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Examining General Educators' Instructional Practices Teaching Mathematics to K-8 Students with Disabilities

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

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Abstract

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MSEd, Walden University, 2010

BS, Trinity Christian College, 2006

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

A disparity in the mathematics performance between students with disabilities (SWDs) and students without disabilities in K-8 grades in international schools may lead to a lack of opportunities for SWDs to take advanced mathematics classes and enter mathematics-related college programs and careers. This problem may be increased if K-8 teachers of SWDs do not use social-constructivist-based practices needed for effective mathematics teaching. The purpose of this bounded qualitative exploratory case study was to explore the constructivist-based practices teachers applied in the mathematics K-8 classrooms for SWDs. Vygotsky's social-constructivism theory was used to guide this study. The research question addressed which social-constructivist principles were used to instruct K-8 SWDs to learn mathematics. Eight K-8 mathematics teachers from 5 international schools were purposefully chosen and volunteered to complete a qualitative questionnaire and to participate in a semistructured interview. Data were analyzed thematically using a priori, open, and axial coding strategies and related to the conceptual framework. Teachers reported building relationships with SWDs to guide and use differentiated instruction, fostering student efficacy, and integrating real-world context and activities in their mathematics instruction. Based on the findings, it is recommended that teachers use self-reflection to align their teaching practices with social-constructivist principles and use self-reflection and feedback opportunities with SWDs to discuss student learning. This endeavor may contribute to positive social change when administrators encourage teachers to use self-reflection and self-assessment of their mathematics instruction to lead SWDs to increased motivation, engagement, and learning, which may result in more options for college majors and career paths for SWDs.

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Dedication

This study is dedicated to my grandmothers, Nanny and Grandma Reuben, who encouraged me to take every opportunity to learn and bolstered my passion for working with students with special needs, and to the One in whose image each student was created. *Soli Deo Gloria.*

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Chapter 1: Introduction to the Study

Students with disabilities (SWDs) around the world demonstrate a lack of achievement in mathematics compared to students without disabilities (SWODs). SWDs exhibit a deficit in mathematics skills beginning in the early grades and maintain a stable gap from SWODs over time (Hojnoski, Caskie, & Young, 2018). With a growing demand for careers in science, technology, engineering, and mathematics, a poor foundation in elementary mathematics concepts places SWDs at a disadvantage when it comes to high school, college, and career options (Wei, Lenz, & Blackorby, 2012).

As more SWDs receive most of their education in the general education classroom, there is a shift in responsibility for mathematics learning from special education teachers to general education teachers. For SWDs and students at-risk for mathematics disabilities, the transition to conceptual meaning may require significantly more intensive intervention than general classroom teachers currently provide (Bryant et al., 2014). Research has shown that providing SWDs with high quality instruction and an opportunity to learn equal to that of their peers was not enough to close the achievement gap between SWDs and SWODs (Elliott, Kurz, Tindal, & Yel, 2017). Additionally, teacher perceptions of student ability have affected the achievement and opportunities of SWDs, with high school general education mathematics teachers setting lower expectations for SWDs than for SWODs based on disability label regardless of actual mathematics potential (Shifrer, 2016). Although some of the instructional practices used with SWODs may also be used with SWDs, general education teachers may need to increase their use of social-constructivist-based practices to provide effective mathematics instruction to SWDs.

Social-constructivist-based instruction involves high levels of student-to-teacher and student-to-peer interaction, teacher scaffolding, and peer involvement in the learning process. Teachers who implement social-constructivist-based instruction provide students with the opportunity to create lasting conceptual meaning out of previously formed foundational complexes (Vygotsky, 1962). Further, there is a move from an understanding of the complex or procedural to the concept or the reasons and relationships that exist at the abstract levels. However, SWDs may require additional support from their elementary level mathematics teachers to move from concrete complexes in mathematics to abstract concepts so that they can build a foundation in mathematics and move on to advanced coursework in the later grades.

In international schools SWDs typically receive most of their instruction in a mainstream classroom, with pullout support from a special education resource teacher targeting academic areas of need. Classroom teachers in international schools may or may not provide social-constructivist-based instruction to SWDs to support mathematics learning in elementary and middle grades. Thus, I explored the social-constructivist-based instruction practices that general education teachers in international schools use to instruct SWDs in mathematics. I hope to provide useful insights for decision makers within the local sites and also in other international schools that may help improve instruction and outcomes for SWDs in mathematics.

In Chapter 1 I provide the background for the study, including information about the local sites. I describe the problem and purpose of the study, review the conceptual framework, and outline the nature of the study. I also provide a summary of definitions, assumptions, the scope, delimitations, and limitations of the study and end with a description of the significance of the study and the implications for social change.

Background

Social-constructivist-based instruction in mathematics provides SWDs an opportunity to learn mathematics conceptually rather than as a set of unrelated facts and algorithms, so students can acquire conceptual knowledge instead of attempting to memorize each individual problem (Hunt, Tzur, & Westenskow, 2016). Social-constructivist-based instruction comes from the work of Lev Vygotsky and follows a progression from concrete to abstract as the teacher guides the student's cognitive processing (Xin, Liu, Jones, Tzur, & Li, 2016). Social-constructivist-based instruction is particularly important during the elementary and middle grades for SWDs, who have shown greater improvement in word-problem solving than their high achieving peers when provided a social-constructivist-based problem-solving intervention (Zhu, 2015). Further, as teachers have implemented constructivist-based mathematics interventions that met individual student needs, SWDs have significantly improved their mathematics performance (Re, Pedron, Tressoldi, & Lucangeli, 2014).

Most researchers examining social-constructivist-based instruction for SWDs in mathematics have conducted studies in the intervention setting rather than the general education setting (e.g., Driver & Powell, 2017; Hunt, Tzur et al., 2016; Ok & Bryant, 2016; Sharp & Dennis, 2017). A limited number of researchers have explored social-constructivist-based instruction at the classroom level in inclusive classrooms (e.g., Krawec & Huang, 2017; Zhu, 2015). Additionally, the benefits of social-constructivist-based instruction to teach mathematics to SWDs have been reported by researchers in public or local schools in multiple countries around the world, including China (Zhu, 2015), Finland (Mononen, Aunio, & Koponen, 2014), Israel (Bishara, 2016), and the United States (Xin et al., 2016), but there have been limited studies conducted in international school settings. During my literature search, I only found two articles related to mathematics instruction in international settings, and only one related to primary grades. Despite the promising results of social-constructivist-based instruction, further research is needed to explore the social-constructivist-based instruction that general education teachers implement to teach mathematics to SWDs in international school settings.

International schools exist in countries independent of national or global governing bodies to provide accountability (Hill, 2016). The term *international school* can encompass anything from a public or local school program designed to attract students from other countries to a school established in a foreign country to support expatriates living abroad (Hill, 2016). International school leaders may adopt initiatives and practices without conducting research to please stakeholders quickly while still attempting to align with the mission and vision of the school (Marvin, 2017). Further research conducted in international schools may aid teachers and administrators in making effective decisions regarding social-constructivist-based instruction in mathematics. Therefore, I examined the constructivist-based practices teachers implement for SWDs in the mathematics general education classroom in five international schools in China, Korea, Malaysia, Peru, and Singapore . The needs of SWDs in K-8 general education mathematics classrooms at these five schools are reported to be greater than their general education teachers are currently addressing.

Problem Statement

There is a gap in the performance of SWDs compared to SWODs in five international schools in China, Korea, Malaysia, Peru, and Singapore as reported by the elementary principal in Peru and the learning differences teacher in China. According to the learning differences teacher, mathematics scores of SWDs at the school in China were reported to be lower than those of SWODs. In addition to performing below SWODs in mathematics, the principal in Peru reported that SWDs struggle with learning how to cope with the overall demands of the general education classroom. Further, according to the elementary principal at the sister school in Turkey, SWDs who remain at the school through their school career continue to fall further behind in mathematics as they move up through the grades and perform significantly below SWODs in their class.

Though SWDs have demonstrated a lower level of mathematics concept development than SWODs at the same grade level (Hunt, Tzur et al., 2016; Xin et al., 2016), SWDs have demonstrated higher rates of growth when provided a social-constructivist-based cognitive strategy instruction intervention (Zhu, 2015). SWDs have significantly improved and maintained fraction word-problem solving skills when social-constructivist-based instruction included concrete-representational-abstract scaffolding and one-on-one instruction with teacher-directed scaffolding and support (Sharp & Dennis, 2017). Thus, teachers who provide social-constructivist-based instruction in mathematics for SWDs could improve the foundational mathematics skills of SWDs to improve achievement in later grades.

Implementing constructivist instruction is important because disparity between SWDs and SWODs in the early grades in mathematics leads to limited college and career opportunities for SWDs (Thurston, Shuman, Middendorf, & Johnson, 2017). Even SWDs who have enrolled in and completed postsecondary degrees in science, technology, engineering, and mathematics have reported being unprepared by science and mathematics classes in middle and high school (Thurston et al., 2017). These SWDs were significantly less likely to pursue advanced degrees in their field and to hold employment than SWODs with a comparable degree (Thurston et al., 2017). Thus, SWDs who do not receive a solid foundation in mathematics in the early grades may find future college and career choices to be limited compared to SWODs.

Due to a lack of research conducted in international schools, little is known about how general education teachers use social-constructivist-based instruction to teach mathematics to SWDs. In this study, I explored how general education teachers use social-constructivist-based instruction to teach mathematics to SWDs in grades K-8. To improve outcomes for SWDs related to mathematics achievement, teachers and administrators need more information regarding how teachers currently provide instruction.

Purpose of the Study

The purpose of this qualitative exploratory case study was to explore how K-8 general education teachers implement social-constructivist-based instructional practices for SWDs in the mathematics classroom in five international schools. I used a constructivist paradigm, acknowledging that I worked with my participants to explore a topic and create meaning from the data. The results of this exploratory case study may be used to identify future research areas related to improving instruction for SWDs in the general education classroom. Insights from teachers' practices could help inform leadership regarding ways to improve social-constructivist-based mathematics instruction in international schools, thereby improving mathematics instruction for SWDs and student outcomes.

Research Question

Research Question: How do K-8 general education teachers in five international schools instruct SWDs to learn mathematics using social-constructivist principles?

Conceptual Framework for the Study

The theory that learning occurs in social settings and that lasting development cannot occur in a social vacuum is the foundation of the social-constructivism framework in education. Vygotsky (1962) described learning as a cognitive activity that is both linguistically based and socially based, because directly teaching a child a concept without emphasizing the cognitive acquisition of the concept may result in the child not internalizing the concept. In mathematics, Vygotsky suggested that learning calculations or operations is only the beginning of a true development of the mathematics concept and that the full cognition of a concept is a lengthy process that is a balance between maturity level and social instruction. Furthermore, this social interaction cannot be based solely on peer-to-peer contact, which is a flaw in educational structures that support drill or rote learning and peer mediated learning rather than interactions with a knowledgeable teacher (Gredler, 2012). According to the theory of social-constructivism, teacher interactions with students account for a large portion of student learning and growth.

Because interactions with the teacher play a significant role in the development of the student and the acquisition and expansion of mathematics knowledge, teachers must be equipped to foster constructivist-based learning in their mathematics classrooms. Teachers who are not comfortable implementing constructivist practices may rely on peer interaction for SWDs rather than providing appropriate teacher-directed guidance in acquiring mathematical concepts (Griffin, League, Griffin, & Bae, 2013). Social-constructivism in the mathematics classroom also requires that the teacher have expertise in mathematics content and instructional strategies that meet the needs of individual students at their unique level of need.

The social-constructivism framework served as the foundation for my study approach and research questions, as I focused on the social-constructivist principles teachers implement in their mathematics classrooms. I used the Constructivist Learning Environment Survey (CLES; Johnson & McClure, 2004) to develop my questionnaire and interview questions to ensure that my methodology aligns with my framework and matches my research question. The interview process also aligned with the social-constructivist framework, as it allowed me to ask clarifying questions within a conversational format much like constructivist-based instruction in the classroom.

Nature of the Study

In this exploratory qualitative case study, I examined the practices of eight general education teachers in grades K-8 related to social-constructivist instructional practices used to teach mathematics to SWDs in their classrooms. I chose a qualitative method to ensure that participants would be given the opportunity to describe and elaborate on the practices they implement in their classrooms. Researchers use qualitative methodology to explore a topic within the natural setting, include descriptions and narrations of collected data, and uncover themes and categories throughout the research process (Rumrill, Cook, & Wiley, 2011). Additionally, conducting a qualitative study allowed me to highlight the complex and unique characteristics of participants in ways that a quantitative research design would not allow (Vaughn & Turner, 2016). Selecting a qualitative approach allowed me to explore the topic of social-constructivist instruction within five diverse schools in depth through teacher questionnaires and individual interviews.

