme 3, educational struggle, emerged from the collapsed codes comprehension, educational struggle, and self-discovery. Theme 4, motivational input, emerged from the collapsed codes equity for all students, motivational input, student-to-student relationships, student-to-teacher relationships. Certain collapsed codes were applied to multiple themes such as heterogeneous grouping (applied to all four themes), literacy (applied to all four themes), creativity (applied to Themes 3 and 4), and communication rather than product (applied to Themes 2 and 3). Details of codes are presented in Table 2, which displays the collapsed codes and the initial codes that supported them. Table 3 showcases the themes and the collapsed codes that supported them.

Table 2

Initial Codes Supporting the Collapsed Codes

Initial Codes	Collapsed Codes
Fresh to the country, knowledge of English, length of time in country, beginner students, intermediate students, advanced high students, age	Awareness of placement level
Target the minority in the majority, find ways to embrace all, embrace all cultures, coming from ice camps, cultural responsiveness, culture shock, awareness of students' socioeconomic status, merging culture and math	Multicultural perspective
Assumptions lead to error, learning may be different, different levels to lay the foundation	Do not assume students are aware
Pacing for deeper comprehension, slow it down, talk instructions slower, tackle all senses of the students in learning, learning at different rates	Pacing
Lesson preparation, building background, comprehensible input, strategies, interaction, practice/application, lesson delivery, review & assessment	SIOP model
Break it down, line by line, dictionary in reach, understand main idea, discover unfamiliar words, understanding transferable words	Word association
Merge the plan, action and math standards, word wall, anchor charts, hand gestures, thinking maps, "I do, We do, You Do"	Visuals
Change seating for new discovery and learning opportunities, usage of mathematical verbiage, build trustworthiness, discourse helps with exposure, pair with English comprehension levels, pair with math comprehension levels, pair for peer instruction, pair for self-discovery, moments to use English dialect	Heterogeneous grouping
How did you get answer? Not cheat to repeat; converse to immerse; read it, speak it, do it; discussion post (technology)	Communication rather than product
Annotating to discover main idea, underlining/highlighting, foreshadowing on how to solve, applying science in measurements, applying history on math standards	Cross-curricular input in instruction
Use multiple strategies, apply same routine when problem-solving, moments for connection, real-world references for students to recall, drills in various deliveries/methods, student accountability	Long-term memory rather than short-term results
Formal and informal assessments, teachers must be aware in how students, comprehend "starting mindset"	Comprehension

(continued)

Initial Codes	Collapsed Codes
"Taking the floaties off", allowing students to solve on their own, challenge first to discover students' foundation	Educational struggle
Problem-based learning instruction, specific words of native language to English dictionary questionable, real-world what-if problem-solving, error analysis	Self-discovery
Read to comprehend, do not just look for numbers, understand to distinguish and decipher	Literacy
Same instructions as on-level, modifications, goal-setting classroom culture, same purpose with differentiated goals	Equity for all students
Freedom to go in-depth, students to tack accountability in learning, students to create or teach problem-solving	Creativity
Small wins, positive reinforcement, "Have the big speech on overall goal," politeness, empathy, reassurance, teachers motivating themselves during frustration, students sense frustration	Motivational input
Respectful learning environment, problem-solving in math through trust, openness to help each other, accountability	Student-to-student relationships
Trust, openness to learn, willing to listen, moments of frustration, growing through frustration, empower students to succeed	Teacher-to-student relationships
Total initial codes: 110	Total collapsed codes: 20

Table 3

Collapsed Codes That Supported the Themes

Theme 1: Demographic Awareness	Theme 2: Math Discourse and Learning Strategies	Theme 3: Educational Struggle	Theme 4: Motivational Input
Collapsed Codes That Supported the Themes			
• Awareness of placement level • Multicultural perspective • Do not assume students are aware • Heterogeneous grouping • Literacy	• Pacing • SIOP model • Word association • Visuals • Heterogeneous grouping • Communication delivery rather than product • Cross-curricular input in instruction • Long-term memory rather than short-term results • Literacy	• Heterogeneous grouping • Communication rather than product • Comprehension • Educational struggle • Self-discovery • Literacy • Creativity	• Heterogeneous grouping • Literacy • Equity for all students • Creativity • Motivational input • Student-to-student relationship • Student-to-teacher relationships

Coding Explanation

Going forward in the data collection and the analysis process, patterns emerged, and codes were formulated based on the meaning from data provided by all participants. In total, 110 codes were formulated from the data, which I collapsed to 20 codes, listed and discussed in the following sections.

Code 1: Awareness of placement level. Participants expressed how important it was to be aware of the placement level (Beginner, Intermediate, and Advanced-High) of ESLs in combination with academic levels. This awareness serves as the baseline for participants to know how to maneuver, model, showcase examples, and focus on what real-world examples to apply in the lessons. Lisa explained the process of how ESL students are placed, based on time frame and literacy skills, once they are in the United States:

> They're based on levels, based on their proficiency and how well they can read, write, and speak the English language. So, *beginner* means, it's like a Level 1. So, a beginner could be a kid that just got to the country, beginner newcomer, and he doesn't know a lot of English. An intermediate kid knows more than a beginner kid, but still not enough to be mainstreamed with on-level kids.

The majority of the ESL population, as Zachary expressed, "come just straight from Mexico, straight from Guatemala, all over the place. So, Guatemala, Honduras, Puerto Rico, El Salvador." This makes the majority of the ESL population in the studied district Mexican or of Hispanic background. Paul described other demographics, "Majority have been Hispanic. The next group would probably be, maybe, of African descent, Nigerian, Indian, as well as Asian. But the majority would be Hispanic." Heather explained, "Being the only person in the classroom that speaks English, surrounded by anywhere from 20 to 30 students that speak Vietnamese, Spanish, Ibo, it's like 'what is going on?'"

Participants also discussed how teachers must be aware of the academic and educational norms of the students' home country, prior to their coming into an English-speaking classroom. Melanie expressed,

> I also had two little girls that were Vietnamese. They were together, they were cousins . . . . You could tell that one of them, she knew the math; so, she would work everything out in her way. Then she would use her little translator.

This makes the math universal but the English language limited; yet, awareness of placement levels also means making sure that ESL teachers know the educational patterns prior to the students' coming to the United States. Melanie summarized the issue:

> And then, another thing I was going to mention was, some of these kids that are coming into the country, we don't even know . . . earlier I was talking to someone about a student who in his country only went up to first grade. So, they're coming in like that, and they're in seventh grade now because of their age. They get put into seventh grade because of their age.

Code 2: Multicultural perspective. Participants expressed applying and understanding cultural responsiveness to bestow a multicultural perspective through problem-solving. This seems so when participants utilize and model aspects and characteristics of native countries within lessons to problem solve, that is, food, native language identifiers, nations' flags, sports, and forms of currency. Elizabeth, expressed:

> I try to eat the food. Because I had a lot of Vietnamese kids, I eat vermicelli or the banh mi sandwiches. And then they see me eat that, so they know that I'm open to their culture, so they can feel more comfortable in my class.

Embodying a multicultural perspective helps students of specific demographics who are in the ESL classroom not to feel or fear being superior to the others. This awareness of ESL students' culture fosters engagement; creates personal connections; and lessens culture shock within the problem-solving process, no matter the mathematical standards that are being taught. When keeping a multicultural perspectives active, future ESL math teachers must consistently use personal reflection to know how to maneuver when teaching and keeping an open culture. Lisa noted, [ESL students'] experiences are different too, so it depends on how they got here, what happened when they were on their way here. Were they with a family member, or are they with a family member now? So, it really depends on each child and his or her background.

Within that ESL math classroom, teachers must see to it that students feel safe in this open, multicultural environment as these students are making monumental academic and everyday lifestyle transitions. Melanie explained,

If a kid that has no English or is not even coming from his own country, he shares no background with anyone. They grew up with different things culturally; so, they come into this country already culture shocked. And, then, as for me, I'm just like, "Okay, how can I help them ease that?"

Code 3: Do not assume that students are aware. Participants stated how vital assumptions play into learning through problem-solving. "Sometimes they don't know they're doing the same thing. But they are learning the content. It's not that you're just learning English, because you're not just learning English," stated Lisa, "You're learning math too. You're learning science. And sometimes I think they forget." Heather noted,

But that lack of confidence, can I actually contribute, do I have what it takes, is this person going to judge me, are they going to laugh at my Spanish, or are they going to laugh at the fact that I don't know English, even though they may not know English.

This makes communication a key factor in providing clarity and lowering assumption with the ESL math classroom's culture. Zachary stated,

You are going to have to interact if you want a job, you have to interact with someone else. You have to interact with a boss, you are working with. You go to the gas station to

> get gas. You have to interact with people. You can't just stand there and expect them to know what's what.

Heather elaborated some more,

> So, we got to make sure that everybody knows what I'm talking about because that is going to lead us to our error; we're going to reach a point where, because you never understood in the beginning what I was talking about, you have no idea even what I want you to do. We can't just assume that everybody understands just because we do.

Code 4: Pacing. Participants made it clear that pacing is important because students are translating, comprehending mathematical strategies, and problem-solving all in one setting. Heather stated, "So a lot of comprehensive input requires pacing myself, and also trying to be dramatic. I'd say, when I'm teaching a lesson, I emphasize important words." Blake noted, "With the ESL kids, I really have to break it down to the most basic level for them. You have to build that concrete lesson for them, at least with the ESL kids." Lisa practices this in her lessons, "They may still need the time to say, 'All right, I'm going to slow down now' and I say, 'You go look up whatever word is confusing you. We're going to talk about this some more.'"

All the participants noted that they use the same materials as they would with their on-level, pre-AP, and multiple-ESL-level placement students whom they teach throughout their instructional day. Elizabeth noted, "When I do my lesson plans, they're the same. Okay? I use the same ESL strategies, my style of strategies that I would use in my ESL beginner class, with intermediates, and with my regular population." Lisa proclaimed,

> So, my first few years here, I taught beginner ESL. With those kids, we went a lot slower than with my intermediate kids, because they still needed that foundation. And with my

> intermediate kids, I still had to take it easier than with my advanced, high, or on-level kids, but you can expect them to catch up a lot quicker.