In an exploratory case study, the researcher examines the views of a group of individuals who share one or more cultural aspects and have insights into a specific topic, phenomenon, or shared experience (Rumrill et al., 2011). The exploratory case study is a form of sociological research that allows the researcher to emphasize the development of ideas and theories as described by participants (Denzin, 2017). I selected the exploratory case study design to place an emphasis on the practices of teachers implementing social-constructivist-based mathematics instructional strategies for SWDs within international schools. In this study, I explored how K-8 general education teachers provide mathematics instruction to SWDs in five international schools located China, Korea, Malaysia, Peru, and Singapore. The sample for this study is comprised of general education teachers in grades K-8 who taught mathematics to SWDs during the 2018-2019 school year. I used purposive sampling to identify potential participants who fit the selection criteria. I chose an exploratory case study because I wanted to explore the use of social-constructivist practices in mathematics in international schools and the instruction SWDs received in the general education classroom.

Data were collected via questionnaire (Appendix A) and individual interviews using a semistructured interview protocol (Appendix B), which included probing questions to explore teachers' use of social-constructivist-based instruction for teaching SWDs. Using an electronic questionnaire prior to individual interviews allowed me to identify probing follow-up questions for individual participants and to explore initial data from the questionnaires before conducting telephone interviews with each participant. The interview process provided participants an opportunity to verbally process and make meaning of their instructional practices in the classroom (see Seidman, 2013). I used a semistructured interview process with an interview protocol to gain rich data and insights into the social-constructivist-based instructional practices and experiences of my participants. Semistructured interviews allow the researcher some freedom in asking probing, clarifying, and follow-up questions to elicit thicker data (Denzin, 2017).

I used thematic analysis with a priori, open, and axial coding to search for categories, themes, and relationships within the data. I began by applying a priori codes based on the conceptual framework of social-constructivism, and then I applied open codes to dissemble the data set. As I continued the data analysis process, I identified axial codes based on the open codes, then analyzed the axial codes to identify emergent themes related to social-constructivist-based instructional practices of general education mathematics teachers. Using thematic analysis allows qualitative researchers to examine the weight of participant responses within categories to determine which areas respondents emphasize most in the data set (Vaughn & Turner, 2016). In thematic analysis, the researcher uses multiple levels of coding to categorize the data then examine relationships between various responses (Vaughn & Turner, 2016). The exploration of relationships between categories and themes allows the researcher to draw conclusions regarding the data set and identify areas for future research (Vaughn & Turner, 2016). My thematic analysis of teacher practices related to constructivist-based instruction in mathematics allowed me to provide recommendations for mathematics instruction based on the results.

Definitions

At-risk students: Students who fall below the 25th percentile on school-wide or district-wide tests of mathematics achievement (Baroody, Eiland, Purpura, & Reid, 2013). Sometimes these students are also referred to as low achievers (Aunio, Heiskari, Van Luit, & Vuorio, 2015).

Constructivist-based practices: Practices that incorporate the social-constructivist concepts of teaching and learning as described by Vygotsky. Social-constructivist practices require the student to use advanced mental processes such as “abstracting, synthesizing, comparing, and differentiating” (p. 122) to develop higher mental functions related to the learned concept (Gredler, 2012). Social-constructivist practices also require a high level of teacher monitoring and input as the teacher guides the student in concept development and prevents him from making errors in the formation of ideas as might occur during student-to-student learning (Gredler, 2012).

Students with disabilities (SWDs): Students who are diagnosed with a disability and receive support services within the school environment. For this study, *SWDs* refers to students in the local sites who receive services by the individual school’s definition, regardless of whether they would qualify for services under state or U.S. federal law.

Assumptions

For this study, I assumed that all teachers answered the questionnaire and interview questions honestly and without bias or personal motivations impacting the content of their answers. Additionally, I assumed that each teacher’s reported instructional practices would differ but that there would also be some common themes related to mathematics practices in K-8 classrooms. All five local sites offer an American-based curriculum, so I expected to find some of the commonly accepted mathematics practices, such as skip counting practice and fact practice, implemented in multiple classrooms. These broad assumptions were necessary for me to trust my participants and view the data as valid. Finally, I assumed that participants in the study would not discuss the study with other participants in a way that would influence or contaminate the responses of other participants. This assumption was necessary for me to explore themes that are present across participants as valid representations rather than contaminated responses resulting from undue influence by other participants. Despite each assumption, I employed a rival thinking approach by reviewing and analyzing all data with skepticism to ensure that I identified and rejected false assumptions to strengthen credibility.

Scope and Delimitations

This study was conducted at five international schools located in China, Korea, Malaysia, Peru, and Singapore. This study was limited to teachers employed at the five school sites in 2018-2019 who teach mathematics to SWDs in grades K-8. A total of 76 teachers who teach mathematics in the general education setting in grades K-8 were invited to participate, but only eight teachers completed the questionnaire and the individual interview. I chose to limit the study to teachers in grades K-8 to focus on building foundational mathematics skills in the early and middle grades rather than focusing on mathematics coursework at the high school level. I focused on the social-constructivist framework of teaching and learning to explore how SWDs are taught mathematics in the general education classroom. Because I limited the study to teacher instructional practices, I chose not to focus on a cognitive framework for this study, which would involve examining the cognitive development of SWDs related to the instruction they receive. Transferability for this study is limited due to the unique research setting, but my findings may be relevant to other international schools with similar diversity in both the student body and faculty.

Limitations

Limitations are present in every study and should be considered by the researcher before the study is completed to ensure that the limitations do not outweigh the benefits (Lodico, Spaulding, & Voegtle, 2010). A major limitation of this study lies within the unique demographics of the schools and the participating teachers, which limits transferability. The study was conducted at five schools in China, Korea, Malaysia, Peru, and Singapore. With students from multiple nations represented at each school, the cultural and language-based needs of students are diverse, as are the perspectives and backgrounds of the teachers. Therefore, the study will not likely hold transferability for a homogeneous public school in the United States.

There are also limitations due to study design and methodology. Despite the use of multiple participants, settings, and data collection instruments, I cannot remove all limitations within the study, but I have reported them as transparently as possible. Qualitative studies include a certain amount of subjective interpretation and flexibility, which is frequently seen as a limitation by proponents of quantitative research (Yin, 2016). By using questionnaires and semistructured interviews, I allowed for subjectivity at both the participant and researcher levels, which limits the dependability of the data. Another limitation is related to the use of purposive sampling and the unpredictability of my final sample, as I could not guarantee the participation of multiple teachers from each of the five schools included.

Significance of the Study

In this study I explored mathematics instruction for K-8 SWDs at international schools in China, Korea, Malaysia, Peru, and Singapore. Because international schools do not fall under the legislation of the U.S. government, there is no funding allocated for services for SWDs, and there is no federal or state accountability for services or for student achievement. Though there is little research on mathematics instruction for SWDs in international schools, research conducted in the United States and other national schools may serve as a foundation for evidence-based practices in mathematics instruction for SWDs. Despite the high level of student diversity represented at the schools in the study, the achievement of SWDs in the United States is relevant due to the implementation of American curriculum and the high proportion of U.S. trained teachers.

Across the United States, despite many years of legislation focused on improving instruction for SWDs, mathematics achievement continues to be lower for SWDs than for SWODs (Schulte & Stevens, 2015; Wei et al., 2012). Regardless of disability category, mathematics proficiency for SWDs demonstrates a plateau that supports the importance of early intervention and support for SWDs (Wei et al., 2012). Without early remediation of mathematics skills, SWDs have little chance of reducing the gap with SWODs in problem solving and numeracy concepts that are essential for future success (Wei et al., 2012). Not developing mathematics skills in the early grades leads to decreased opportunities in high school and a higher risk of unemployment as an adult (Morgan, Farkas, Hillemeier & Maczuga, 2016).

Mathematics instruction for SWDs that incorporates teacher-directed constructivist-based practices can provide significant results in a relatively short period and could potentially help SWDs to close the achievement gap. For example, SWDs in Italy who received individualized instruction with a focus on scaffolding and making meaning of mathematical concepts demonstrated significant growth over the course of the year compared to SWDs who received the standard mathematics instruction offered in the general education classroom (Re et al., 2014). Additionally, SWDs who received instruction in schema-based problem solving in the general education class have outperformed their control group peers on measures related to ratios and proportions (Jitendra, Dupuis, Star & Rodriguez, 2014). Thus, teachers who implement constructivist-based practices such as schema-based instruction and individualized concept instruction may improve the mathematical reasoning of SWDs in the general classroom and reduce the achievement gap between SWDs and SWODs.

Positive Social Change

Identifying constructivist-based practices implemented by teachers of SWDs and areas for future improvement could impact SWDs within the local sites. As the quality of mathematics instruction improves, the achievement of SWDs may also improve (Bottge et al., 2015). Improved teacher efficacy in mathematics could also decrease the stigma and stratification of SWDs in mathematics courses by improving teacher attitudes toward the mathematics potential of SWDs (Shifrer, 2016). Improved mathematics skills and abilities may lead to more options for college majors and career paths for SWDs who may previously have been held back from areas of interest due to low achievement in mathematics and mathematics related courses such as science and technology.

Summary

In Chapter 1, I provided an introduction to the study set within the context of a specific problem at the study site. Data illustrating the achievement gap between SWDs and SWODs were presented and a brief overview of the local setting was provided. The theoretical framework for the study was presented to give context to the role of the teacher as instructor and facilitator of student learning. Research in the area of mathematics instruction indicates that teachers are a more important resource than standards, curriculum, or materials. Therefore, the purpose of this study was to explore the social-constructivist-based practices teachers implement for SWDs in the K-8 mathematics general education classroom. In Chapter 2, I will provide an in-depth examination of the current literature regarding mathematics instruction for SWDs. In Chapter 3, I will describe the methodology including further discussion of the exploratory case study design and a description of participant recruitment procedures. I will describe the results of the study in Chapter 4 and discuss the relevance of the findings as well as conclusions and recommendations in Chapter 5.

Chapter 2: Literature Review

Introduction

Throughout the literature I discovered data indicating an achievement gap between SWDs and SWODs in mathematics performance, which begins with poor numeracy skills in first grade and leads to significant deficits by seventh grade (Geary, Hoard, Nugent, & Bailey, 2013). SWDs who fall behind SWODs in the early grades are rarely able to catch up with their peers in terms of mathematics skills and will have limited course options upon high school entry due to a lack of foundational skills in mathematics (Faulkner, Crossland, & Stiff, 2013; Morgan et al., 2016). Whether the gap is cumulative or compensatory, it is apparent from the literature that SWDs require greater levels of support to match the achievement of SWODs in mathematics, and even specialized instruction cannot close the gap (Fuchs et al., 2015).

In addition to the achievement gap, I examined constructive-based instructional practices in the mathematics classroom, which are discussed in-depth in this chapter. For SWDs to learn advanced mathematics concepts, teachers need to implement constructivist-based principles to scaffold the transition from concrete to abstract learning (Hord & Xin, 2014). Structured cognitive instruction can help students move beyond memorization to acquire abstract concepts such as the underlying numeracy concepts behind multi-digit multiplication with regrouping (Flores, Hinton, & Schweck, 2014). Effective use of constructivist practices may play a significant role in improving the mathematics achievement of SWDs.

Further, nonconstructivist instructional practices play a significant role in building a mathematics foundation in basic, concrete skills. Instructional methods that are nonconstructivist set the foundation in mathematics fluency when students memorize basic facts and number relationships (Bryant et al., 2014). Teacher-directed instruction that does not move to the conceptual level is a structured form of teaching that has been effective in teaching numbers and basic facts to SWDs in kindergarten classrooms (Davenport & Johnston, 2015). Nonconstructivist practices may help set the foundation for SWDs in the early grades so that they are prepared to build concepts in upper elementary and continuing into middle school and high school.

This literature review was undertaken to examine effective social-constructivist-based practices in mathematics instruction for SWDs in elementary grades. Based on my findings, I divided this literature review into three primary sections: the mathematics achievement gap between SWDs and SWODs, social-constructivist-based instructional practices, and nonsocial-constructivist-based instructional practices. I begin the literature review with a summary of the findings regarding the discrepancy between mathematics achievement and related outcomes for SWDs and SWODs.