In addition, using the same material but pacing the material variously is beneficial, as Heather reasoned, “Yes, because at the end of the day, they will all be tested on the same thing.” Thus, pacing provides extra time to bridge the English language with mathematical computation. As noted by Elizabeth,

> it takes time. Instead of doing two examples, I might do three. I mean, that's not the stressful part, but that’s the part where I’ve learned that I need to accommodate myself to my students and try to make sure that they’re understanding what I’m teaching . . . my race is not your race.

Code 5: The SIOP model. The participants explained during the interviews that they have been trained in and are applying the Sheltered Instruction Observation Protocol, or the SIOP model. It is significant and important to utilize this model because it targets the aspects of lesson preparation, building background, comprehensible input, strategies, interaction, practice/application, lesson delivery, and review/assessment. This helps the participants and is a major benefit to those who are not bilingual or fluent in other languages, as mentioned by Allen,

> I would say that the first year teaching ESLs was challenging because they do like to talk in their native language. And being that I’m not bilingual, I felt uncomfortable with them speaking in Spanish because I really didn’t know if they were on task, or if they were referring to the actual math content. Throughout my first year and working into my second year, I just encouraged them to use more academic language in the classroom.

When teachers model these strategies for their students, then each student “learns the SIOP model. It carries with them, and in turn, it helps them with other content,” stated Paul.

Heather added, "I took a 3-day training for SIOP where we learned all the domains and all that, received lots of resources, and they really just broke it down on the way to be successful with the students." Melanie explained how

> you get to focus more on the student, you know, rather than just lecture, lecture . . . . No. Like this, the students get to work on their, what do you call it, they can be more involved with their journey rather than just be given all the information.

In addition, the SIOP model helped Zachary's teaching because "one thing is if I'm teaching a concept that can be related and most of the time, 90% of the time, I try to relate the concept to where they come from." Blake provided a personal testimony in support of the SIOP model by emphasizing its importance and also how he benefitted from being once an ESL student himself:

> It helped a lot to see how kids work together and how they learn from engaging in activities. And also having the support of my ESL specialists and my content specialists—all these materials I can now provide to my kids. Besides that, a lot of it came from, I guess, personal experience being an ESL kid once and remembering what my teachers did for me and trying to reapply that to my kids because it helped me out in the classroom.

Code 6: Word association. The participants expressed that word association for ESLs is vital because it gives rise to synonyms and mathematical actions that must be applied in problem-solving to retrieve the correct answer. Zachary stated,

> So, what I did was I put up on the board different words to look for, what they meant, and so they can look for that, and so they end up doing it on their own. And they can also apply that to different things in other areas.

Elizabeth detailed an example,

> And I point out different key words. Okay, ascending means to go up, descending means to go down. So, when you see these right here, these two words, you know what we're talking about. And so basically then, the next question that I give them is something very similar to what they just saw, but it’s just . . . the same two key words, just different names, different numbers, a different situation, so they can understand and distinguish between the two words.

Blake expressed the same sentiment by stating, “I have to go really into depth with vocabulary words with those kids and grab some key words for them and then pretty much repeat and repeat . . .” Participants have expressed that certain students associate math verbiage with tangible objects; deeming what words are transferable. Allen mentioned, “What I found out that the table in math would be *tabular*, whereas the table that you eat on would be *mesa*.”

Melanie said,

> In my class, I feel like the main strategies that I use are, for sure, if they get a big word problem, which more than likely they will, I tell them to cut it up into sentences, first of all. Then, focus on the words that you have been learning or that you should know by now, and try to remember from your notes, or think about what the specific words mean. When you look at those words, you’ll for sure kind of have an understanding of what they’re asking for, or what the question wants you to solve for.

Anissa similarly noted,

> We came up with different words that sound the same but mean different things to help them in math, like table. Table can be an actual table or a table with numbers in it. So, they knew lists of math words that sound the same but have different meanings. Just like with *table*, the word *can* might mean “I can” or a “can of soup.”

In addition to pointing out key words, the method of speaking these examples of word associations provides an ongoing learning experience that furthers a deeper comprehension. Lisa stated,

> Yes. Don't just tell me you multiplied, what did you multiply? And you don't have to walk me through the stuff, because I can see it in your words. So, don't just say, "Hey, I'm multiplying 4.3 times five, and then I had to count the decimal." No, just tell me, "I multiply these two numbers. This is what I got." At least tell me that. Because your work shows it. For eighth grade was the calculator use. "I plugged in the calculator." "No. What did you plug into the calculator? How did you produce that?"

This is vital because "if they see these words in everyday life, they can use that and they can solve the problem on their own," mentioned Melanie.

Code 7: Visuals. The participants stated that they used the teaching strategy of visuals in order to connect the verbal portion of the lesson to the actions needed to perform math. Paul stated, "Other methods are visuals and manipulatives. Sometimes, when I'm going to have a manipulative and point to it or use as a reference, that also helps bridge the gap of what I'm saying." Visuals mentioned were thinking maps, color coding, pictures to real-world scenarios, and vocabulary representation. Zachary stated, "And so for me to reach out, I found out that pictures work. Pictures, visuals, and everything. Because they can relate to visuals, they can relate to pictures." Anissa said, "Yes. Well, I use colors anyways in any teaching, but we did visuals. I would have to draw a lot." Blake added,

> I use a lot of visual representations for them, and a lot of graphs. Vocabs. Something that I see is that they're most likely visual learners, especially when English is not their first language. Once they see that graph, there are certain things that you can do with that

> graph. So, it kind of cuts down on the whole eighth-grade content to particular stuff we might be teaching.

Elizabeth stated, “So something that I did for them to kind of self-discover, even in their math skills. I started doing what’s called fruit math.” This form of visuals represent tangible items that the students see on a daily basis to represent numbers. “But I feel the way that I teach addresses regular students, ESL students, SPED students because I provide those different word walls and anchor charts. That’s going to help them with key words, and that’s going to help all students across the board,” claimed Heather.

Code 8: Heterogeneous grouping. The participants expressed how heterogeneous grouping aids the math discourse in that it provides an opportunity for peer interaction among students who vary in both their English language skills and academic levels. As Melanie mentioned, “what I also like to do is putting kids that are low, kind of lowish, put them with the higher group.” Heterogeneous grouping becomes an outlet for discovery of multiple ways of problem-solving, utilizing the English language, and speaking and applying mathematical verbiage. Blake explained, “Sometimes I put the seventh grade with the lower one because some of those kids learn better from their peers.” Paul professed

> I typically will get us through it, or a few students will. Have that student who’s having trouble with the language, have him immerse himself in a group of at least four or five different people that can reiterate the things that I was saying.

Melanie explained,

> Because they collaborate and they’re able to speak on. Maybe this Johnny had a different way of solving rather than Chris, you know, rather than that. So, they get to share the steps that they’re taking in order to receive their answer,

Anissa agreed with that, “What I got from it was having them do more group work and things in groups so that they would learn from each other.”

“Depending on their scores, I would mix those groups according . . . I would try to get a high in one of those groups,” stated Paul. He explained, “There may be one or two beginners in there, but I also put a couple more students that are more advanced in the group with them because they can relate better.” “Because as teachers, we have to use proximity to hear, actually communicating it correctly,” stated Lisa.

In addition, participants explained how students have the ability to express their individualized thinking to benefit the heterogeneous group’s needs. Heather stated,

> Now, when you are also working by yourself, and you understand, and you are getting it, and you go into a group setting, you have something to share. You have your ideas to share, that the group probably did not come up with, so that's how that can benefit. And if you are working in a group and you go to work by yourself, you take all those ideas, and now you don’t have to go with it, but you see how to think, where to go, and I like that, now I’m going to twist it, put my own spin on it, and bam!

Lastly, participants stated how ESL math teachers must change the heterogeneous groups. “Change the group to change the outlook on math and literacy in the English language,” Lisa explained. Elizabeth stated,

> I’ve tried to regroup them, but it's the same thing. If I regroup him with a lower, not lower, but on level with him, I don't think that they benefit from each other. So, I try to put them into different groups, where they have a diverse learning level.

Code 9: Communication rather than product delivery. ESL math teachers expressed how communication delivery in all aspects promotes a deeper comprehension in the problem-solving process rather than just the production of a product, or answer. Aspects of this code were expressed as: How did you get the answer? Not cheat to repeat, converse to immerse; “read it, speak it, do it;” and technology-based discussion posts. Lisa stated,

> If you’re friends, and they’re talking to you, and they’re explaining it in Spanish, I’m not going to make a big deal by saying, “Hey, they’re still talking about it.” But I’d probably be like, “Hey, come on. Try it in English now. Now that you said it in Spanish, or now that you’ve said in your language, try in English.”

ESL math teachers also emphasized that communication delivery should lower the incidences of cheating among ESLs. Cheating to produce a product should not be the goal, but to further mathematical growth for long-term benefits. “They would just end up copying,” stated Anissa. Lisa testified in stating,

> Although our beautiful students think they are clever, they cheat quite properly. So, since it’s homework, sometimes they come, and the sentences were the same, where the work was on the same side of the paper. It was just obvious. I had seen this before, so I wouldn’t look through their numbers. And, actually, that happened a lot with ESL kids. They copied a lot, because they thought they could, but once they know they can’t, it’s easier. So, at first they're going to try to copy all of those beautiful sentences, and misspelled the same misspelled word. And after that, I did it in the classroom again. “I’m sorry, we're going to do this for a bit longer . . . So, we did it for warm-up. I pulled up the divider, I picked one of the questions, the most copied one, and I gave it to them, and I said, “All right, here you go, problem solve, do it.”

Participants expressed that communication delivery assists in the engagement and the tone of the classroom culture to promote problem-solving. Heather stated, The reassurance that you are okay, and “I can’t force you to do anything. It’s expected, it's hopeful that you would do it, but it's at your own pace, small steps.” I’m not going to plead, “You have got to move, you have got to move!” Be polite about it, be nice about it, and make your class warm and welcoming to the fact that you can try new things, you can work with a new group.

Allen stated,

> I let them know that making a mistake is how we actually learn in math. Even though that is true, they have to see it as well. So, when I make a mistake, instead of me trying to clear it up quickly or just moving past it, I actually put light on my mistakes, and I would allow other students who caught that mistake to share why I did make that mistake. So, it gave those students who were too scared to speak or who are scared to make a mistake, it let them know that it's really okay, that I didn’t even penalize myself.

Code 10: Cross-curricular input in instruction. Participants apply cross-curricular input (English, science, social studies, and electives) and references within their lessons to problem solve. Allen stated,

> I definitely try to incorporate cross-curricular activities within most of my lessons; for instance, the one that I mentioned with the rational numbers. Just bring it, tie in social studies, tie in geography, tie it to the math, and tie it in. The PBL, the problem-based learning, that I mentioned, goes as well for geometry. Those students were able, actually, to use art, and they were able to use math.

Elizabeth noted,

If we talk about a compound, I know that they're going to hear that word in science. So, I automatically bring that up and we talk, we share a little bit about what a compound is in math and science.

Blake further elaborated,

I do cross-curricular to represent some problems to them. So like right now, since we were actually doing our lesson plan with scientific notation, I tried to attach it to science, getting big numbers into the smaller; something they can visualize.

Anissa stated, “We used the Spanish to English dictionary, that was one. A lot of the times, I would ask them to just translate the entire problem into their language; that may help them understand the reading.” Zachary added, “They use annotation in English when they’re doing a paragraph. But you also needed math, and we like to annotate a word problem to decipher the word problem.”

In addition, participants have expressed how they use the cross-curricular input through real-world references. Lisa mentioned,

So, I told them that, without reading, they weren’t going to get anywhere. You cannot do anything without reading. You have to read, to know: Where am I going to get out of the building? Where's the exit? You have to read, to know . . . Where’s the entrance? What are the names of the streets? You have to read every day.

Paul explained further,

Reading and writing are probably my two biggest components because they kind of need each other. And then math, all you're doing is reading. Regardless, I mean if you have straight computation, but for the majority of the math that we do, you read, read, read, and you write, write, write.

Melanie stated,

> And, I feel like if they don't have that, at least during the same time as they're doing their regular content classes, I feel like then our job as math teachers would be even way harder. So, I'm kind of, okay, that really helps out with the math part, because once they start seeing the word problems, or the bigger problems.

Code 11: Long-term memory rather than short-term results. Participants pointed out that variations in strategies and applying multiple real-world references help ESLs toward long-term rather than short-term data gains. Paul stated,

> Well, I think that that's the common ground that we all have. When we all have some of the same experiences, or when I'm able to dive into a situation that they really have gone through or they see every day, it gets their attention, and so it makes the problem real. It makes the connection real.

Heather added, "Bringing it to life, you gain a better understanding of it, and if you can understand something, the challenge will be to try to bring it out in writing, in verbalizing it, but it will make it easier." Allen summarized it by using the example of the mathematical topic of sets and subset,

> Yes, it definitely can help, especially if you provide an anchor chart for both. So, if you show examples of yourself being where you live in comparison to the city, the state, and the country, and then maybe have that side by side with actual sets and subsets of numbers, that will remind them that this is how we actually live. I feel that it is a good mnemonic device.

Lisa commented, "So, if they can visualize it, they can tie a topic to it," and Blake noted, "Because it also reinforces their reading level. Guess what? You're reading problems. And since you're reading, you're able to connect stuff. You might be able to actually see the same stuff in a different classroom."

Code 12: Comprehension. Participants detailed ongoing comprehension when applying the problem-solving process, whether in its formal or informal assessments. ESLs noted that the objective is that both representations give them informative feedback on how to maneuver in lessons in the future or how to alter the problem-solving process. This can be through exit tickets, think pair share, miniquizzes, error analysis, and mathematical debating. Paul noted,

> And just keep praising them and telling them, "Great job!" and keep working hard and making sure that I am doing small exit tickets or smaller assessments for them to be able to see also the work that they're putting in.

This can be the delivery of creating spots in the lessons for quick checks, as mentioned by Elizabeth, who stated,

> I love to use whiteboards in my classroom. I've noticed that the kids love to use whiteboards, too, especially since they've never seen a whiteboard or an Expo marker before. But a lot of that, it helps me because it's a quick check.

Participants detailed how communicative aspects assist them in knowing that the students fully comprehend something. Lisa explained,

> They grumble, "But why do I have to write the four sentences?" "If you can explain it, you've got it in the bag. It's just like, if you can teach your table mate, I know that you've got it. That's the teaching piece."

Heather agreed, "You gain a better understanding of it. And, if you can understand something, the challenge will be to try to bring it out in writing, in verbalizing it, but it will make it easier."

Further, ESL math teachers described the technological applications that their district provided, which were used to assess comprehension and see the growth of ESL students throughout the year. Paul stated,

> I-Ready is a program that we use. It's really good, especially for the ESLs' learning because it gives them three major assessments. It gives them a preassessment early in the school year to kind of see where they start off. Then, it gives them a midassessment, around Christmas time, Thanksgiving time, to kind of see where their middle level is, and we exit them out at the end of the school year. We'll see what their final growth was. Did it raise or stay the same or get lower?

Paul further supplied,

> One in particular that I love is using Plickers. Plickers is a program that I use where they all have their own barcode, and I will put a problem up on the projector or on my phone, or I might send a problem to their phone or their tablet and it, for whatever reason, it gives them an access to feeling like they're really learning. They're really being empowered by their own learning because they're able to walk around the room with their devices and share and take pictures and so on and so forth. So, we do a lot of Plickers, like I said, which is their own bar code. So, it's individualized for them. We do a lot of Schoology here, where I'm able to see real-time access, real-time answers to a problem.

Lastly, within the problem-solving process, English content strategies of annotating and emphasizing word associations helps students comprehend what is asked of them to solve in a word problems. Blake contributed the following:

> Like you said, find the main idea. Especially, since math is a lot of word problems. One of the things is for them to underline key words and even circle the words that they don't know, for them to look up. Because in my experience with the ESL kids, they might be able to read it to you, but they probably don't comprehend anything they're reading. So, like I tell my kids, go through it, read it twice, underline, circle key words that you might need some help with, or try to get the main idea of what the question is asking you for.

Code 13: Educational struggle. Participants noted that it is perfectly natural and supportive to let the students struggle in the midst of problem-solving. "I've also noticed that those kids who don't understand any English, they also struggle in math," said Elizabeth. In agreement, Allen added, "What I feel that certain students struggle with, certain ESL students struggle with, is the reading content because they don't know certain academic language, just as our regular students don't know it." Zachary took *educational struggle* to a math foundational level by stating, "So, I try to tie it in with the math, and I can say that, if someone's struggling with addition, they have some of that struggle with addition, subtraction, and everything else." "Break it down," noted Zachary, "in the sense of, I need to grasp the deeper meaning. Yes, it's a math problem, but I have to read it and comprehend it. And that is the struggle with math for ESLs."

Paul expounded on his rationale why educational struggle assists the problem-solving process,

> I think struggle is good; you kind of have the fortitude to of finish it. So, my rigor would lead more toward taking some of the floaties off, taking some of the support I had given away from them. Even though the support's right there, they could see it, they could touch it; if they need it, they can go to it, but try to be more individualized and see if you

> can break down some of these problems by yourself. And if you can't, tell me what's the problem that you're having. Not that I can't figure it out, but *tell me* what the hurdle is.

Lisa began by stating, "It depends on the kid, because with a lot of the kids it was either you were here to learn, or you were going to struggle with the language because you were still attached to your native language." She further noted, "I gradually stopped speaking Spanish too, because most of my kids were Hispanic, so they spoke Spanish. I did have kids who didn't speak Spanish. So, especially the classes that didn't speak Spanish, I let go a lot sooner."

Code 14: Self-discovery. Participants explained that self-discovery allows students to become more accountable in their learning in order to relate and become further engaged in the problem-solving process. Allen stated,

> Problem-based learning. I did started that in my second year of teaching here. Problem-based learning is basically having those kids discover a certain skill through discovery, through trial and error, through collaboration. That was one way that I really got a hold of all of my students in the classroom, because they enjoyed it. They enjoy the problem. They enjoy actually figuring out a way to get to the solution. That was pretty much what I used.

The delivery can be displayed through independent or communicative opportunities. Lisa stated, "The kid that solved it one way, got the answer. Then, I've got another kid that solved it differently and still got the same answer." Supporting Lisa, Melanie stated,

> I feel like once you connect things like why they work and show them visually or with hands-on stuff, they're able to be like, "whoa, okay." So, all this work basically is the distance around the specific thing. And, then, having something to touch and see helps them out a lot.

Participants also attested that teaching ESL students allowed them to have a baseline on what the student knows, be it in mathematics, English vocabulary, or real-world comparisons, allowing the teachers to initiate further discoveries. Zachary stated,

> So, one thing is if I'm teaching a concept that can be related and most of the time, 90% of the time, I try to relate the concept to where they come from and everything else. So, say I'm trying to teach going back to financial literacy. I'll put up a dollar sign, and I say, "Hey, tell me what you know about this." Actually, last year I did, I held up a dollar and I said, "Hey, tell me about this." Well, I have somebody to translate to tell them about this. Someone people said *dinero*, some people said *money*, and then some people said you got to go make that. Just different approaches.

Code 15: Literacy. Participants emphasized how literacy grows, and mastery plays a big role in problem-solving and fully comprehending the standards of math. "You really are teaching literacy skills to everybody, but it's intensified with beginners and intermediates," stated Lisa. Elizabeth added, "The isolation, it heightens their literacy, because obviously they get to work by themselves, and they have to think for themselves in order to solve a problem." With regard to literacy, pacing and word associations must be emphasized. Zachary explained,

> So, that's where I spend time, and I usually, even daily, spend time on one phrase, converting it from Spanish to English, or I say, "That's what this is in Spanish, and that's what this is in English." I try to teach them a word a day, so they know, they're learning English while they're learning math. Because sometimes teachers don't take that time, they just say to themselves, "Oh, they don't understand." And here it is: To me, math and reading are very important. So, teaching them words is very valuable.