Literature Search Strategy

To locate relevant articles, I searched four major databases for current, peer-reviewed journal articles related to the topic. I performed searches in SAGE, ERIC, Academic Search Complete, and Educational Research Complete, with keywords *special education, mathematics instruction*, *disability*, *mathematics instruction* and *constructivism* to locate articles related to mathematics instruction for SWDs and articles employing constructivist practices. From the articles retrieved, I eliminated studies that were conducted prior to 2014, articles that were secondary sources, and articles that were focused on specific low-incidence disabilities. The population under examination for this study does not include students with severe/profound physical or cognitive impairments, so articles reporting interventions or approaches specific to only the severe/profound population were not included in this analysis. I also eliminated studies focused on middle school and high school instruction except for studies that were longitudinal in nature beginning in the elementary grades. I explored the practices of elementary teachers of SWDs in this study, so I considered articles related to middle school and high school instruction irrelevant.

Conceptual Framework

Learning requires engagement and a connection between instructor and pupil. For teachers to provide instruction for SWDs in mathematics, they must implement instructional strategies that are appropriate for the students they are serving. Thus, the conceptual framework of social-constructivism, where learning operates as a give-and-take exchange between teacher and pupil provided the foundation for this study (see Powell & Kalina, 2009). According to the theory of social-constructivism, students must receive instruction based on their current level of knowledge and skills (Gredler, 2012). Additionally, learning is viewed as a complex and intricate process, which requires scaffolding for the learner to reach internalization of new concepts and skills (Powell & Kalina, 2009). Examining the practices of teachers from a framework of social-constructivism allowed me to emphasize the constructivist-based mathematics instruction that elementary teachers use to teach mathematics to SWDs.

Literature Review Related to Key Concepts

Achievement Gap and Mathematics Growth Trajectories

An area of concern to educators is the sustained gap between SWDs and SWODs in mathematics achievement. This gap is first apparent in early elementary school when students are identified as at-risk for mathematics disability or mathematics difficulty based on their performance on classroom-based measures or universal screening measures (Clarke et al., 2014; Morgan et al., 2016). Researchers have also found that the performance of students in seventh grade is predicted by their mathematics skills when they enter first grade (Geary et al., 2013). In longitudinal studies, SWDs who began third grade with the lowest mathematics scores displayed the slowest rate of growth over time compared to SWODs, a gap that increased even if they exited special education services at some point in elementary or middle school (Schulte & Stevens, 2015; Stevens & Schulte, 2017). Conversely, in a study of early numeracy skills conducted in Finnish kindergarten, the lowest achievers demonstrated higher rates of growth than high and average achievers, though they did not close the gap and ended the school year below the entry level of the average-achieving students (Aunio et al., 2015). Even controlling for gender, parent education, and socioeconomic status, students who entered kindergarten with lower levels of readiness in numerical context and counting skills maintained a significant gap from average and high achievers throughout the school year (Aunio et al., 2015). Although low achievers may be capable of significant growth, the opportunities presented in the general classroom are insufficient to narrow the achievement gap and to bring SWDs or low achievers up to grade level in mathematics.

To support research on achievement gaps, the presence of mathematics difficulties can be seen as early as kindergarten, despite the fact that many disabilities such as learning disabilities and attention deficit disorders are not diagnosed until later grades. Kindergarten students scoring in the lowest 25th percentile on standardized tests and screenings were 4 times as likely to be diagnosed with a mathematics disability in elementary or middle school than their peers who score above the 25th percentile (Morgan et al., 2016). Further, SWDs with limited verbal competence who experienced play-based mathematics instruction in daycare showed an advantage over their peers who attended formal preschools with more structured instruction, but the growth was no longer visible after students had completed kindergarten (Hildenbrand, Niklas, Cohrssen, & Tayler, 2017). Although standards-based instruction has improved opportunities to learn for SWDs it has not provided sufficient growth to decrease the gap with SWODs (Blank & Smithson, 2014). Even when opportunity to learn was found to be equal for SWDs and SWODs, educational outcomes on mathematics measures still demonstrated a significant gap between SWDs and SWODs (Blank & Smithson, 2014; Elliot et al., 2017).

Students deemed at-risk for mathematics difficulty in kindergarten or first grade, and those later identified with mathematics disabilities, may experience limited opportunities to take advanced mathematics courses in high school. Diagnosis of a disability has resulted in lower teacher perceptions, regardless of actual mathematics potential, and a combination of low teacher perception and disability status is "virtually prohibitive of placement in algebra, even in the presence of high math performance" (Faulkner et al., 2013, p. 338). The stigma of a disability diagnosis in elementary and middle school has had a greater effect on limiting access to advanced courses for SWDs than actual student performance (Shifrer, 2016). SWDs do not participate in the same assessments as their peers and have been frequently held to a lower standard for mathematics mastery in countries around the world (Barnard-Brak, Wei, Schmidt, & Sheffield, 2014). Placing SWDs in lower level mathematics classes in elementary and middle school can lead to limited opportunities for SWDs to advance in mathematics in high school.

Numerous factors may play a role in the growth of SWDs and students struggling in mathematics. Students with mathematics difficulty but without a diagnosed disability have displayed lower self-concept than their peers with and without diagnosed learning disabilities or reading disabilities, which has led to lower academic achievement in all areas (Holopainen, Taipale, & Savolainen, 2017). Students diagnosed with attention deficit hyperactivity disorder, without mathematics learning disabilities, also display mathematics deficits over time that are substantially greater than deficits seen in the general population (Colomer, Re, Miranda, & Lucangeli, 2013). Fact fluency also plays a role in overall mathematics achievement (Nelson, Parker, & Zaslofsky, 2016). Lower general cognitive abilities in first grade students has predicted greater difficulty with numeration by third grade but has less impact on their multi-digit calculations, suggesting that first and second grade curriculum provides instruction for SWDs to learn procedures but not the underlying concepts (Fuchs, Geary, Fuchs, Compton, & Hamlett, 2014). SWDs performing below their peers in mathematics facts and their lower performance on facts correlates to lower overall achievement across grades (Nelson et al., 2016). Self-concept and mathematics a lack of fact fluency may impact the achievement of SWDs and contribute to the achievement gap between SWDs and SWODs.

Not all researchers agree with the cumulative theory regarding the achievement gap in mathematics, as some focus on the sometimes-accelerated growth of SWDs in the early grades. In one longitudinal study, SWDs exhibited an accelerated or increased growth rate for a period, but the achievement gap did not close (Aunio et al., 2015). SWDs have demonstrated similar growth trajectories in mathematics over time, though they started lower and ended lower than SWODs (Mazzoco, Myers, Lewis, Hanich, & Murphy, 2013). Regardless of whether the achievement gap is cumulative or compounds through the grade levels, the existence of the gap between SWDs and SWODs may prevent SWDs from accessing advanced mathematics courses in high school.

Constructivist Instructional Approaches and Strategies

I located a number of studies that described interventions for SWDs and students at-risk for mathematics difficulty. I categorized the instructional practices I found in the literature based on whether they fostered a constructivist approach by emphasizing cognitive development or a nonconstructivist approach by emphasizing rote and repeated instruction without a transition to conceptual learning. Instruction that aligns to standards and targets concept acquisition rather than focusing on test preparation has been lacking in both general education and special education instruction for SWDs, but when used, has been found to significantly improve achievement for SWDs (Blank & Smithson, 2014). Constructivist instruction places an emphasis on student developmental levels, individualized and/or targeted growth, student directed pacing, and multiple means of concept acquisition principles, and requires teacher expertise to implement successfully.

Early instructional interventions. Due to the mathematics achievement gap as early as pre-kindergarten, instruction for SWDs in the early grades should be aggressive and intentional (Aunio et al., 2015; Morgan et al., 2016). Teachers should select and implement early interventions in mathematics carefully, as the sequence of concepts taught is important for numeracy development (Mononen et al., 2014). Further, students in first grade who received contraindicated interventions have demonstrated no growth but displayed significant growth following implementation of the appropriate intervention (Burns et al., 2015). Teachers who planned and implemented developmentally based interventions to support growth for SWDs in kindergarten saw significant gains on the Test of Early Mathematics Ability, and the growth rate of SWDs exceed that of SWODs in some areas (Clarke et al., 2014). Therefore, early, individually targeted mathematics intervention should be the first step in working to close the mathematics achievement gap between SWDs and SWODs.

Early intervention begins with screening all students in kindergarten and first grade, identifying the students who perform at the lowest percentiles in mathematics before designing targeted support that extends the general education classroom for students identified as at risk. However, there is not an agreement on the achievement level that constitutes a mathematics difficulty. For example, Morgan et al. (2016)

identified students performing below the 25th percentile as those who are most at-risk for "persistent mathematics difficulty" in later years (p. 305). But Driver and Powell (2015) support a cut-off of the 21st percentile, with students at or below that level categorized as MD, which is defined by the authors as "students with or at-risk for mathematics difficulty" (p. 127). In contrast to a percentile standard, Clarke et al. (2014) identified the five lowest students in each classroom as at-risk for difficulties in mathematics. Students who are low achievers in kindergarten and first grade continue to achieve below grade level as they move up through elementary and middle school (Geary et al., 2013; Schulte & Stevens, 2015). The lack of consensus regarding cut-off points for students at-risk for mathematics difficulties may prevent students from receiving services before a formal disability diagnosis is achieved.

In mathematics, early intervention is often focused on numeracy instruction, numbers and operations concepts, and fluidity of number practice (Baroody et al., 2013; Clarke et al., 2014; Doabler et al., 2015). SWDs require a greater amount of practice than SWODs, often with explicit instruction in numbers and operations concepts and increased practice with mathematics fact fluency to develop the basis for later mathematics learning (Aunio et al., 2015; Fuchs et al., 2013; Mononen et al., 2014). Number concepts represent the foundation for mathematics acquisition; basic skills with numbers, including both fluidity with facts and a grasp of the underlying number relationships, contribute to positive mathematics outcomes in later grades (Baroody et al., 2013). Thus, instruction in the early grades should target number skills and concepts for SWDs and for students identified as at-risk for disabilities to establish a foundation and enable them to build fluidity with the basic mathematics facts.

It is also important that the instructional approach implemented matches the type of intervention and the needs of the students. Teachers can provide frequent feedback and individualized scaffolding to support each student in reaching the conceptual level (Doabler et al., 2015). For instance, first grade students with mathematics difficulties benefitted more from teacher-directed activities than from student-centered activities, though their peers without mathematics difficulties benefitted from both teacher-directed and student-centered activities (Morgan, Farkas, & Maczuga, 2014). Additionally, SWDs and students at risk for mathematics difficulty who received high levels of verbal interaction with their teacher in small groups demonstrated significant growth in quantity discrimination and missing number measures (Doabler et al., 2015). First graders at risk for mathematics difficulty also demonstrated significant growth following small group tutoring in number relationships, numeracy, and operations (Gersten et al., 2015; Fuchs et al., 2013). Further, students at-risk for mathematics difficulties in preschool, kindergarten, and first grade have improved counting and number sense skills following short, teacher-led instruction in small groups (Hinton, Stroizer, & Flores, 2015). Conversely, self-regulated classrooms with student-centered rather than teacher-directed situations have provided more growth in mathematics skills for third and fourth grade SWDs in Israel (Bishara, 2016).

Numeracy foundations in numbers and operations. Apart from the research on instructional strategies, there is considerable agreement regarding the content of early mathematics instruction, which is typically focused on building student skills with numbers and operations. In a study of SWDs with significant mathematics difficulties in second grade, all SWDs made significant improvement in their achievement on the state progress monitoring and achievement test and were able to generalize the newly acquired skills to additional problems after completing an intensive intervention in numbers and operations (Bryant et al., 2014). At-risk students in kindergarten made significant gains following a supplemental intervention focused on whole number concepts, and although this did not close the gap between high and low achieving students, it significantly reduced the gap by the end of kindergarten (Clarke et al., 2014).

Growth for at-risk students and SWDs may not always be sufficient to close the achievement gap within a single school year, but targeted support in numbers and operations produced significant improvement within a year. Growth for first grade at-risk students using an intervention curriculum focused on procedural and conceptual knowledge of numbers concepts was significant, through slower than anticipated, considering the increased and intensified instructional time (Doabler et al., 2015). The slower than anticipated growth may have been due to student deficits across multiple areas, which required students to strengthen foundational skills over time before building additional concepts (Doabler et al., 2015). SWDs in second grade who completed tutoring that emphasized non-standard (i.e. 8=3+_) equations demonstrated more growth than their peers in the control group and peers who completed tutoring using only standard (i.e. 5+3=_) equations (Powell, Driver, & Julian, 2015). Numbers and operations interventions that support SWDs and at-risk students in building strong foundations in numeracy in the early grades could help to reduce the achievement gap by setting up a strong foundation for mathematics ideas and concepts.