In agreement, Heather stated,

> Let's look for the words that you have seen before, that I have shown you before, that look familiar, or that will assist you, and let's break down those words. What does that word mean to you? And we just work from there. I'd say: We just had a discussion on what we can do to help you understand this problem: What don't you understand?

Other participants expressed how the language barrier or the knowledge that the teacher speaks their native language can often be a downfall. Anissa stated,

> Very much so. Now I don't know if they did that on purpose because they know I speak Spanish. So, they pretended maybe that they're totally dazed and confused when they really aren't. Or maybe they actually were that dazed and confused. Sometimes, it really seemed that they were, and so it led to me speaking way too much Spanish, way more than they should have had that year.

The role that English literacy plays in the students' lives is that it will make ESLs innately bilingual. Paul mentioned,

> By them finally achieving mastery in whatever it may be, math or reading or writing. I think it builds confidence in a student because he or she essentially knows that it makes them bilingual. It essentially makes them a student who can now and forever after help other students as well who have language barriers because they were once the student who had those problems.

Code 16: Equity for all students. Participants expressed the best quality of their problem-solving process as being fair to their ESL demographic in providing the same instruction as for on-level students with modifications, goal setting for classroom culture, and same purpose with differentiated goals. "Once again, on level fields, I have more freedom to go a little bit into depth with harder, probing questions," said Blake, "With the ESL kids, I really have to break it down to the most basic level. You have to build that concrete lesson for them, at least with the ESL kids." Allen concurred, "Yes. I give them pretty much the same work. If I need to modify, I will. Last year, I did have the translator dictionary. I only had maybe one student that would actually use it."

The ESL teachers stated that there must be a balance in aiming at academic and English competency levels. Heather noted,

> Yes, because at the end of the day, they will all be tested on the same thing. I don't know if this is off topic, but what I do not really like about the ESL program is that, high or low, they are all going to be in beginners because they are new to the country; they don't speak English. I have some really bright students, but because they couldn't speak English, they were in a class with other people who didn't speak English, who were really of low competency. So, this balance is way off.

Lisa added,

> I did integrate them, and it was nice. I got to see it was all right. The problem was that they were able to see that it was the same work, but they could do it a lot quicker, and especially do more problems. There was a problem with that, but they were also able to say, "Hey, it's the same work. I can do this." So, you get that double effect.

Code 17: Creativity. Participants agreed on how creativity was a factor in the problem-solving process. To keep ongoing engagement alive in the students, one had to tap into their own interests. Allen explained,

> I didn't restrict my students when it came to problem-based learning. If they needed to move around, or if they needed to use more color, they were able to do that. Those artists

> that you may have in a classroom, it brought them out; it actually brought out all kinds of skills in these students.

Elizabeth expressed how it can foster accountability and independence as well by stating, “I have seen that they’re not so clingy, which is as I want them to be. I mean, because I want them to be independent.” Zachary mentioned how it transpires to real-world math problem-solving projects,

> Some positives that I really feel that some of the ESL students have is a starting mindset of how to start a business because I had given them a project where they had to create a business, where they could sell a product. What they had to do was to research their product. They had to research how to get their product, how to make that product, how to make money, how to rent a building, how to rent a . . . whatever, a cart or a section in a mall or anything.

In agreeance, Heather stated,

> We're not actually at a bank or a store, but we can replicate it in the classroom where they can get the hang of it, and get all the aspects of learning, the physical, the touching, the scene, the breathing it, and bringing it to life.

“You’ve seen perimeter before, all we're doing is just having those building blocks put together to create something new,” stated Blake.

Other ESL math teachers utilize math discourse as means for creativity to flourish. Lisa stated,

> So, I use that for creativity. I’m like okay, I teach a certain way, I taught it this way, that’s how they did it. He found a different way to do it. Did it work? Yes or no? Yes. Let’s try with a different problem. Did it work again? Yup. It worked again. If it works

> three times, it works. Is what I told them. So, I allow them to see, all right, there's not just a single way here. There are different ways to think about this. There are different ways to attack this problem, and if I don't get it this way, hey, I may get there by a different way. So, some kids were eager to say, "Hey, can I do like this?" "Yup. You can do it like that. It works."

Paul stated, "Now, this creates a dialogue that one of us is wrong and one of us is right. So, let's talk, so we can figure this thing out. Where did I go wrong? Where did . . . let's figure this thing out collectively. And I think that's what helps because now I've just failed the . . . "Oh, I made a mistake here. Oh, I understand that."

Code 18: Motivational input. In alignment with mathematical content, mathematical discourse, and problem-solving, motivational input was considered of great importance by all participants. ESL students are aware that they are learning the same content as others, but that accommodations are being made to allow them to learn differently from other students at the school. Paul began by describing his insights regarding motivational input by stating,

> I know, with a lot of students, it's because we have those barriers, at times it can shut down some of their confidence, and they might not be as ready to answer a question. They might know it, but they might not be able to read or understand it properly.

You do get some students who say, "Hey, I'm not. I don't want to do it. I don't want to do this." But you just have to keep them motivated, like, "Hey, you need to do this," noted Zachary. Lisa expressed, "They think they're dumb because they don't get things as fast as other kids do." This knowledge allowed participants to use positive reinforcement, incentives, and celebration of the positive strides in reaching success. Allen mentioned, "I really had to provide incentives for the students because it was lack of motivation." Paul stated in agreement, "I would often recall some of the successes that an individual has had, and I would work with that. I would build upon the small successes."

In addition, participants expressed how students are motivated to work independently, but need that extra push when going into group work or collaboration. Melanie stated, "Motivation to do group work—some want to work independently because the students consider group-based activities reserved for cultural aspects." This can increase apprehension. This is when all participants focused on "their big speech." Blake stated, "But, then, I try to convince them with, 'Well, when you work with so and so, you can either solve the problem more quickly or you can help each other out, if you need help, or she needs help.'" Heather mentioned focusing on the small wins,

> They might be apprehensive, and once they are in the group, they may not say much. They may not talk, but like I say: small wins! The fact that you went over there with the new group, small wins. The next day maybe I can get you to say a word or two, or just write down your thoughts, but you have to work with other people.

Code 19: Student-to-student relationships. Participants shared the importance of student-to-student relationships and how it builds trust and willingness to collaborate in the problem-solving process. Allen stated, "I always encourage students to praise one another, and I let students know that it's okay if they make a mistake. I think another great way is when I make a mistake." Lisa stated, "Yes. I think it's beneficial to expose them to other kids that are going to push them to learn the language because they learn from each other." Heather added how she comments to students,

> I'm sure you are probably dying for some kind of communication with someone else. So, you can go over there and gain assistance. Now, when you are also working by yourself

and you understand, and you are getting it, and you go into a group setting, you have something to share,

Zachary added, "Just because the group helps, they may look at me like, 'What's he saying?' But you put them in the group, they learn how that problem-solving aspect works, and that's when you can go to a different level."

Code 20: Student-to-teacher relationships. Participants expressed how student-to-teacher relationships establish honesty, support, and trustworthiness to elaborate on problematic areas for the students to problem solve. In addition, these relationships help students to get engaged in the learning process. As Paul had previously stated, "And if you can't do it, tell me what's the problem that you're having. Not that I can't figure it out. Tell me what's the hurdle?" ESL math teachers are including themselves to make it a collective effort rather than a singular one. "So, when I first try to get to know them, I speak Spanish to them. Just to kind of get a feel. So, they can also feel comfortable with me, that I'm here for them, you know?" said Elizabeth. Heather stated. "It's just, once they trust you, they buy into what you are doing; they see that you are actually trying to help. Then they don't have a problem." Anissa expressed signs of frustration with that:

> I had a very hard time making connections with the students and teaching. Since Spanish is my native language, speaking only English to them was very difficult. Seeing them not understanding what I was saying and me being able to translate it for them. So, it just created a lot of instances for me translating, and they didn't learn as much English as I think they should have that year.

Zachary stated, “That one is just a . . . It doesn’t happen the first day. Yeah, you have to just learn who the student is.”

Initial Codes, Collapsed Codes, and Emergent Themes

I implemented internal validity to establish the credibility that the research reflects the study and results are purposefully supported by data (Shenton, 2004). The strategies that I used for validity and credibility (congruence with findings) are: (a) familiarity with the culture of each middle school within the district; (b) triangulation through the instrumentation, analyzing data from the experiences of each participant, member checking interviews, and personal narratives; (c) face-to-face interviews at private sites to ensure honesty; and (d) debriefing participants to recognize my own biases and preferences; and current literature to support the study (Shenton, 2004). The outcome of the study can be expected to apply to other settings or situations (Shenton, 2004). I aimed to produce truly transferable results from ESL teachers’ experiences with problem-solving with ESL learners in mind and did not disregard the importance of context, which is a key factor in qualitative research (Shenton, 2004). I continued to describe the study plan, expound on operational details of data gathering, and evaluate the effectiveness of the process of inquiry undertaken in detail to enable a future researcher to replicate the work (Shenton, 2004).

The initial codes are shown in Appendix H. The second column shows collapsed codes that are aligned by commonalities, which are listed in the first column of initial codes. The emergent themes are aligned, based on the collapsed codes, in the third column. Four emergent themes were revealed to answer the research question: What are the experiences of ESL math teachers who are embedding the problem-solving structure in the middle school bracket?

Summary

Certain areas were emphasized and detailed more elaborately by the participants, but the four themes of problem-solving with middle school ESL students and teachers in mind were relevant to all: (a) demographic awareness, (b) mathematical discourse and multiple learning strategies, (c) educational struggle, and (d) motivational input in the midst of problem-solving. The findings revealed that participants are trained through SIOP to apply multiple learning strategies and implementing differentiated learning opportunities for ESLs to problem solve. Participants suggested to keep an open and culturally responsive classroom to foster engagement, communication, and learning on a continuous pace. To conduct lessons with problem-solving embedded, it was deemed necessary by the participants to engage all the senses: reading problems to comprehend, hearing others when collaborating, and speaking aloud their own perceptions of solving for further clarity.

Chapter 5 details a summary of the results. It contains a discussion of the results and an examination of the results in relation to the existing literature. I also discuss the limitations of the study, implication of the results for practice, policy, and theory, and recommendations for further study.

Chapter 5: Discussion and Conclusion

The purpose of this qualitative case study was to gain an understanding of the experiences of ESL math teachers regarding math problem-solving throughout the middle school bracket. The case study examined, through the experiences of ESL math teachers, the benefits of ESLs problem-solving through math to increase connectivity in literacy skills, mastering math readiness standards through collaborative instruction, growing the ability to apply learned behavior as rigor increases, and applying problem-solving with cross-curricular instruction. The purpose of Chapter 5 is to present the discussion, conclusions, and implications for practical application and further study. I showcased the findings, as they are aligned with the literature review and social constructivism discussed in Chapter 2. Chapter 5 concludes with recommendations based on practice, policy, and anticipated future needs.

Summary of Results

The research question guiding this study asked: What are the experiences of ESL math teachers who are embedding the problem-solving structure in the middle school bracket? The question was posed to inquire about the experiences of middle school ESL math teachers utilizing the problem-solving process within their lessons to provide deeper, richer, and more meaningful lessons, rather than the repetitiveness of solving problems with simple algorithms. Face-to-face initial and second interviews, member checks, and my personal narratives provided detailed information from the sample of middle school ESL math teachers.

The results from the participants indicated four vital areas when embedding the problem-solving process within the classroom culture: (a) demographic awareness, (b) utilizing mathematical discourse and multiple learning strategies, (c) use of educational struggle, and (d) motivational input. The participants' point of view indicated that the problem-solving structure allowed the learning environment to maintain engagement in the midst of continuous growth for English mastery. Participants were aware that the language barrier or the students' taking comfort in using their native language can be a struggle, but focusing on the small strides that the students were making did support their problem-solving goals in mathematics.

The results also indicated that the participants must be knowledgeable regarding their students' length of time within the country and their academic levels to seat them properly because it will assist mathematical comprehension and discourse. Participants utilized these methods based on the Sheltered Instruction Observation Protocol (SIOP) trainings provided by the district. This training provides an avenue for various levels of students to use the English language with mathematical vocabulary, peer instruction, and literacy skills. Several participants embedded the problem-solving process to discover ESLs' starting mindset to provide lessons that encompassed relatable real-world references for students to talk, write, and apply mathematics to something that was personally meaningful. Participants indicated that this was beneficial because achieving this goal fostered the use of cross-curricular methods for the students to employ in all content areas.

Discussion of Results

Answering the Research Question

The research question asked: What are the experiences of ESL math teachers who are embedding the problem-solving structure in the middle school bracket? The participants voiced that being aware of whom one is teaching directs the problem-solving process within the mathematics classroom. All participants indicated strategies and methods to use for multiple learners, creating a differentiated learning environment. The participants stated that the use of visuals (anchor charts, color coding, and word walls) for the visual learner, math discourse for the auditory learner, and problem-based learning (PBL) projects for the kinesthetic learner, as well as innate creativity, were most useful.

The participants noted that literacy, the ability to read and write, is showcased in how they teach problems in alignment with day-to-day tasks. Be it that students attempt to use their native language with multiple opportunities, the educational struggle pushes the connectivity of what is currently known into what they are trying to learn. Participants expressed that problem-solving in all delivers (reading, writing, speaking, and listening) allowed ESL students to be immersed not only in mathematics, but also in various deliveries using the English language.

The participants described their experiences based on their style of teaching and problem-solving. Despite their personal teaching styles, the participants' experiences showed the commonality of being committed, culturally responsive, competent, and caring toward the demographic and type of student they were teaching. This attitude creates a classroom culture that builds stronger teacher-to-student and student-to-student relationships because there is trust and the willingness to learn despite the feelings of "culture shock," lack of motivation, and the fear of being wrong when trying. The participants were not focusing on short-term academic achievement, but on modeling and implementing problem-solving strategies for long-term benefits that ESL students can apply in future math classes and later in life.

Results in Relation to the Literature

Problem-solving bridges the gap in academic success and math comprehension for ESL learners; stretching their mathematical mindsets into more advanced mathematics, exploring whether real-world experiences, the math curriculum, and cross-curricular standards intersect (Appleton et al., 2017; Beal & Galan, 2015; Mwei, 2017; Scherer & Beckmann, 2014).

Participants were aware in their lessons and classroom culture that ESLs will reach mastery when they become proficient in the following four domains: labeling the main idea of the problem, devising a plan to solve the problem, implementing the selected method to answer the question, and reflecting on the question to see if it could potentially have been solved in a different way (Hinnant-Crawford et al., 2016; Mwei, 2017; Orosco, 2013, 2014). Participants expressed that this proficiency must be mastered in all mathematical representations: verbal, numerical, visual, and kinesthetic renditions.

In improving metacognitive skills in ESLs, researchers have provided training sessions for teachers to apply various methods to assist ESLs when extracting relevant information, when they are unaware that an answer is incorrect because they do not understand the mathematical process, or when they need encouragement through motivational instruction. The district provides the SIOP model to assist lesson delivery to touch all areas for the ESL learner to be successful. Literature has focused on other training sessions as well, offered through the PACE method, conceptual models, coaching and mentoring, annotating, developmental patterns, reference numbers, mathematical dialogue, and the IMPROVE method (Aisha et al., 2017; Bishara, 2016; Burt & Stringer, 2018; Cave et al., 2018; Ganor-Stern, 2016; Hansen-Thomas & Grosso Richins, 2015; Hojnoski et al., 2014). However, knowing what the participants in the district have been trained on, they were active participants to express their experience with models and methods used for the ESL learner.

Demographic Awareness

Participants were aware that they had to be knowledgeable about the demographics of ESL students whom they were teaching to properly apply problem-solving in their lessons, that is, length of time in the country, academic levels, and cultural responsiveness. This aligns with the problem-solving process because the participants were observed to guide, support, and shape actions of the novice ESL student (Cardimona, 2018; Cave et al., 2018; Hinnant-Crawford et al., 2016). This awareness helped participants' reasoning about student performance on specific problem-solving tasks and their ability to link instruction to their home and community experiences (Turkan & de Jong, 2018). Exploring demographic awareness extended the participants' understanding of how to teach numerical processes taking place in everyday life and propose ways to improve such important skills (Ganor-Stern, 2016; Orosco, 2014); Thai et al., 2014). Participants were also aware that ESLs must be shown how to use what they already know because it enables them to move to different levels of math (i.e., more challenging tasks), and it enhances the transfer of classroom terminology to everyday practice (Burt & Stringer, 2018).

In addition, participants expressed that their awareness of academic levels and background was applied as a baseline in approaching the problem-solving process as it is applied to all Readiness TEKS math standards. Problem-solving skills require nonverbal intelligence, executive functioning, and task persistence (Aisha et al., 2017; Jogi & Kikas, 2016). Participants must analyze previous problem-solving skills, linguistic ability, and the cultural background of education, age, and executive functioning. Evaluations guided participants in deciphering the highest level of potential development and solving through observation, student feedback, and physical work provided by the ESL student (Orosco, 2014; Thai et al., 2014).

Math Discourse and Learning Strategies

Effective problem-solving within the math classroom for ESLs must be modeled, taught, and explained through all representation to accomplish long-term benefits. Participants detailed the use of math discourse, visuals, word association, manipulatives, and pacing. When participants continuously applied multiple problem-solving strategies, ESLs underwent the consistent use of rehearsal, maintenance, processing, updating, and manipulation of internally held information for math, reading, linguistic input, and intelligence (Friedman et al., 2018; Fung & Swanson, 2017; Lee, 2016; Wu et al., 2017). Recent literature supported each participants' use of math discourse and learning strategies because they assist ESLs with their English language proficiency to mold a common language and a way of thinking, talking, and writing about their math processes (Coppens, 2018; Kingsdorf & Krawec, 2016; Newkirk-Turner & Johnson, 2018; Rice et al., 2013; Sherman & Gabriel, 2017; Swanson et al., 2014; Taylor, 2018; Thompson, 2017).

Math discourse and multiple problem-solving strategies will assist ESLs in labeling the main idea of the problem and devising a plan in the problem-solving process (Hinnant-Crawford et al., 2016; Mwei, 2017; Orosco, 2013, 2014). Eventually, participants' saw the patterns of each student's strengths and weaknesses regarding problem-solving in real time. In addition, participants' applied moments for communication (in the English language) and various methods of problem-solving to enhance the efforts for ESLs to increase mathematical ability to explain their thinking. They can work within a common language and through a mathematical way of thinking, talking, and writing (Aisha et al., 2017; Beal & Galan, 2015; Brown et al., 2016; Burt & Stringer, 2018; Cafarella, 2014; Sherman & Gabriel, 2017; Taylor, 2018).

Connectivity Through Educational Struggle

Participants were aware that educational struggle in the ESL population can be an experience of growth rather than a mindset for "spoon feeding" or "pass or fail." Participants expressed that they have experienced ESLs' educational struggles in the areas of heterogeneous grouping, communication delivery rather than product delivery, comprehension, self-discovery, literacy, and creativity. Within these aspects, the problem-solving process is heightened by failures, errors, and analysis to generate or discover the correct solutions on their own and for the teacher to capture and define error types observed in students' work (Brown et al., 2016; Burt & Stringer, 2018; Kapur, 2014). These moments of struggle will now become the result of prior knowledge activation for ESL students. Students can differentiate between thinking that compares student-generated solutions and thinking about correct solutions, marking the constructive nature of learning, interpretation, activity, and evaluation (Kantar, 2014; Kapur, 2014).