Concrete, semi-concrete, abstract, representational instruction. Mathematics instruction that guides students along the concrete to representational continuum aligns with the theory of social-constructivism by acknowledging the need for students to construct meaning in their own way, rather than simply teaching a behavioral response to representational stimulus (Baroody et al., 2013). Many SWODs easily make the connection between concrete and abstract concepts in mathematics, allowing them to use abstract numerals and symbols rather than objects and physical shapes for advanced mathematical calculations (Clarke et al., 2014; Satsangi & Bouck, 2014). SWDs often struggle to bridge the gap between concrete objects and the representations of those objects on paper (Baroody et al., 2013). High achieving SWODs showed less growth in word problem solving than SWDs after receiving an intervention that included representational problem-solving procedures (Zhu, 2015). Teachers providing mathematics instruction for SWDs should implement practices that support and scaffold the relationship between concrete, representational, and abstract mathematics concepts, with the recognition that SWDs may require more instruction to transition along the continuum to abstract concepts than SWODs require.

SWDs may have more difficulty navigating the concrete, semiconcrete, representational, abstract (CRA) continuum than SWODs, and may require explicit instruction to move from the construct level to conceptual knowledge. Explicit instruction in CRA aligns with social-constructivist practices and includes six key procedures: use of an advance organizer, teacher modeling or demonstration, guided practice with teacher prompting and questioning, independent student practice, advanced application of the skill, and specific feedback (Agrawal & Morin, 2016). CRA instruction can be used to guide students to develop conceptual knowledge, or to support acquisition of mathematics procedures (Agrawal & Morin, 2016). SWDs in 3rd grade displayed significantly higher mathematics growth when placed in an intervention that included concrete materials, or an intervention that combined visual and verbal strategies provided by the teacher (Swanson, Orosco, & Lussier, 2014). SWDs placed in the materials plus visual strategies group, the materials, plus visual, plus verbal strategies group, and the control group showed significantly lower growth over time (Swanson et al., 2014). In a case study involving a fourth grade SWD, the student was able to reach the representational (visual/pictorial) level of problem solving with teacher guidance, but due to limited time in the intervention was not able to move to the abstract level of reasoning during the course of the intervention, which limited his ability to solve more complex problems (Xin et al., 2016).

Providing explicit and systematic instruction in the use of concrete, semi-concrete, and abstract representations for mathematics concepts can enable SWDs to make the connection between concrete objects and representational symbols in mathematics. SWDs performed better on problem solving tests that presented nonsymbolic equations with pictures and stories rather than symbolic equations presented using only numerals (Driver & Powell, 2015). Explicit instruction, using the concrete to representational continuum, improved the performance of SWDs in number sense and quantity-based problems (Baroody et al., 2013), area and volume concepts (Hord & Xin, 2014), solving word problems (Kingsdorf & Krawec, 2016; Morin, Watson, Hester, & Raver, 2017; Swanson, Lussier, & Orosco, 2013; Zhu, 2015), and computing with fractions (Sharp & Dennis, 2017; Watt & Therrien, 2016). Systematic instruction also benefitted SWODs in the area of ratios, proportions, and fraction equivalency (Hunt, 2014). Abstract concepts should be taught along the continuum of concrete and semi-concrete to enable SWDs and SWODs to understand the underlying concepts behind the abstract procedure.

CRA instruction supports SWDs and students at-risk for mathematics difficulty in developing foundational mathematics concepts in the early grades. Students at-risk for mathematics difficulty in second grade who participated in a small group, CRA-based intervention related to Base-10 numeracy, significantly improved foundational mathematics concepts, with most of the students performing above the 25th percentile cut-off at the spring benchmark (Bryant et al., 2014). SWDs in preschool, kindergarten, and first grade improved counting and numeracy skills following explicit instruction using CRA-based interventions in counting and numbers concepts (Hinton et al., 2015; Mononen et al., 2014).

Students in the upper elementary grades may benefit from CRA interventions to support fact fluency and operations concepts. SWDs in fifth grade with demonstrated significant growth in fact fluency and more sophisticated problem solving strategies following an intervention that used representational materials to build conceptual knowledge of multiplication (Ok & Bryant, 2016). Students with behavior and attention related disabilities in fourth and fifth grade improved accuracy and speed in drills after participating in number modeling instruction with immediate feedback (Whitney, Hirn, & Lingo, 2016). Third grade students who were at-risk for mathematics difficulties improved their addition and subtraction skills using a concrete-representational-abstract approach to conceptualize the Base-10 number system (Flores, Hinton, & Strozier, 2014). Fourth and fifth grade SWDs learned multiplication with regrouping using a problem solving strategy combined with a CRA approach to develop conceptualization and demonstrated generalization of the concept (Flores, Hinton, & Schweck, 2014). CRA interventions may provide the scaffolding SWDs need to transition from constructs to concepts as they build foundational mathematics knowledge and learn advanced skills.

Implementing CRA interventions does not automatically guarantee success for SWDs learning mathematics. Commercially available interventions did not meet the needs of SWDs without modifications or additions (Krawec & Huang, 2017). Fifth and sixth grade SWDs participating in a modified problem-solving intervention displayed greater growth than their peers receiving the traditional problem-solving instruction (Krawec & Huang, 2017). Special education teachers also modify mathematics interventions to increase scaffolding, improve instructions, and decrease or increase the cognitive load based on their perceptions of student need (Hunt, Valentine et al., 2016). In contrast, teacher implementation of CRA strategies such as manipulatives and calculators did not provide improvement for SWDs or SWODs (Morgan et al., 2014). Growth for SWDs was only associated with teacher-directed instruction, but SWODs demonstrated growth during both teacher-directed and student-centered learning activities (Morgan et al., 2014).

Technology-based instruction as a constructivist practice. Another area of mathematics instruction that appears frequently in the research is the use of technology-based instructional programming to teach mathematics concepts and to practice mathematics facts. Technology-based programs are becoming more common in schools as teachers and program developers identify new ways to use technology to enhance interest and develop real world connections for students learning advanced mathematics concepts (Creech-Galloway, Collins, Knight, & Bausch, 2013). Technology can be used in both non-constructivist (i.e. direct instruction and rote practice) and constructivist practices (i.e. within anchored instruction, as a self-modeling tool), based on how it is employed and the mathematical level of the students (Baroody et al., 2013; Bottge, Ma, Gassaway, Toland et al., 2014; Burton, Anderson, Prater, & Dyches, 2013). Instruction that incorporates technology to provide real-world connections and encourage active student participation in learning fosters a constructivist-based approach.

Technology based programs can be effective tools for supporting SWDs in acquiring fact fluency and number foundations. First grade students at-risk for mathematics difficulty improved their performance on basic addition fluency for add 1, doubles, and near-doubles facts after using a computer intervention that explicitly taught the add 1 and doubles strategy, and used discovery learning to learn the near doubles facts (Baroody, et al., 2013). Third grade SWDs in Turkey increased number sense acuity and decreased numbers and operations errors following the use of a computer assisted intervention that targeted numeracy (Mutlu & Akgun, 2017). SWDs in fourth grade participated in alternating treatments including teacher directed instruction, instruction using an iPad application, and instruction combining teacher directed and iPad based learning to practice and memorize multiplication facts (Bryant et al., 2015). Students showed comparable growth in multiplication fact fluency between all three conditions, but students reported different preferences for their own learning and engagement on social validity scales, indicating that efficacy of treatment and student preference should both be considered when selecting an intervention (Bryant et al., 2015). Fifth grade SWDs demonstrated significant gains in multiplication fact fluency following use of an intervention that combined a problem solving approach to multiplication numeration with a doubling strategy and regular fact practice (Ok & Bryant, 2016). SWDs may be able to strengthen fact fluency and numeracy concepts using teacher selected technology-based instruction.

Computers and technology tools can also support the development of mathematics problem-solving skills for SWDs when they are used as part of an overall curriculum and are tailored to the specific needs of the student. SWDs in third grade who used eWorkbooks as a flexible learning experience displayed greater attention and focus during instruction and exhibited other positive learning behaviors such as referencing previous materials and using hints to improve accuracy during independent practice (Kaczorowski & Raimondi, 2014). Third and fourth grade SWDs improved their ability to solve paper and pencil multiplication word problems using a computer-based tutoring program that provided immediate, specific feedback and coaching to prompt students to reach the correct conclusion, but students in teacher-directed tutoring showed minimal improvement (Xin et al., 2017). Teachers reported increased student engagement, and improved independence and mathematical understanding while using a mathematics app to individualize instruction for fourth grade students with SWDs (Kaur, Koval, & Chaney, 2017). SWDs and students at risk for mathematics difficulties in 4^{th} grade demonstrated more growth than SWODs after using an iPad application to practice decimal and multiplication concepts (Zhang, Trussell, Gallegos, & Asam, 2015). Fifth grade SWDs demonstrated twice as much growth as the control group following an intervention with a computer based test question practice that aligned questions from mathematics structures along Bloom's taxonomy of cognitive progression (Zhang & Zhou, 2016). Technology-based mathematics support can provide accelerated growth for SWDs when used appropriately within the classroom curriculum.

Although none of the articles I located reported an overall lack of effectiveness for technology-based interventions, individual students using technology-based interventions demonstrated different levels of achievement. In a single case, alternating treatment design comparing technology-based interventions with teacher directed interventions, only five out of the six students showed significant improvement in mathematics skills over the course of alternating interventions (Bryant et al., 2015). In another single case design study, students completed social validity scales to report on their preferences for using a computer program to practice solving fraction word problems, and only two out of three of the students indicated they would continue using the program if it was available (Shin & Bryant, 2016). Technology-based interventions may be appropriate in some situations to support SWDs, but teachers should choose interventions carefully to match student needs and should monitor to ensure positive outcomes for SWDs.

Enhanced anchored instruction. Built on the social-constructivism platform, enhanced anchored instruction (EAI) involves interactive and real-world experiences in mathematics as learning opportunities for underlying concepts. Similar to problem-based learning, EAI is used to set up authentic learning situations where students view short context or situational videos, before solving real-world problems that allow them to acquire skills in related content areas (Bottge et al., 2015). In mathematics, teachers can use EAI to provide applications for traditionally taught concepts within an engaging context that motivates students and improves their maintenance of the concepts learned over time (Bottge, Ma, Gassaway, Toland et al., 2014; Bottge et al., 2015). A primary goal of EAI is to enhance real-world skills such as collaboration and problem solving in mathematics in ways that cannot be taught using pencil and paper applications (Bottge, Ma, Gassaway, Toland et al., 2014). SWDs taught mathematics using EAI improved both participation rates and skills acquisition in fractions and ratios (Bottge, Ma, Gassaway, Toland et al., 2014). SWDs receiving EAI applied problem solving skills more effectively than SWDs receiving business as usual instruction and the progression of errors from pre- to post-test demonstrated increasing sophistication of fractions usage (Bottge, Ma, Gassaway, Butler, & Toland, 2014). Within my extensive review of the literature regarding mathematics instruction, I was unable to locate any current studies that presented a differing view regarding the effectiveness of EAI. Increasing the real-world relevance of instruction for SWDs can be a critical piece of improving student participation and learning in mathematics classes.

Problem solving strategy and skills instruction. Foundations in arithmetic concepts, numbers, and operations are not exclusively responsible for the development of quality problem solving skills in later grades. Effective problem solving must be taught using constructivist-based approaches because it requires students to process multiple layers of information and simultaneously use number concepts and operations skills, which is challenging for SWDs who struggle with the cognitive demands of problem solving (Hunt & Empson, 2014; Kong & Orosco, 2016). SWDs and at-risk students follow similar trajectories of problem solving skills development as SWODs, but require far more time to develop more sophisticated approaches and to eliminate more cumbersome strategies from their habits of use (Hunt & Empson, 2014; Hunt & Vasquez, 2014). Second grade SWDs were more fluent with nonsymbolic problems on assessments than with symbolic problems but performed far below SWODs on both problem types (Driver & Powell, 2015). SWDs also approach learning problem-solving and mathematics concepts differently than SWODs and may require different types of instruction to successfully conceptualize new concepts such as fractional quantity (Hunt, Welch-Ptak, & Silva, 2016).

SWDs benefit from increased instruction that is individualized, intensive, and responsive to their cultural and linguistic needs. Students at-risk for mathematics disabilities who were also classified as English language learners demonstrated significant growth in word problem solving following an intervention that was provided in small groups, included culturally and linguistically responsive techniques, and included visual supports such as drawings, objects, and graphs (Driver & Powell, 2017). In a study of second grade SWDs in Italy, students in the control group received additional mathematics training but displayed minimal gains, while students in the treatment group who received individualized mathematics programming demonstrated significant growth in almost all mathematics components tested and were able to demonstrate maintenance of the skills at follow-up (Re et al., 2014). SWDs in fourth, fifth, and sixth grade achieved greater rates of success than in any prior school year when participating in a classroom that was structured around intensive precision teaching to target individual problem solving and mathematics skills in small groups (Weisenburgh-Snyder, Malmquist, Robbins, & Lipshin, 2015). Developing quality problem solving skills requires more intensive instruction and support for SWDs than for SWODs, due to the additional time needed for practice and establishing patterns and habits of practice.