The literature suggested that educational struggle for the ESL population can result from evaluation or interaction (Brown et al., 2016; Burt & Stringer, 2018; Kapur, 2014; Lee, 2016). ESL math teachers must identify whether ESLs are not appropriately assessing their work for the performance required of them in a problem or whether ESLs understand universal content concepts but misinterpret or are unable to convert characteristics of math problems (semantic error; Brown et al., 2016; Lee, 2016). When ESLs are able to account for their own mathematical problem-solving struggle, they can foster an engaged performance as the perception of their capacity to complete a given task increases, which benefits self-regulation in order to gain domain-specific, complex skill achievement (Boonen, de Koning, et al., 2016; Boonen, Reed, et al., 2016; Gasco & Villarroel, 2014; Jõgi & Kikas, 2016).

Motivational Input

Participants described how motivation in the problem-solving process helps ESLs become intrinsically motivated because ESLs experience various emotions in and out of the classroom. These emotions include happiness, worry, relief, frustration and anger, nervousness, and pride (Aisha et al., 2017; Cave et al., 2018; Tornare et al., 2015). In addition, the emotions are not always related to math ability; rather, the anxiety can occur while having to solve a math problem (McFarland et al., 2017; Trezise & Reeve, 2014). Evidence shows that, if the ESL student has anxiety, more than likely, he or she will avoid math tasks and show less persistence when it comes to math-related work (Justicia-Galiano et al., 2017). The variation in emotions during the problem-solving process can make it difficult for ESL to maintain the positive cognitive state needed to achieve their desired learning objective, but participants must alleviate students' anxiety about classmates seeing their work, hearing their oral participation, or collaborating with others outside of their norm (Aisha et al., 2017; Norquay & Rapke, 2018).

Participants explained how they must remain consistent in applying motivational input to problem-solving in various ways over a more substantial span of time to challenge the ESLs' self-efficacy (Cave et al., 2018; Tornare et al., 2015). Tornare et al. (2015) noted that the combination of emotional experiences and the ability to access prior knowledge during a problem-solving task raises vital questions for teachers, namely, how to direct the flow of problem-solving without disrupting or influencing the students' self-efficacy and with what frequency they might appropriately try to detect their emotional responses. Motivational factors of choice foster an engaged performance as the perception of one's capacity to complete a given task benefits self-regulation in order to gain domain-specific, complex skill achievement (Boonen, de Koning, et al., 2016; Boonen, Reed, et al., 2016; Gasco & Villarroel, 2014; Jõgi & Kikas, 2016). For instance, participants highlighting the students' "small wins" and successes were supporting problem-solving mastery. The ESL student's objective is to believe in his or her capabilities to perform the specific tasks required to produce and reach problem-solving mastery. Participants mentioned how they transitioned the student's mindset and have him or her persevere in spite of math anxiety and not dwell on it; it must also be distinguished from enduring anxiety (Aldemir & Gursel, 2014; Cave et al., 2018).

Limitations

Sample

Limitations are areas of potential weakness in a case study. This study was limited to nine middle school ESL math teachers who worked in the same district and had applied the problem-solving process in lesson preparation and classroom culture. Participant involvement occurred solely through interviews (initial and second) and member checking. The information gathered does not necessarily represent experiences of all middle school ESL math teachers within the district. Accuracy within the study was based on the participants' willingness to provide information with honesty and trustworthiness.

Study Design

For this qualitative case study, I gathered and analyzed data through initial interviews. Data were collected through face-to-face, 45-minute interviews at the school sites where the participants worked. I conducted 30-minute personal narratives in isolation after each interview. I followed up with a member-checking procedures for accuracy of participants' responses, based on the initial-interview transcripts. When these three data-collection processes were complete, I used the information to apply Hatch's (2002) inductive analysis model and Saldaña's (2016) initial and axial coding models. In addition, I used the information from all three data collections to analyze the data, formulate the second-interview questions, and repeat the same steps as in the initial interviews. I used personal narratives to align my personal experiences as a middle ESL math teacher with the participants' information to guide the analysis process. Again, I followed member checking procedures for accuracy of participants' responses. I repeated and applied Hatch's (2002) inductive analysis model and Saldaña's (2016) initial and axial coding models.

Research Method

To discover, analyze, and answer the research question, the qualitative approach of an intrinsic case study was best suited for the study. A case study allowed me to be descriptive, not about a problem but to develop an in-depth understanding of a particular case in problem-solving, detailing events, problems, processes, activities, and programs from middle school ESL math teachers within time and space (Creswell, 2007; Stake, 1995). Time was a possible limitation of the availability of participants. This could have directed when and how long an interview could take place. To address these limitations, I used multiple interviews (initial and second, 45-minute sessions), member checks (30 minutes), and personal narratives (30-minute reflections) to provide clarity in understanding and analyzing data. The interviewing process was based on the availability of ESL math teachers. The number of participants was small ($N = 9$), making it easy to ensure that all participants were informed that their site and personal identity would remain confidential. The strategies that I used for validity and credibility were as follows: (a) familiarity with the culture of each middle school site within the district; (b) triangulation through the instrumentation, analyzing data from the experiences of each participant, member checking interviews, and personal narratives; (c) face-to-face interviews at private sites to ensure honesty; (d) debriefing participants to recognize my own biases and preferences; and (e) review of current literature to support the study (Shenton, 2004).

This case study is dependable because it is consistent and can be replicated based on (a) descriptive reports of experiences of each participant by commonality of problem-solving and instructing ESLs; (b) triangulation through interviews, member checking, and personal narratives; and (c) reflective details of insight of each participant and my personal experiences with problem-solving and ESL students. Narratives allowed me to be open in interpreting and analyzing data from research. I had the ability to comprehend human experiences regarding the description, support, and development of ESL math teachers' instruction for ESL students to problem solve. I aimed to produce truly transferable results from ESL teachers' experiences with problem-solving with ESL learners in mind and did not disregard the importance of context, which is a key factor in qualitative research (Shenton, 2004).The district provides extensive professional development for ESL math teachers, including how to problem solve, making them knowledgeable about lesson preparation, modeling problem-solving, and ESL students' accountability. Results may not be valid in other surrounding districts, but if the same conditions apply, then transferability can be possible. This may vary by case and the experiences of other ESL math teachers in other districts.

Data Collection

The collected data came from a small group of middle school ESL math teachers. The data were based on an initial interview, personal narratives, second interview, and member checking. I conducted interviews at the participants' school where each one instructed, causing a limitation. I was limited to 45 minutes for each interview sessions, 30 minutes for personal narratives, and 30 minutes for member checking. After the first three data collections were analyzed, there was another round of 45-minute interviews, 30-minute personal reflections, and 30-minute member checking.

I only spent 2.5 hours with each participant (45 minutes for each interview and 30 minutes for each member checking). I did not communicate with participants outside of this time frame. The small amount of time was a limitation because the time frame did not provide opportunities for gaining a deeper understanding regarding certain topics.

Analyzing data from the interviews, personal narratives, and members checking was deemed a limitation. I analyzed data during a 4-month time frame with Hatch's (2002) inductive analysis. The data analysis did not exceed the time frame.

Implications of the Results for Practice, Policy, and Theory

Implications of practice, policy, and theory are discussed in this section. I discuss social constructivism, the conceptual framework, and implications of practice and policy as they align with the literature reviewed. The research implications are based on the conclusions drawn from the results of the study and how vital these conclusions are for policy, practice, and theory. This section identifies the gaps between middle school ESL math teachers' points of view and the problem-solving structure to benefit ESLs. In addition, this section details how the social constructs of problem-solving provide explanations of multiple avenues for learners to learn and apply learned behavior together through applied language to share experiences and construct validity (Cottone, 2016; Logan, 2015; Mishra, 2014).

Practice

Participants stated that they were constantly seeking new learning opportunities to benefit their ESL learners. Participants mentioned the benefits of the SIOP model, but would like to undergo a math content SIOP model developmental course. This requires participants to attend ongoing professional development sessions to observe various strategies and techniques that can be applied and modeled in the ESL classroom. I would recommend the development of a math SIOP course. Since a specific math content SIOP course is not given, participants can attend a combination of math, problem-solving, and ESL professional development, which the district provides.

Policy

The results of this study do not represent all middle school ESL math teachers' experiences within the district regarding problem-solving for the ESL learners. The participants in this study have made it clear that problem-solving helps to connect the aspect of language barriers, mathematics, and problem-solving. Districts that have a high demographic where English is not a student's first language can benefit from making problem-solving a policy initiative to bridge the gap of missed mathematical content standards and the English language. It is to the ESL math teachers' best interest to align multiple models, professional developments, personal teaching experiences, pacing, conceptual models, coaching and mentoring, annotating, developmental patterns and reference numbers, mathematical dialogue, and cross-curricular strides (Aisha et al., 2017; Bishara, 2016; Burt & Stringer, 2018; Cave et al., 2018; Ganor-Stern, 2016; Hansen-Thomas & Grosso Richins, 2015; Hojnoski et al., 2014).

Within the district, I recommend that ESL math teachers complete a questionnaire or a survey to reflect and assess what methods, strategies, professional developments, and developmental identifiers best suit their classroom culture, as well as areas of weakness in problem-solving that need improvement. Participants have voiced what the district currently provides and what they wish to learn to improve their teaching, that is, building relationships with ESL students, overcoming the language barrier, and SIOP training that is centered on mathematical content. The participants have indicated that learning is ongoing and considering that they are educational leaders for their ESL demographic, they must be granted opportunities to increase their knowledge of problem-solving practices with the ESL student in mind.

Theory

The results of this study suggest that participants are mindful of the demographics, lesson delivery, educational struggles, and motivational input based on their experiences. As the conceptual framework for this study, social constructivism makes and supports meaning of the participants' use of problem-solving to benefit the ESL student in the middle school bracket.

Social constructivism supports how ESL students deal with a multifaceted social reality, not given but produced and reproduced under the influence of ESL teachers for self-presentation, identity formation, and the embodiment of culture in sets of practices that express particular ways of being in the world (Clammer, 2017; Cottone, 2016; Logan, 2015; Mishra, 2014; Sterian & Mocanu, 2016). The participants' experiences regarding problem-solving for the ESL learner helped provide an in-depth understanding from their point of view in a natural setting. Participants elaborated on the social constructs of problem-solving in providing explanations of multiple avenues for learners to learn and apply learned behavior together through applied language to share experiences and construct validity (Cottone, 2016; Logan, 2015; Mishra, 2014). The participants made only claims that agreed with the facts about which mathematical entities actually populate the reference of real-world applications and ideal (Clammer, 2017; Logan, 2015; Mishra, 2014). Social constructs helped the participants with the ESLs' problem-solving because they were continuously heightening the aspects of maintenance, negotiation, and possible change of social and cultural norms when multiple avenues in problem-solving arose through literacy and experiences from students' or teachers' initial articulations (Clammer, 2017; Logan, 2015; Mishra, 2014).

The participants guide problem-solving for ESLs students to prevail in social norms, processes, and practices for mathematical discourse in academia (Clammer, 2017; Cottone, 2016;

Logan, 2015; Mishra, 2014; Sterian & Mocanu, 2016). The findings of this study state that participants consistently used problem-solving in the ESL classroom. The participants expressed their ability to apply social constructs to engage learners to become aware through exposure, find strategies to access existing knowledge of the students prior to and during instruction, and foster human creativity when problem-solving in the educational setting (Clammer, 2017; Mishra, 2014; Sterian & Mocanu, 2016). This knowledge helps to develop and sustain a classroom culture of inquiry in which a strong interface between students' everyday knowledge and school knowledge takes place (Mishra, 2014).

The only concern expressed by the participants in the study was for those ESL students who lacked the motivation to buy into the problem-solving process. Interventions or other methods should be in place for students who resist problem-solving, which has long-term benefits for math. For problem-solving, ELSs are required learning to know, learning to do, learning to learn with others, and learning to be (Sterian & Mocanu, 2016). The gap in knowledge and resistance hinders opportunities for engaging, long-lasting, and meaningful lessons for the ESL student to further clarify the benefits of applying problem-solving in ESL classrooms with limited experience.

Recommendations for Further Research

Areas of Improvement

Areas of improvement for future researchers include formal observations of problem-solving in the midst of participants' teaching. This can help researchers visually appreciate how the problem-solving process is modeled for ESL in a natural setting. Without student indication, future researchers can have participants share ESL students' work based on various mathematical standards to understand the quality of work from a beginner, intermediate, and AP ESL student.

In addition, researchers having a time frame to compare data through formal assessments of on-level and ESL students from all grade levels to see common errors and the growth of students when the problem-solving process is implemented. This can support data received from ESL math teachers' responses during the interview and member checking stage of a case study. Lastly, combining formal observations, student work, interviews, and member checking may need a longer time frame for a case study, depending how it will be replicated by future researchers.

Participants

Adding more participants to the case study could support and provide more insights into middle school ESL math teachers' viewpoints regarding problem-solving. Because the sample in this study was small ($N = 9$), the shared experiences were personalized. Having a higher participant involvement could have provided increased in-depth understanding of experiences with problem-solving and ESLs. This could help answer the what, when, how, and where of lessons built around problem-solving methods to benefit the ESL learner.

Additional Recommendations

Additional recommendations include studying the administrative staff and ESL students in the problem-solving process. Administrative staff appraise teachers on various domains (planning, instruction, learning environment, and professional practices and responsibilities) to support teachers in their professional growth. Having administrative insights could provide an in-depth comprehension (based on the district studied) on the "glows" of what ESL math teachers are implementing in lessons that are distinguished and "grows" of the areas that need improvement. In addition, ESL students are the building blocks of problem-solving and the ESL demographic. The students could expound on what learning style, approach, and problem-solving processes help their mathematical comprehension.

Furthermore, applying a quantitative approach would be beneficial to the understanding of the problem-solving mindset of all stakeholders (parents, administrators, and students). It could be used with surveys, observations, and secondary data. Surveys could reveal aspects of problem-solving for ESLs that are of either high or low importance. Observations could be used to showcase the number of times a problem-solving method is used during classroom instruction. Secondary data could be used to compare state standardized testing scores before middle school and again after ESL students finish middle school. This could take the study in another direction but might be useful toward future teaching methods for future middle school ESL math teachers.

Conclusion

In this chapter, I discussed the results of the study and how they answered the research question. The participants stated that problem-solving with the ESL learner in mind helps create meaningful lessons and fosters accountability for the ESL learner. Participants provided various methods, strategies, and experiences that gave impetus to the problem-solving mindset in the classroom. In addition, the participants verified that they are using the problem-solving process to benefit ESLs through the inclusion of visual, auditory, and kinesthetic methods. The use of problem-solving allowed ESLs to use multiple avenues of comprehending, explaining, and solving what math problems are asking them to do. Social constructivism provided a suitable conceptual framework for the study, which allowed me to align the participating ESL math teachers' meaningful information with my own experience as a middle school ESL math teacher.

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Appendix A: Initial Interview

Interview: Initial/ Face-to-Face

Name: _______________________

Date/ Time: __________________

Thank you for your participation in this qualitative case study. The study will involve four forms of instrumentation: first interview, second interview, member check interview, and my own personal narratives based on your responses. Today, we will complete the (____________) interview based on your experiences of problem-solving for the ESL learner. At a later date, we will schedule times for a second interview to extend your thoughts of your personal experiences from the first interview. Then, we will schedule a member check interview to verify if all responses and my interpretations are accurate from each script and documentation. I appreciate your willingness to participate, but participation is voluntary, and you have the free will to withdraw at any moment. If you would like a copy of your interview, I will provide it upon your request. You have the obligation to accept or decline being recorded. *Concordia University Office of Doctoral Studies has approved the proposed study, and all requirements of the IRB have been met*.

1. What is your experience in education and teaching ESL students?
2. How has your experience been teaching the ESL population?
3. What are the benefits for ESLs when establishing an individualized organizational approach (problem-solving) in math problem-solving while emphasizing mastery in all four categories (i.e., labeling the main idea of the problem, devising a plan to solve the problem, implementing the selected method, and reflecting on the question to see if it could potentially have been solved it in a different way?).

4. What experiences in mathematics (i.e., prior knowledge in algorithms or real-world experiences) can assist the problem-solving process when ESLs are learning new concepts?
5. How does the variation between isolation and communicative techniques in problem-solving heighten literacy in all mathematical representation for ESLs?
6. What are you experiences in recalling or attending trainings to properly model the problem-solving process?
7. In what ways do you align self-discovery and ESLs learning math readiness standards in your learning environment?
8. In what ways do cross-curricular techniques assist the learning culture within your ESL classroom, and how does that affect how students problem solve?

Appendix B: Second Interview

(Second-interview questions created after all initial interviews have been completed)

Interview: Second face-to-face interview will depend on the findings from the Initial Interview.

Name: ______________________

Date/ Time: _________________

Thank you for your participation in this qualitative case study. The study will involve four forms of instrumentation: first interview, second interview, member check interview, and my own personal narratives based on your responses. Today, we will complete the (___________) interview based on your experiences of problem-solving for the ESL learner. At a later date, we will schedule times for a member check interview to extend your thoughts of your personal experiences from the first interview. Then, we will schedule a member check interview to verify if all responses and my interpretations are accurate from each script and documentation. I appreciate your willingness to participate, but participation is voluntary, and you have the free will to withdraw at any moment. If you would like a copy of your interview, I will provide it upon your request. You have the obligation to accept or decline being recorded. *Concordia University Office of Doctoral Studies has approved the proposed study, and all requirements of the IRB have been met*.

1. What experiences are a vital factor in math problem-solving to close the developmental gaps between ESL and non-ESL students in acquisition, working memory, and mathematical tasks?
2. When teaching ESL students, what are common mistakes that the students make when solving math problems whether numerical, verbal, or pictorial renditions?

3. What have been difficulties for you as the ESL math teacher when applying problem-solving in math, be that English is not their first language (possible answers based on my experience are lack of motivation or not being connected to lessons due to lack of experience)?
4. From your experiences as ESL math teacher, what alterations do you make during instruction when embedding problem-solving to benefit student math practices?
5. When teaching ESL students, what are common mistakes that the students make when solving math problems whether numerical, verbal, or pictorial renditions?
6. How did you apply learned strategies, techniques, and behaviors from professional developments and experiences to lower error when similar math problems are given in the future?
7. During instruction, how do you apply individualized relativity to individualize the lesson to benefit each ESL student?

Appendix C: Member Checking Interview

Third Interview: Member Check/ Face-to-Face

Name: _______________________

Date/ Time: __________________

The member check interview is to verify the accuracy of participants' responses. Scripts and interpretations from the first and second interview will be given to the participant and confirmed. If alterations are made, I will add to the write-up below to readjust each participant's responses. You have the obligation to accept or decline being recorded.

Write-Up for Changes:

Appendix D: Personal Narratives

Date:______________________ Interviewee:_______________________________

Circle Which Interview: First or Second Time: __________________________

My personal narratives will occur after all interviews for 30 minutes. I am anticipating on discovering commonalties in themes of ESL math teachers' experiences in learning math through collaborative problem-solving to benefit ESLs' learning experience, once in the classroom. Reflecting will allow me to form themes from the initial interview to guide questions into the second interview. Personal narratives will also add depth in problem-solving for ESLs, bridging the experiences from the participants to myself.

1. What did I observe that I noted during the interview and my personal thoughts are . . .?
2. What I noticed that is similar to my experience in teaching ESLs was . . . ?
3. What skills did I comprehend that differed from my experience in teaching ESLs?
4. Based on commonalties, what steps am I gaining to improve the problem-solving process for ESLs?
5. What extension questions could I have asked in going deeper into understanding the participants' experiences?
6. What mattered most from this interview to distinguish this participant versus others is . . . ?