Moving beyond increased practice opportunities and additional time to develop the skills required for problem solving, for SWDs to effectively learn problem solving skills requires explicit, step-by-step instruction in strategies that target critical thinking and task analysis and utilize the constructivist-based principle of student-centered learning. In the early grades, problem-solving instruction typically targets specific constructs and concepts in mathematics such as numeracy, multiplicative reasoning, word problems, and fractions and ratios (Hunt & Vasquez, 2014; Kong & Orosco, 2016). Moving into the upper elementary grades, a primary focus of problem solving relates to the use of fractions concepts and supporting students in developing an understanding of part to whole relationship, which is particularly difficult for SWDs (Hunt & Empson, 2017; Hunt, Tzur et al., 2016; Sharp & Dennis, 2017). Problem solving instruction to support growth in fractions concepts and problem-solving should include frequent formal and informal assessment to determine changing areas of need for SWDs, and should target current performance by introducing systematic strategies that build on previous learning (Cuenca-Carlino, Freeman-Green, Stephenson, & Hauth, 2016; Hunt & Vasquez, 2014; Kong & Orosco, 2016).

Combining instruction at the concrete and representational levels with specific strategy instruction may help SWDs develop effective problem solving strategies. Strategy interventions that place less demand on working memory, by providing verbal and visual supports and using manipulative materials, were more effective for SWDs in problem solving (Swanson et al., 2014). SWDs in fifth grade who received a constructivist-based intervention that focused on helping students internalize fractions concepts improved their ability to solve fractions problems compared to previous explicit instruction that focused on following problem-solving steps (Hunt, Tzur et al., 2016). Fourth grade SWDs demonstrated growth from a baseline of zero to nearly 100 percent accuracy in solving word problems comparing fractions after learning a problem-solving strategy that included model-drawing to compare, order, visualize, and verbalize the fractions represented (Sharp & Dennis, 2017). Combining explicit instruction, the use of models and exemplars, and student-generated visual and verbal representations improved the mathematics problem-solving skills of third grade SWDs and students at-risk for mathematics disabilities (Kingsdorf & Krawec, 2016; Morin et al., 2017; Swanson et al., 2014). Instruction that combines problem-solving strategies, explicit instruction, and concrete-representational supports may enable SWDs to simultaneously acquire problem-solving approaches and build conceptual knowledge.

Problem-solving strategies that focus on limited areas of mathematics skills acquisition without advancing SWDs to develop conceptual fluency may fail to meet the needs of SWDs when solving real world, multi-step or multi-faceted problems, which require a flexible, cognitive strategy approach. Fourth-grade SWDs in China demonstrated a greater rate of growth than SWODs using a cognitive strategy approach to problem solving and ended up surpassing the SWODs in overall growth by the end of the study (Zhu, 2015). Cognitive strategy instruction with significant amounts of student verbalization and teacher guidance improved problem solving and concept development for third, fourth, fifth, and sixth grade SWDs and students at-risk for mathematics disabilities (Flores, Hinton, & Schweck, 2014; Flores, Hinton, & Strozier, 2014; Krawec & Huang, 2017; Xin et al., 2016). Emphasizing the use of critical thinking and cognitive-based strategies use to solve problems supports the development of lasting skills for SWDs rather than providing temporary approaches to solving limited problem sets.

Paraphrasing and visually representing mathematics problems are metacognitive approaches that allow teachers to observe students' cognitive processes, and were linked to problem solving accuracy for SWDs and low-achieving students, but were not necessarily an indicator of average achievers' success (Krawec, 2014). Third grade minority students at-risk for mathematics difficulties improved their word problem solving skills after receiving a dynamic strategic mathematics problem solving intervention that emphasized applying specific thinking steps to each individual problem (Kong & Orosco, 2016). There is support for the use of cognitive strategy instruction for average achieving SWODs, but there is also indication that the use of cognitive strategy interventions did not produce the same rate of growth for high achieving SWODs, and considerable evidence regarding the benefits for SWDs (Zhu, 2015). Although I did not locate articles in my literature search that indicated problem solving strategy instruction to be ineffective, Burns et al., (2015) reported a lack of growth when SWDs were intentionally provided an intervention that did not match their need, followed by significant growth when the appropriate intervention was provided.

Non-Constructivist Approaches

Fact practice for fluency. Mathematics instruction that emphasizes memorization of information and repetition of skills rather than open-ended cognitive growth does not fit the model of constructivist learning, but may still be necessary for SWDs and SWODs to build a foundation in basic mathematics. Performance on mathematics fact skills in late elementary and middle school is a strong predictor of growth and achievement through eighth grade (Nelson et al., 2016). When mathematics facts are taught for memorization, rather than to build the concepts of numbers and numeracy foundations, SWDs may improve repetition of facts more quickly, but SWDs may or may not make solid number connections as they learn the facts.

Frequent practice and fact repetition are frequently used to build fact fluency for students in elementary schools. SWDs in third and fifth grades showed immediate improvement in multiplication fluency when they began a race-based mathematics fact practice intervention (Skarr et al., 2014). Repeated response, both written and oral, improved the subtraction fact fluency of SWDs in third grade, with written repetition providing the highest effect (Reynolds, Drevon, & Shafer, & Schwartz, 2016). Fifth grade SWDs and SWODs improved multiplication fact fluency after nine weeks using the Rocket Math fact fluency curriculum as a whole class intervention (Rave & Golightly, 2014). Fact tutoring and practice improved the fact fluency of first grade students at-risk for mathematics difficulty, but added instruction in vocabulary did not have an effect on fact fluency (Powell & Driver, 2015). Repeated fact practice strengthened the fact fluency of SWDs and SWODs when non-constructivist practices were used.

The way that students practice facts may have an effect on how students acquire them, but the order in which facts are presented did not show an effect. Students at risk for mathematics difficulty in first grade who practiced facts under timed conditions (speeded practice) yielded higher results in 2 digit fact calculations than students who practiced without a timed condition (Fuchs et al., 2013). SWDs in upper elementary grades who practiced multiplication facts that were grouped by characteristic did not display greater improvement than students who practiced facts in a traditional grouping (Agaliotis & Telli, 2016). Students who had not developed sufficient numeracy concepts before practicing addition and multiplication facts displayed poor growth during the intervention, but showed significant growth when provided the conceptual practice needed to understand the facts (Burns et al., 2015). Fact practice is important for all students, but teachers of SWDs should carefully consider interventions that include timed practice and that match the needs of the SWDs.

Teacher-directed, non-constructivist instruction. In contrast to the recommendations for constructivist-based, student centered learning, there is also evidence that supports the use of non-constructivist, explicit or teacher directed instruction to support SWDs. In a longitudinal study designed to examine which instructional practices implemented by teachers in first-grade produced the highest achievement in SWDs, explicit or direct instruction, without an emphasis on constructivist-based practices, was found to positively predict student success (Morgan et al., 2014). SWDs in fifth grade reported preferences for instructional materials designed by their teachers over professionally produced materials and charts (Igbo & Omeje, 2014). SWDs in third and fourth grade demonstrated more growth through teacher directed instruction that deemphasized peer-mediated instruction and emphasized teacher discourse (Griffin et al., 2013). Teachers who use direct instruction may improve SWDs acquisition of mathematics procedural knowledge.

Direct instruction was not effective for all mathematics concepts, even in the early grades. SWDs in first grade who participated in addition tutoring plus explicit vocabulary instruction made slightly smaller gains than students who participated in addition tutoring with vocabulary merely embedded in the instruction (Powell & Driver, 2015). Although SWDs in both groups improved over SWDs in the control group, it was anticipated that SWDs who received the additional, explicit instruction in vocabulary concepts would demonstrate greater achievement following the intervention than SWDs in both of the other groups (Powell & Driver, 2015). The exact reason for the lack of growth during explicit instruction is unclear, so further research is needed to determine the effectiveness of explicit instruction for teaching mathematics vocabulary to SWDs.

Technology-based instruction as a non-constructivist practice. Many mathematics instructional technology applications are constructivist-based in their approach to mathematics and problem solving, but applications that are non-constructivist-based can still hold value for students at various levels of mathematics learning. SWDs made larger gains than SWODs and narrowed the achievement gap following the use of technology-based interventions to practice decimal knowledge and multiplication facts (Zhang et al., 2015). In the area of geometry, computer-based virtual manipulatives can provide a bridge for students between concrete and abstract concepts, and can improve focus for SWDs with attention-based disorders by increasing the contrast and visual input (Satsangi & Bouck, 2014). Virtual manipulatives for advanced content practice allow students to manipulate 2D and 3D objects to enhance understanding and access and to increase visual focus (Satsangi & Bouck, 2014). Computer-based mathematics practice can improve student focus and accuracy by limiting overwhelming visual input and by providing access to practice that builds upon previous concepts. None of the articles I located in my search provided null results for using technology to practice mathematics facts.

Summary

Mathematics is a complex content area with layers of concepts that build on foundational knowledge. Within my review of the current literature I described the ongoing mathematics achievement gap between SWDs and SWODs. The achievement gap puts SWDs at a disadvantage because it frequently prevents them from taking advanced mathematics classes in high school, and limits their college and career options following high school (Barnard-Brak et al., 2014; Shifrer, 2016). Teachers of SWDs must implement high-quality effective practices to support the mathematics development of SWDs and close the achievement gap.

After describing the achievement gap, I examined the effectiveness of various constructivism-based teaching practices for SWDs in the mathematics classroom. Constructive practices require the teacher to focus on critical-thinking skills to build meaning related to concepts and emphasize the cognitive development level of the student rather than relying on memorization of facts to develop skills (Gredler, 2012). Practices such as enhanced-anchored instruction (Bottge, Ma, Gassaway, Toland, et al., 2014), concrete to abstract instruction (Hord & Xin, 2014), and problem solving strategy interventions (Cuenca-Carlino et al., 2016) can provide context and meaning as SWDs learn new mathematics concepts. Teachers of SWDs should be prepared to implement appropriate constructivism-based practices in mathematics.

Next I identified interventions that are non-constructivist in nature, such as direct instruction, repetition, and some computer-based practice programs, that also benefit SWDs when properly implemented. Teachers who employed direct instruction and repeated practice to teach and reinforce basic mathematics skills for at-risk students and SWDs saw significant improvement in students' fact fluency (Rave & Golightly, 2014). Balancing and appropriately applying both constructivist and non-constructivist practices could potentially reduce the achievement gap by providing a solid foundation in mathematics skills and building concepts at appropriate developmental levels for all students.

Despite the amount of literature available regarding mathematics instruction, there were no studies that examined both the constructive and non-constructive practices teachers report using in the classroom. To close the research to practice gap, I will explore the instructional practices teachers report using to provide mathematics instruction to SWDs in the elementary classroom.

Chapter 3: Research Method

Introduction

In this chapter, I discuss the research tradition and methodology that was used to examine the social-constructivist-based instructional strategies K-8 general education teachers implement for SWDs in their mathematics classrooms. I also describe the role of the researcher and discuss the data collection and analysis procedures. Finally, I include a discussion of the measures that were taken to ensure trustworthiness of the study and ethical protections for human participants.

Research Design and Rationale

Research Question

Research Question: How do K-8 general education teachers in five international schools instruct SWDs to learn mathematics using social-constructivist principles?

Central Phenomenon and Research Tradition

In this study, I examined how general education teachers implement constructivist-based mathematics practices in the K-8 classroom to support SWDs by implementing a qualitative methodology with an exploratory case study design, which involved a questionnaire and individual teacher interviews. A qualitative design was most appropriate due to my focus on how teachers use social-constructivist principles in the mathematics classroom. There is a lack of studies on how classroom teachers at international schools implement constructivist-based practices in the K-8 mathematics classroom. Therefore, I selected a qualitative exploratory case study design so that I could extend previous research related to best practices for SWDs in mathematics.

Quantitative measures and statistical analyses of student scores are useful in substantiating a problem or identifying correlational relationships (Creswell, 2012; Triola, 2012), but these measures lacked the depth needed to explore how teacher practices align with constructivist-based practices to guide SWDs in learning mathematics. Furthermore, due to the small sample size within the local setting, a controlled, randomized experimental trial was not an appropriate tool for examining teacher practices in this study (Triola, 2012). I also rejected alternative quantitative analyses such as quasi-experimental design, single-case design, and correlational studies, as they would not provide the desired depth of investigation within the study (Creswell, 2012; Triola, 2012). This led me to determine that a qualitative study was the best fit for my research questions and population.