Appendix E: Steps for Collecting Data

Initial Interview

1. Recruit participants.
2. Schedule times with each participant based on school site.
3. Inform each participant that their identity, their school, and information of the district will be strictly confidential.
4. Inform each participant that at any moment they can decline continuing with the study or in the future for further interviews.
5. Inform each participant of the objective, purpose, the research question, and how their participation will help me to create answers towards the research question.
6. Use a hard copy of interview questions to take notes and set recorder (Rev.com) to conduct the interview (upon approval by participant).
7. Read questions the same to each participant, and if clarity for a question is needed, I will provide it.
8. After questions have been answered and responses have been written, I set up a time for a second interview based on the participant's availability and after the confirmation of a member check from the initial interview transcript.

Second Interview

1. Schedule second interview times with each participant based on school site.
2. Inform each participant that their identity, their school, and information of the district will be kept strictly confidential.
3. Inform each participant that at any moment, they can decline continuing with the study or in the future for further interviews.

4. Inform each participant of the objective, purpose, the research question, and how their participation will help me create answers toward the research question.
5. Use a hard copy of interview questions to take notes and set recorder to conduct the interview (upon approval by participant).
6. Read questions the same way to each participant, and if clarity for a question is needed, I will provide it.
7. The member check interview will be planned based on the participant's availability.

Member Check Interview

Each member check will last approximately 30 minutes.

The outline of the member check interview process is as follows:

1. Schedule times with each participant via phone conference at the same time.
2. Over the phone or via e-mail dialogue, I informed each participant that their identity, their school, and information of the district will be kept strictly confidential.
3. Inform each participant that at any moment they can decline continuing with the study.
4. Inform each participant of the objective, purpose, the research question, and how their participation will help me create answers toward the research question.
5. Send a hard copy of the interview transcript via interoffice mail or e-mail to each individual participant.
6. Participants reviewed their interviews, and if clarification is needed, they will notate it on the transcript and send it back to me to make further changes.
7. If there was a possibility of changes needing to be made, I repeated the same methods to ensure that their points of view and responses are ethically and truthfully sound.

8. Delete recordings from Rev.Com application when confirmed within 24–48 hours.

Personal Narratives

1. Directly after the initial, second, and member check interview have been conducted, I located an isolated space from each participant's school to ensure that information gathered is fresh on my mind and can be reflected upon.
2. I designated 30 minutes to answering my created reflection form.
3. Based on the responses of the participant, I reflected on how each participant differed from the others.
4. I will apply my own experiences in teaching ESL students and other positions in education to compare and contrast my experiences from those of the participants.

Appendix F: Recruitment Phone Call—Script and Flyer

Circle One: Building Principal Math Specialist ESL Math Teacher

Say: Hello, I am Christopher Lacy an ESL 8th-grade math teacher. Currently, I am in a Doctorate Program at Concordia University–Portland, and I am recruiting volunteers for my research to compile data for my dissertation. If you have a moment, can I discuss with you the problem, purpose, and my research question to shed light on what it is that I am studying?

(Allow for possible participant to respond)

Say: First, let me say that this study will be fully confidential. Your identity, place of work, where you work, and any other identifiers will be kept out of the study. The problem this study will address is the experiences of ESL math teachers understanding the problem-solving process that results in how these experiences transpire into classroom instruction to establish growth of mathematical operations and literacy comprehension for ESL students when reading, understanding, and applying all representations of mathematics. The purpose of study is to gain an understanding about the experiences of ESL math teachers regarding math problem-solving through the middle school bracket. I want to examine, through the experiences of ESL math teachers, the benefits of ESLs problem-solving through math to increase connectivity in literacy skills, mastering math readiness standards through collaborative and isolated instruction, growing the ability to apply learned behavior as rigor increases, and applying problem-solving with cross-curricular instruction in mind. So, my question that I am seeking to find answers for is: What are the experiences of ESL math teachers who are embedding the problem-solving structure in the middle school bracket? Is this a topic relatable to your experiences with this demographic and content that you are teaching?

(Allow for possible participant to respond)

Say: Again, your voluntary participation will be strictly confidential. I will only need to do two interviews with you. These interview will be two different occurrences and will only be 45 minutes for each interview. You will need nothing, but bring yourself to recall your experiences in the ESL classroom. Would this be something that you would be interested in?

(Allow participant to respond)

If possible participant says yes:

Say: Awesome. After each interview I will send you a transcript of each interview for you to confirm your responses and to allow you to see that I am being trustworthy in the research gained from each interview. Can we designate a time where I can meet you at your home campus to conduct both interviews? (Schedule a date, time, and location for recruited participant). Lastly, you will have the opportunity to decline at any time during the research process.

If participants says no:

Say: I appreciate the dedication that you do for the children of today. This is an individualized call and for confidentiality purposes will not be mentioned to any other person. Again, thank you for your time.

Teaching in the ESL Math Middle School Classroom

Participants needed for studies investigating teachers' experiences applying problem solving in classroom instruction

Covered to not give away identifiers of district or city information

WHO DO I NEED

- Texas teacher
- certified in Mathematics 4-8
- ESL certified or trained
- currently teaching the ESL population at a middle school within the district

Contact for More Info

Covered to not give away identifiers of district or city information

Appendix G: Initial Codes, Collapsed Codes, and Emergent Themes

Table 4

Initial Codes, Collapsed Codes, and Emergent Themes

Initial Codes	Collapsed Codes	Emergent Themes
Fresh to the Country	Awareness of Placement Level	How teachers are aware of the ESL Demographic you are teaching?
Knowledge of English		
Length of Time in Country		
Beginner Students		
Intermediate Students		
Advanced High Students		
Age		
Target the Minority in the Majority	Multicultural Perspective	
Find ways to Embrace All		
Embrace all Culture		
Coming from ICE Camps		
Cultural Responsiveness		
Merging Culture and Math		
Culture Shock		
Awareness of Students' Socioeconomic Status		
Assumptions Lead to Error	Do Not Assume Students are Aware	
Learning may be Different		
Different Levels to Lay the Foundation		
Pacing for Deeper Comprehension	Pacing	How teachers utilize mathematical discourse (communication) and multiple learning strategies for students to build an in-depth knowledge of math strategies and moments for students to be interactive in the problem-solving learning experience
Slow it Down		
Talk Instructions Slower		
Tackle all Senses for the Students in Learning		
Learning at Different Rates		
Lesson Preparation	SIOP Model	
Building Background		
Comprehensible Input		
Strategies		
Interaction		
Practice/Application		
Lesson Delivery		
Review & Assessment		

(Continues)

Initial Codes	Collapsed Codes	Emergent Themes
Line by Line	Word Association	
Break it Down		
Dictionary in Reach		
Understand Main Idea		
Discover Unfamiliar Words		
Understanding Transferable Words		
Merge the Plan, Action, and Math Standards	Visuals	
Word Wall		
Anchor Charts		
Hand Gestures		
Thinking Maps		
I do, We do, You Do		
Pair with English Comprehension Levels	Heterogeneous Grouping	
Pair with Math Comprehension Levels		
Pair for Peer Instruction		
Pair for Self-Discovery		
Moments to Use English Dialect		
Change Seating for New Discovery And Learning Opportunities		
Usage of Mathematical Verbiage		
Build Trustworthiness		
Discourse Helps with Exposure		
How did you get Answer?	Communication Delivery rather Product	
Not Cheat to Repeat		
Converse to Immerse		
Read It, Speak It, Do It		
Discussion Post (Technology)		
Annotating to Discover Main Idea	Cross-Curricular Input in Instruction	
Underling/ Highlighting		
Foreshadowing on How to Solve		
Applying Science in Measurements		
Applying History on Math Standards		
Use Multiple Strategies	Long Term Memory rather Short Term Results	
Apply Same Routine when Problem-Solving		

(Continues)

Initial Codes	Collapsed Codes	Emergent Themes
Moments for Connection		How teachers use educational struggle during the problem-solving process for students to self-discover to provide connectivity through literacy, error, math, and real world examples for long-term results rather short-term data
Drills in Various Deliveries/ Methods		
Student Accountability		
Formal Assessments		
Informal Assessments	Comprehension	
Comprehend "Starting Mindset"		
"Taking the Floaties Off"		
Allowing Students to Solve on Own	Educational Struggle	
Challenge First to Discover Students' Foundation		
Error Analysis		
Real World What if Problem- Solving	Self-Discovery	
Problem Based Learning Instruction		
Specific Words- Native Language to English Dictionary Questionable		
Read to Comprehend		
Do not just look for Numbers	Literacy	
Understand to Distinguish and Decipher		
Same Instructions as On-Level		
Modifications	Equity for All Students	How teacher use motivational input and building relationships to engage ESLs during the learning culture to communicate and inspire in the midst of problem-solving.
Goal Setting Classroom Culture		
Same purpose with Differentiated Goals		
Freedom to go In-Depth		
Students to tack Accountability in Learning	Creativity	
Students to Create or Teach Problem-Solving		
Small Wins		
Positive Reinforcement	Motivational Input	
"Have the big speech on overall goal"		
Politeness		
Empathy		
Reassurance		
Teachers Motivating Themselves		
During Frustration		

(Continues)

Initial Codes	Collapsed Codes	Emergent Themes
Students Sense Frustration		
Respectable Learning Environment		
Problem-Solving in Math through Trust	Student to Student Relationships	
Openness to Help Each Other		
Accountability		
Trust		
Willingness to Learn	Teacher to Student Frustration	
Moments of Frustration		
Growing through Frustration		
Empower Students to Succeed		
		(End)

Appendix H: Statement of Original Work

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

Statement of academic integrity.

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

Explanations:

What does "fraudulent" mean?

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

What is "unauthorized" assistance?

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

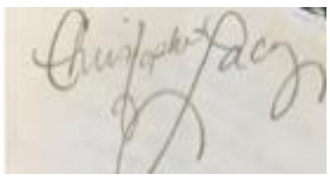
- Use of unauthorized notes or another's work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the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

Statement of Original Work (Continued)

I attest that:

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

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



Digital Signature

Christopher Lacy (Typed)

Name (Typed)

November 21, 2019

Date