I selected the exploratory case study over other qualitative designs because I focused on a small group of individuals with shared values and goals and explored similar perspectives of the subjects related to social-constructivist strategies for mathematics instruction for SWDs (Creswell, Hanson, Clark, & Morales, 2007; Creswell, 2012). The case study provides an element of context to any investigation, which allows for the researcher to probe deeper into the topic (Creswell et al., 2007). My research questions were written to frame an exploration of the constructivist-based practices teachers implement for SWDs in the mathematics general education classroom. A qualitative exploratory design with a small sample was the best approach to gain insights into teacher practices related to my topic because it allowed me to collect and analyze data simultaneously and continually throughout the process (Glaser & Strauss, 1965;

Miles & Huberman, 1984). Additionally, my emphasis on open-ended, qualitative data allowed me to explore the data using a priori, open, and axial coding to identify themes.

I rejected a phenomenological design because although it is applicable to a small sample, it is focused on participants' subjective views regarding a shared life experience such as living through a natural disaster or participating in a major historical event (Rumrill et al., 2011). Although the participants share the experience of teaching mathematics to SWDs, how they teach is unique due to their diverse backgrounds, and no single phenomenon is central to how each of them teach mathematics to SWDs. I also considered a grounded theory approach, which involves systematically collecting data, identifying themes, forming a theory regarding the central topic or process, and then repeating the data collection and analysis to continue to refine the theory (Creswell, 2012). However, my focus was to explore how general education teachers use social-constructivist-based principles to provide mathematics instruction for SWDs rather than develop a theory. I also rejected the ethnographic approach, which is focused on shared values, beliefs, and ideals within a relatively homogeneous people group (Creswell, 2012) because the teachers at the local sites come from diverse backgrounds and have varied experiences. Further, I studied how these teachers provide social-constructivist-based instruction to SWDs and was not focused on what they believe or value about social-constructivist-based instruction.

Role of the Researcher

I took the researcher role of observer-participant in this study. Although I taught for 9 years at one of the school sites and know one of the participants from my time living in that country, I have never had a supervisory relationship with any of the participants of the study. Furthermore, the participant I know was not employed at the school during my tenure there. My previous experiences teaching at an international school and teaching in a general education classroom allowed me a deeper insight into the experiences of my participants, but my distance from the individual sites and participants helped reduce potential power conflicts with participants (Yin, 2016).

Methodology

Participant Selection

The sample for this study included eight classroom teachers in grades K-8. There is no specific number of participants required for a qualitative study; when the methodology requires thick descriptions of the data, the researcher must include an appropriate number of participants to maximize information without overreaching the constraints of the study (Yin, 2016). In this study I addressed both a broad level and a narrow level by exploring data across schools and within distinct communities (see Yin, 2016). To collect sufficient data while maintaining appropriate focus on my topic, I limited the study to a maximum of 12 teachers with a goal of acquiring participants from eight different schools. Seventy-six participants from the eight schools were invited to participate, with the recognition that not all teachers would opt-in to the study. Eight teachers from five schools agreed to participate in the study. These teachers are responsible for providing core instruction in mathematics to SWDs in their general education classrooms. This approach to sampling is considered purposeful, criterion sampling because inclusion and exclusion were based on criteria that are related to the topic and the potential value of insights the participants can provide (Creswell, 2012; Rumrill et al., 2011). Inclusion criteria for this study was general education classroom teachers who (a) provide mathematics instruction to K-8 SWDs in the general education setting and (b) were employed at one of the eight school sites for the 2018-2019 school year. If participants did not respond to my first e-mail contact within 2 weeks, I resent an e-mail one time inviting them again to participate. Due to the low number of positive responses, I included all the respondents after verifying they met the inclusion criteria and were willing to complete all portions of the study.

Instrumentation

Data were collected using an open-ended questionnaire (Appendix A) that was provided to teachers in a Google Form and through a semistructured interview (Appendix B). I used the CLES (Johnson & McClure, 2004) to guide development of the questionnaire and the primary interview questions. I obtained permission to use the CLES via e-mail from one of the primary authors on April 30, 2018. The CLES is a quantitative teacher survey used to examine teacher reported use of constructivist practices in the science classroom, focusing on five constructivist domains: personal relevance, uncertainty, critical voice, shared control, and student negotiation (Johnson & McClure, 2004). The CLES has good internal consistency throughout the form (Johnson & McClure, 2004). I modified the questions presented in the CLES to fit the mathematics classroom (i.e., substituting the word mathematics for the word science) and to frame them as open-ended questions on teachers' use of social-constructivist-based practices in the mathematics classroom. I used the questionnaire to elicit initial data from teachers, and based on my analysis of the first questionnaires, I added an additional question to the interview protocol. I also added probing follow-up questions for individual teachers if there were comments in their questionnaire that were brief, vague, or lacking sufficient details. These follow-up questions were inserted at appropriate points during the interview and were phrased in the form of "you mentioned [topic] on the questionnaire, can you explain more about that idea or practice?"

Additional data were collected through semistructured interviews (Appendix B) based on the social-constructivist framework. I wrote the interview questions to go deeper than the questionnaire and expand on the main areas of constructivist-based instruction outlined in the CLES. I updated the overall interview protocol following analysis of the first two questionnaires and then noted areas for probing follow-up questions on the individual interview protocols based on each teacher's responses on the questionnaire. The interview protocol aligned with the research questions and provided an opportunity for participants to fully describe the practices they implement in their own classrooms. To prompt participants to describe how they teach mathematics to SWDs and permit me to explore the topic in depth, I used a semistructured interview rather than a fully structured interview, which would limit the responses of participants (Yin, 2016). Interviews were conducted using the freeconferencecall.com platform for dialing in, recording, and downloading the audio sessions.

Procedures for Recruitment, Participation, and Data Collection

I contacted the local school director or principal at the original three schools located in China, Peru, and Turkey to request permission to conduct the study. Following receipt of permission from the school site directors, I submitted the proposal for approval to Walden University Institutional Review Board (IRB; approval no. 10-26-18-0079021). Once I received IRB approval and administrator permission from the three schools, I requested e-mail contacts for teachers who met the study criteria and sent an e-mail invitation to each teacher included in the lists. I received positive responses from two teachers. Once participants indicated they were willing to participate, I e-mailed a link to the initial questionnaire (Appendix A) in Google Forms. I initially anticipated receiving more responses to my request, so I had planned to limit the study to the first 12 teachers who responded and matched the selection criteria. Because I received only two responses that matched the criteria, I accepted both participants. I resent the invitation e-mail to teachers who had not responded within 2 weeks of my initial email to remind them of the invitation. I analyzed the data from the questionnaires and added Question 11 to the semistructured interview protocol as well as adding probing follow-up questions for each individual teacher if there were any responses to questionnaire items that were brief, vague, or required further clarification.

After completing the first two interviews, I contacted additional schools in the network that had not previously expressed interest and reminded them of my request for their permission to conduct the study at their school. I received permission from an additional five school administrators, received IRB approval for the modified protocol, and requested the contact lists from school administrators. I invited all teachers included in the additional lists and sent a follow-up e-mail after 2 weeks to teachers who had not responded. Six additional teachers responded, completed the questionnaire, and participated in the interview for a total of eight teachers from five schools.

As participants completed the questionnaire, I scheduled interview times with them and conducted recorded telephone interviews within 2 to 3 weeks of receiving their questionnaire submissions. Interviews were conducted in the evenings, on weekends, or on holidays based on each participant’s schedule. All interviews lasted between 45 minutes and 1 hour. Because all participants were located outside the United States and most were in different time zones at the time of the study, interviews were conducted and recorded via telephone using freeconferencecall.com. Before beginning the interviews, I reminded participants that they were under no obligation to participate in the study. Additionally, I reminded each participant that the interview would be digitally recorded and that I would fully transcribe each interview for data analysis. Following each interview, I transcribed the audio recordings using NVIVO Transcription and stored them in a password-protected Google Drive account to ensure accuracy and security of the typed transcriptions and original recordings.

Questions for the initial questionnaire (Appendix A) were broad and open-ended. Participants answered the questions via Google Form and included their name, school location, e-mail address, current grade level, and the number of SWDs in their classroom for the current school year to ensure that participants met the selection criteria. The questionnaire included broad questions that align with the five main areas of constructivist teaching as presented in the CLES (Johnson & McClure, 2004). Each question asked teachers to describe how they implement the principles of personal relevance, uncertainty, critical voice, shared control, and student negotiations in their mathematics instruction. The questionnaire addressed instruction at the classroom level, which allowed me to target follow-up questions within my individual interviews to probe how teachers implement social-constructivist-based practices specifically for SWDs, including any special modifications they make to classroom level instruction.

Interview questions for the semistructured interviews (see Appendix B) focused on how teachers' use social-constructivist-based instructional practices for teaching mathematics to SWDs. Data from each teacher's questionnaire were used to add probing follow-up questions to the individual interview protocols (Appendix B) as needed. Sample primary and follow up questions were included in the interview protocol, but specific follow-up questions included for each participant varied slightly based on teacher responses on the questionnaire and during the interview. These semistructured interviews allowed participants to describe how they use social-constructivist-based instruction in their own classrooms to teach mathematics to SWDs. Once all interviews were conducted and data analysis was complete, participants were invited to participate in member checking to provide feedback or correction of my interpretations as needed.

Following analysis, I provided a copy of my results to each participant via email with a request to respond with any comments or suggestions for correction within seven days. If a participant requests to be removed from the study at any point, up to final approval and publication of the study, I will remove all data provided by the participant, reanalyze the data set, and rewrite results as needed. Following completion of the member checking process, I emailed each participant a thank you letter and an electronic gift card as a thank you for participating in the study. I also included my contact information again to allow participants to contact me with any questions they may have in the future.

Data Analysis Plan

I used a thematic analysis approach to analyze the data, with a priori, open, and axial coding, in this qualitative exploratory case study. Data collection and analysis occurred in two phases. In Phase 1 I collected and analyzed data from the questionnaires then used the data to make necessary alterations to the semistructured interview protocol (Appendix B). In Phase 2 I collected and analyzed data from the interviews, then I combined the data from both instruments and conducted further analysis to search for themes. I coded the data from the electronic questionnaire as soon as possible following receipt of each questionnaire, and I transcribed and coded each interview recording as soon as possible following each interview. I used NVivo to help me organize and structure the coding process, to sort codes and files, and for easy reference of codes, and NVivo transcription to help me transcribe the recorded interviews quickly and accurately (QSR International Pty Ltd, 2014). Regular review of the questionnaire and interview data with repeated analyses allowed me to develop familiarity and a deep understanding of the emergent themes and patterns in the data (Creswell, 2012; Rumrill et al., 2011).

During the first stage of analysis, I input questionnaire transcripts from all participants into NVivo and explored the results for individuals and across participants. Data for the questionnaires were collected using a secure Google Drive Form and were stored in spreadsheet format and Google Doc format without identifying information attached. Following receipt of the first two questionnaires and prior to beginning the first wave of interviews I added Question 11 to the semi structured interview protocol after my analysis revealed that one participant mentioned relying heavily on technology for instruction and the other participant did not even mention technology. Data from all eight questionnaires were analyzed together. Prior to each interview I examined each teacher's questionnaire responses to determine whether there were responses that were brief, vague, or required additional explanation and added probing follow-up questions to their individual protocol.

As I conducted interviews, I transcribed all interviews using NVivo Transcription, uploaded the data as individual Google Drive documents in my Google account, and then reviewed each transcription to ensure the accuracy of each transcript. During transcription, I removed false starts such as "hmm" or "umm" and filler words such as "like" where these words had no meaning in the data. Using my Google account, I stored all data documents securely in my password-protected account. Google Drive has constant backup protocols that will help prevent any future accidental loss of data due to computer errors. Documents and spreadsheets in Google Drive can be exported in multiple formats in order to be used with software analysis tools such as NVivo, which I used for coding the data as well as performing sorts and queries to aid me in the process of analysis (QSR International Pty Ltd, 2014).

I used NVivo to manage, sort, and store coded data throughout the collection and analysis stage. When a researcher utilizes software for the coding process the researcher is able to more easily manage, sort, and apply codes to data for analysis, and can more easily avoid overlooking related themes or concepts during repeated readings (Creswell, 2012; Rumrill et al., 2011). I inputted the data from each questionnaire and interview transcript into NVivo and began to identify codes to apply to the data as I conducted repeated reviews of the data (QSR International Pty Ltd, 2014). I initially used a priori coding to identify words and phrases in the data that align with social-constructivist practices. Following the a priori coding, I used open and axial coding to analyze the data by combining codes, reanalyzing, and combining codes again. Open and axial coding are used by researchers to generate categories of data, then link categories and create subcategories to refine the analysis (Yin, 2016). I used a priori and open coding to generate specific categories that align with my research question and with the initial data from the questionnaire. Following analysis of the data collected from the questionnaires, I identified primary and follow up questions that I added to the individual interview protocols for specific participants (Appendix B). After including data from the interviews in the data set, I used further open coding to explore subcategories and to link categories in the data. Eventually, after I added interview transcripts and codes to the study in NVivo, I combined the open codes into axial codes and reanalyzed the data to identify themes that reflect how general education teachers use social-constructivist-based instruction to teach mathematics to SWDs in these international schools, and to allow me to answer the research question using the gathered data from both the questionnaire and the interviews (QSR International Pty Ltd, 2014). Once the final interview transcripts were added and coded, I explored themes that I identified in the data across instruments and across school locations.

As I explored the data and the common themes, I also searched for discrepant cases to ensure that my results fully encompassed the data. Discrepant cases or negative instances are instances where most data records fit a code or label while one or two appear to contradict the label (Yin, 2016). These data are important in the analysis process as they can lead to the researcher refining data interpretations and reexamining the meaning of the data from multiple perspectives (Yin, 2016).

After my data analysis was complete, I provided a copy of the findings section of my study to each participant via email and asked each participant to review my findings and either return comments via email or request a phone conference to discuss or clarify if preferred. Member checking is not directly included in the data analysis process as described by Yin (2016), but I used participant feedback elicited during member feedback to edit my findings as needed to reduce misinterpretation and errors.

Trustworthiness

Establishing trustworthiness in a qualitative study may be more challenging than ensuring reliability and validity in quantitative research. In this section I will describe how I will address the aspects of credibility, transferability, dependability, and confirmability to ensure that the results of my study are trustworthy. Yin (2016) asserts that it is my responsibility to build trustworthiness in my study by infusing an attitude of openness throughout the study and selecting methods in a way that will support the credibility and authenticity of the study.

Credibility

Credibility in a qualitative study is the measure of internal validity, or the measure of how accurately a researcher's findings reflect the setting that the researcher studied (Yin, 2016). To establish credibility for my study, I triangulated data by including data from five separate school sites. Triangulation from five different sites in five different countries represents a form of data triangulation by expanding my sample to include participants with dissimilar characteristics who still possess relevant perspective regarding the topic of study (Denzin, 2017). Obtaining data from five distinct sites allowed me to explore how general education teachers in five countries with diverse school settings report using social-constructivist-based practices to teach mathematics to SWDs.

I also implemented member checking so that I would have the opportunity to fine-tune my findings and receive feedback from participants to validate my conclusions and reduce the chance of errors in my conclusions. Member checking, also known as respondent validation, is used by the researcher to minimize misinterpretation of participants in qualitative studies where self-reporting tools such as interviews and questionnaires are used (Yin, 2016). Member checking is of particular value in qualitative research where participant perspectives or voices are sought, as it provides the opportunity for participants to clarify their views if they feel the researcher has arrived at erroneous conclusions (Creswell, 2012; Rumrill et al., 2011). Member checking can also help to clear up misinterpretations or discrepancies in qualitative data, to ensure that the researcher has a clear understanding of the participants' views and insights (Rumrill et al., 2011).

Transferability

Transferability is the measure of external validity that a study holds, or the extent to which the results can be transferred to other similar settings, situations, and participants (Yin, 2016). My primary means of providing transferability in my study was providing thick descriptions of the settings, participants, and qualitative data, including direct quotations from teachers that clearly described their experiences within the research settings. Thick or rich descriptions help provide detail and variety to data that support a researcher's findings in a qualitative study (Yin, 2016).

Dependability

Dependability is another facet of trustworthiness and involves establishing the reliability of the data collected and ensuring that the procedures used throughout the study are consistent and carried out carefully (Miles, Huberman, & Saldaña, 2014). One method of establishing dependability is through triangulation of the data (Yin, 2016). In addition to comparing data across school sites, I also looked for verification in the data provided by participants within school sites and within individual data transcripts to confirm my conclusions and to help me refine my findings to best match the cases under study.

Confirmability

Confirmability is also known as objectivity and requires me to do everything within my power to establish neutrality and reduce researcher bias within the study

(Miles et al., 2014). Two practices I used to establish confirmability for this study were maintaining a reflective journal during data collection and analysis and exploring and reporting rival or competing conclusions. Keeping a journal during data collection and analysis helped me to increase self-awareness of my biases and assumptions to minimize the impact of my personal values, biases, and assumptions on my results. Reporting rival conclusions in the study serves as a means of increasing confirmability by showing that alternate ideas and perspectives have been considered and taken into account (Miles et al., 2014).

Ethical Procedures

Of primary importance in any research study involving human subjects, is the careful consideration and protection of all participants, including protecting participant confidentiality and using data and information ethically. Part of conducting ethical research includes establishing procedures to ensure the security of all data and to prevent identifying or confidential information. Additionally, ethical researchers work to minimize the risks to participants and ensure that participants may elect to end their participation at any time.

To ensure that all participants were protected, I implemented the following procedures. The directors and principals of the school sites were invited to read a summary of the proposal and to provide final approval prior to IRB approval and data collection. As the schools do not have regulations, procedures, or policies regarding research studies, the directors and/or principals have authority to provide permission for the study, and could have chosen to elicit approval from their school board if they preferred. Once I received approval from the IRB, each school director or principal provided me a list of email addresses for participants who met the criteria for the study. Participants were invited to participate in the study via email. I sent a follow-up email within two weeks for those who had not responded, requesting they either accept or decline.

To protect participant privacy and confidentiality, all participants were assigned a participant code and all interview transcripts had identifying information redacted. All questionnaire responses were stored electronically in a password-protected account and will be maintained for a period of 5 years. An audio recording of all interview calls was also stored in electronic format, along with all transcripts and notes, in a password-protected account and will be maintained for a period of 5 years. The only individuals who will be provided access to the data at any time, following individual member checks, will be myself, members of the doctoral committee, and the university IRB in the event of a need to verify data or procedural methods. Participants may revoke their agreement to participate at any time, as outlined in the Informed Consent Form, and if consent is revoked after data collection, all data will be removed from analysis and destroyed. Within the results section of my study, I used pseudonyms when needed to directly report data, and took care to ensure that identifying information was not included in the report.

Summary

In this chapter, I provided a description of the qualitative methodology proposed for this study and the role of the researcher in the local setting. I also outlined the procedures set in place to select and protect human participants, and the instrumentation that will be used for data collection. Finally, I explained the proposed procedures for data analysis, and for ensuring trustworthiness and ethics. In Chapter 4, I will provide a summary and explanation of the results and discuss the findings related to each research question.

Chapter 4: Results

Introduction

In this study, I explored how general education teachers provide mathematics instruction to SWDs in K-8 classrooms at international schools. My focus was on examining the teachers' use of social-constructivist principles of instruction to answer the research question "How do K-8 general education teachers in five international schools instruct SWDs to learn mathematics using social-constructivist principles?" In this chapter, I will review the study setting and demographics, describe my data collection and analysis procedures, present relevant results including discrepant cases, and describe trustworthiness procedures.

Research Setting

In qualitative research the researcher should takes steps to ensure that participants' identities are protected, but the researcher must also provide a rich description of the setting and relevant characteristics to allow for transferability (Yin, 2016). This study was conducted across five international schools located in China, Korea, Malaysia, Peru, and Singapore. These schools are part of a network of sister schools that provide an international, American-based education to expatriate citizens living internationally. All five schools are relatively small with fewer than 500 students per school. Despite their small sizes, the schools are diverse with multiple passport countries represented at each school.

In total, 76 teachers from eight international schools were invited to participate. Letters of cooperation were obtained from the principal or director at each of eight schools located in Bolivia, China, Korea, Malaysia Nairobi, Peru, Singapore, and Turkey. School administrators then provided e-mail addresses for teachers who met the criteria for the study and 76 invitation e-mails were sent, with follow-up emails sent after 2 weeks to any teachers who had not responded. Out of the 76 teachers invited, eight teachers responded, met the criteria for the study, and completed both the questionnaire and the study.

The final sample for the study included eight participants from five schools in China, Korea, Malaysia, Peru, and Singapore. Two participants taught at the middle school level, and six participants taught in elementary grades. One participant was male. Participants' years of experience ranged from 1 year to over 20 years teaching. All eight participants were licensed teachers and provided mathematics instruction to SWDs in the general education classroom. Due to differing laws, a lack of resources in some countries, and no provision of government funds for identified students, each school uses its own procedures to determine which students qualify as a SWD and what types and levels of services to provide.

Data Collection

Data were collected through an open-ended questionnaire (Appendix A) that was focused on classroom structures and the use of certain social-constructivist procedures in the general education mathematics classroom and a semistructured interview using a protocol (Appendix B) that was developed to focus on how teachers implemented social-constructivist instruction to support SWDs in mathematics. Teachers provided responses for the questionnaire electronically via a Google Form. Responses varied in length with some teachers providing substantial paragraphs for each question and some teachers responding with brief sentences or phrases. Semistructured interviews were conducted following the completion of the questionnaire and were scheduled at the participants' convenience on evenings and weekends. Each interview lasted between 45 minutes and 1 hour and was recorded on freeconferencecall.com to create a downloadable MP3 file. Questions for the questionnaire and the semistructured interview were drawn from the CLES but were modified to match mathematics rather than science instruction and were edited to include specific reference to SWDs in each question stem for the interviews. Each semistructured interview included all the questions in the interview protocol (Appendix B), but I asked additional probing and follow-up questions to seek clarification and elicit more information as needed throughout the interviews.

Data Analysis

Following data collection, data were analyzed using a priori, open, and axial coding. I uploaded questionnaire data into a new NVivo project and analyzed data for the questionnaire alone. Due to the timing of data collection with the two waves occurring months apart, only data from the first two participants' questionnaires were analyzed prior to the beginning of interviews. I did not draw preliminary themes from the first two questionnaires alone but chose to add a question to the interview protocol after reading through both questionnaires (Question 11). Following completion of all questionnaires, I assigned a priori codes based on the social-constructivist framework, then I conducted additional open coding on each questionnaire. A priori codes included "real world," "student voice," "student choice," "concrete," "abstract," "representational," and "inconsistencies/multiple meanings" and were selected based on the social-constructivist framework and my findings in the literature review. Open codes were assigned to fragments and sections of text that held additional meaning beyond the a priori codes or did not fit into any of the a priori codes. I repeatedly reviewed each coded section and then combined open and a priori codes into axial codes. When I was no longer able to combine codes into axial codes, I reviewed all coded sections under each axial code and identified three preliminary emergent themes from the questionnaire data set, which are presented in Table 1.

Table 1

Preliminary Emergent Themes from Questionnaires

Preliminary Theme	Subthemes
1. Flexible instructional methods	• Expand/reduce number of methods • Flexibility on concrete to abstract continuum • Multiple methods and modalities for differentiation
2. Student voice and choice	• High levels of student engagement • Structured student collaboration • Students choose and share methods; select content for review
3. Real world integration	• Cross-curricular integration • Real world examples • Student produced examples • Real-life problem-solving structures

Following completion of all interviews and transcription of each recording. I input interview data from each participant into NVivo and applied the same a priori codes as I used for the questionnaire data set. As I conducted repeated readings of the interview transcripts, I applied open codes to relevant sections of the text that supported teacher use of social-constructivist practices or that indicated a lack of these practices. Throughout the analysis process I worked first to apply narrow codes to small portions of the data then to identify which codes were related and represented an axial code level. By combining related codes and reviewing data in each axial code cluster, I identified four preliminary emergent themes in the interview data describing how teachers use social-constructivist principles to instruct SWDs in the mathematics classroom, which are presented in Table 2. Three of the four themes align with the preliminary emergent themes I identified in the questionnaire data. Further discussion of the preliminary themes from both data sets is provided in the Results section.

Table 2

Preliminary Emergent Themes from Interviews

Preliminary Theme	Subthemes
4. Flexible, Responsive Instruction	• Implement concrete to abstract continuum with flexibility • Differentiate content, review, assignments, assessments, and instructional methods • Provide individualized correction and feedback • Variety in centers, game-based learning, technology, worksheets, models, and manipulatives
5. Student Efficacy	• Student voice and choice • Peer relationships • Structured cooperative and collaborative opportunities • Active student engagement and participation
6. Real World Integration	• Cross-curricular integration • Real-world example problems • Performance assessments/activities
7. Teacher-Student Relationships	• Growth mindset • Learn student strengths and weaknesses • Establish trust

After I completed analysis of both datasets, I compared the preliminary themes. The themes found in both datasets were similar, with three overarching themes across the two sets: flexible instruction, student efficacy, and real-world integration. The fourth theme emerged from the interview dataset as teachers discussed the importance of building relationships with SWDs and creating a trusting environment where students feel comfortable taking risks and making mistakes. In the next section, I discuss each of the preliminary emergent themes and describe the growth or expansion of each theme with the combination of both datasets.

Discussion of Results

Through analysis of the data, I identified seven preliminary emergent themes—three from the questionnaire data and four from the interview data. These themes aligned to social-constructivist practices, were well represented and supported in the data, and described mathematics instruction provided by the participants. I discovered additional layers of information during the interview process and used the preliminary themes from both datasets to refine the final emergent themes: flexibility with instruction, student efficacy, real-world connections, and teacher–student relationships. In the remainder of this section I describe the preliminary themes and the final emergent themes, provide rich descriptions from the data, and explore the presence of a cap in practice.

Preliminary Theme 1: Flexible Instructional Methods (Questionnaire)

Teachers reported several practices and approaches that demonstrated their use of flexibility to meet the needs of SWDs in the mathematics classroom. In some instances, a teacher might provide additional methods for SWDs to apply when solving problems, and in some situations they may limit the number of methods taught to SWDs to reduce any confusion. Teachers reported using the concrete-to-abstract continuum intentionally and with flexibility to support SWDs in learning mathematics concepts. Teacher 1 stated, “For this we use many models and word problems to help students understand, for example, how the multiplication of fractions/decimals equals a smaller number." The flexibility that teachers employ may not always match what a student prefers but is designed to match their current functioning level and support growth in concept development. According to Teacher 4:

> When I teach methods for solving problems, I teach multiple strategies and require all students to practice with each of the strategies. I stress the importance of modeling math through pictures, base ten blocks, counters, diagrams, etc. I have a few students that are very strong in mental math and do not like to model their work. However, I have to help them make the tactile connections or else it is simply an abstract concept.

This flexibility in teaching methods, materials, and approaches is designed to ensure that SWDs do not simply learn procedures in mathematics but that they develop an understanding of the mathematics concepts behind each procedure and process.

Preliminary Theme 2: Student Voice and Choice (Questionnaire)

Teachers also described activities and structures in their classrooms that promote active engagement and learning on the part of SWDs. Collaborative structures, peer teaching or tutoring opportunities, and small group activities contribute to student engagement. Although most teachers reported that students have little to no choice in content due to a prescribed curriculum, they reported creating opportunities for students to choose content, methods, and mediums during review activities such as practicing problems on an individual whiteboard, using a software program, completing a worksheet, or using manipulatives. Most importantly, teachers described working to create a positive learning environment that allows SWDs to feel comfortable sharing their ideas and contributing to classroom learning. Teacher 2 described student involvement in this way: “Students feel free to say how they feel about a subject and even the quietest of my students are willing to participate. We discuss different ways of doing things.” Teachers reported working to create an environment that promotes active participation by SWDs and verbalization of the ideas, triumphs, and struggles of learning mathematics.

Preliminary Theme 3: Real World Integration (Questionnaire)

Teachers create context for mathematics concepts by helping SWDs see how mathematics relates to the real world and how we use mathematics in the real world for day-to-day tasks. The teachers reported designing projects to use mathematics concepts in real contexts to support students in making connections such as using fractions to make pizzas and using geometry to design a resort that would provide enough space for the specified number of guests. Real-world connections provide a purpose for learning mathematics and help SWDs to retain concepts with higher accuracy because there is a meaningful connection. Another teacher reported having students bring in real-life examples of percentages they discovered in their city and the class worked together to calculate the discounted sales prices or interest rates. Teacher 6 requires students to present real-world examples to the class at various times during the year: “I ask them to find examples of what we learned outside of school and present them in class.” Teachers also reported making simple adjustments to curriculum such as including students’ names and objects of interest into mathematics problems to create more interest and relevance for students.

Preliminary Theme 4: Flexible, Responsive Instruction (Interview)

Teacher responses on the interview expanded on previous comments on the questionnaire related to differentiating instruction to ensure success for SWDs. Teachers reported using centers, small group instruction, and one-on-one sessions to meet student needs for social learning and engagement. Teachers implemented technology-based lessons, games, and reviews to encourage student engagement and to provide opportunities for students to complete remediation or extension activities. This flexibility in approach may tie back to how teachers view mathematics from their own experiences. For example, Teacher 3 shared:

> I believe that there's many ways to solve a math problem and it's my goal to show students as many different ways that they can do a math problem, because as long as they derive the correct answer, who cares how they…, what route they took to get there.

Another teacher described using graphic organizers to help a SWD model and conceptualize word problems to ensure that the SWD follows the entire process and shows work at every step. Although the SWD in this teacher's story had displayed the ability to solve a majority of problems in his head using mental math, when he struggled with multi-step problems, he was unable to identify his errors. To support his continued growth, his teacher required him to use the graphic organizer for multi-step problems while other students used the organizer for all word problems.

Preliminary Theme 5: Student Efficacy (Interview)

Moving beyond merely creating opportunities for student voice and choice, student efficacy involves building capacity for learning mathematics and encouraging students to actively engage in the content. Teachers reported establishing positive peer relationships through the use of partnerships, collaborative opportunities, and cooperative learning structures such as 'Sage and Scribe' and 'Stand Up, Hand Up, Pair Up.' Improving efficacy for SWDs in mathematics leads to more active engagement and participation in mathematics and improves student perceptions of their own abilities as learners. According to one teacher: "the success for him was that he was enjoying how… enjoying the math and he was knowing how to do it without raising his hand. He [SWD] was able to work on it independently" (Teacher 1). The emphasis on student efficacy means removing the concept of failing to encourage risk taking and persistence in learning. Teacher 2 reported: "I don't think any of my students are kind of worried about failing; failing is never mentioned. You are just learning, learning what you can learn." Teachers worked to increase student efficacy by building a positive learning environment so that SWDs feel safe asking questions and digging deeper into content.

Preliminary Theme 6: Real World Integration (Interview)

Teachers work to create real-world context for mathematics concepts and skills to give SWDs an anchor for their learning. Teachers reported using performance tasks and performance assessments such as cooking and backing to anchor mathematics concepts in the real world.

> I had them make their own smoothie recipe… everyone posted about their recipe on the app…, I encourage them to go home and look at what each of their classmates posted…, and encourage them to make it at home. (Teacher 4)

Teachers also made efforts to bring the role of mathematics in future career choices into the classroom, even at the elementary level, by bringing in guest speakers in careers such as architecture and engineering. To encourage relevant real-world integration, teachers encouraged students to bring in their own examples of mathematics concepts from the real world and used those examples in problems with the whole class.

> I asked the students to come to class with either pictures or screenshots or note it down of where they have seen percentage used over the last week or so. I use some of those examples as our practice. (Teacher 5)

Relevant, real world context supports learning for SWDs and helps them to generalize the skills and concepts to their life outside of school.

Preliminary Theme 7: Teacher-Student Relationships (Interview)

Teachers reported investing time and effort in building relationships with SWDs to empower them and build trust. One teacher described working with SWDs one-on-one to coach towards a growth mindset perspective in mathematics. Although the SWD began the year with a very negative attitude towards mathematics, by the middle of the year he would share his successes and identify areas he had mastered independently. Teachers reported investing time to get to know students' strengths and weaknesses to effectively provide support and instruction. Another important aspect for building relationships that teachers mentioned was offering positive and constructive feedback so that SWDs can accept errors and learn from their own mistakes. According to the teachers, investing time in building a trusting relationship with their students allowed the SWDs in their classroom to trust them enough to ask questions, participate completely, and take risks in learning mathematics.

Final Emergent Themes

Following analysis of the seven preliminary themes I identified in the literature, I examined how the preliminary themes from the questionnaire and the interview data aligned and I identified a total of four final emergent themes from the data.

Final emergent theme 1: Teacher-student relationships. Teachers described building relationships with SWDs as a foundation for differentiation, trust, and effective mathematics instructions. Although each teacher described building relationships using different methods and words, they each emphasized the importance of knowing SWDs, knowing where their SWDs were at in mathematics learning, and knowing how to motivate their SWDs to persist through challenging learning concepts. “You have to know your students. You have to know what they’re capable of, you have to know where they’re coming from” (Teacher 3). The foundation of relationship provides teachers with the ability to know what they need in a certain situation in order to ensure success for each student.

> So when I ask him a question, or when I ask the class a question, I know that it’s going to take him additional time to come up with an answer. I know that he is capable of coming up with an answer but I know it’s going to take him more time. (Teacher 4)

Positive relationships with teachers also played a role in motivating SWDs to participate and persevere in learning tasks. "[R]elationships in the school, with me, with a student, makes a big difference in how they react to how much they want to do well (Teacher 5). [T]he stronger the relationship that you have with certain kids…, the more willing they are they to learn from you and the more willing they are to listen to you and to hear what you have to say (Teacher 6). Relationships served as the foundation for teachers to plan and differentiate instruction that met the needs of SWDs in the mathematics classroom.

Final emergent theme 2: Flexible instruction. Teachers described a variety of flexible instructional methods, tools, and approaches to meet the needs of each SWD. All eight teachers indicated that they allow students to have additional time as needed to complete tests and assignments, and that they modify lessons to support SWDs and English language learners in their classrooms. Teacher 1 described using manipulatives such as blocks, realia, and playing cards to address individual student needs in small group settings. Teacher 2 reported giving SWDs choices regarding the manipulatives and models they used for problem solving and then asked students to report on their preferred model and their reason for that preference. Other teachers reported giving students choice regarding when to use manipulatives, but also reported stepping in and moving SWDs from representational back to concrete supports to ensure that they fully grasped the mathematics concepts at work. Out of all instructional methods, teachers talked about flexibility along the concrete to abstract continuum more than any other method, and all teachers reported using various methods along the continuum such as manipulatives, models, realia, representations, drawings, and standard abstract algorithms.

Flexible instruction may also include the use of calculators, but not all teachers agreed regarding calculator use. Teachers were not directly asked about calculator use but were asked about tools that they use to support student learning and were asked about technology related to mathematics instruction in their classrooms. The two middle school teachers reported significant calculator use in their classes, reasoning that their instructional goal is cognitive mathematics processing rather than rote memorization of facts. One elementary teacher also mentioned calculator use during the interview but indicated that calculators should not be allowed in the elementary grades to ensure that students memorize facts. Five teachers did not mention calculators when discussing the tools, instructional supports, and technology they use in the classroom.

Teachers also described using technology flexibly for instruction, review, and motivation. One teacher uses technology as the main curriculum, with students essentially self-pacing through the structured program. Although students typically work to complete four lessons per week, the teacher allows for SWDs and other struggling learners to work at a slower pace as needed, and provides additional support when necessary, including skipping advanced lessons that are extensions rather than part of the core curriculum. Other teachers reported using technology for real-world connections, such as assignments where students locate various shapes around their homes or measure objects at home and submit photos. Teachers implemented a variety of flexible instructional methods based on their knowledge of the strengths and needs of their students to effectively teach each SWD in their classroom.

Final emergent theme 3: Student efficacy. Teachers worked to build self-efficacy for SWDs by creating learning environments where risk taking was safe and errors were learning opportunities rather than failures. According to Teacher 2: “I don’t think any of my students are kind of worried about failing; failing is never mentioned. You are just learning, learning what you can learn.” Teachers helped SWDs build the confidence to ask questions and to persist with challenging content when they were struggling.

> I have to constantly remind him [SWD] that when he doesn’t know what to do-- instead of just messing with another student or wondering-- giving him the confidence to ask for help and to raise his hand. And so when he does do that, when I see him asking for help and when I see him raising his hand, I really try to praise that behavior and say, “Thank you for asking me. Thank you for raising your hand. I want you to know that I am here to help you.” Because early on in the year, I don’t think he felt confident enough to ask me for help. (Teacher 4).

Teachers also worked to build positive peer relationships so that SWDs were confident participants in class as they interacted with their peers. One teacher cited small class size as a contributing factor in how her SWDs and SWODs got along well:

> [I]t helps that it is a very small class. So I have eight students and all of them, at least in my class, seem very accepting. So I haven’t had any negative comments like you know, “That’s a stupid question. Why can’t you see that?” They are all

> helpful of each other. And you know even the brightest students will sometimes make mistakes and nobody will be down on them for that. So I found this, just that sense of acceptance amongst the students. (Teacher 5)

Teachers reported pre-teaching collaborative skills and cooperative structures such as ‘Sage and Scribe’ and “Stand up, Hand up, Pair up’ to provide opportunities for SWDs and SWODs to work together effectively and to build confidence in their mathematics abilities. [W]e talk a lot about taking turns…, and listening to each other. We talk a lot about giving time to each person in a group to do something (Teacher 2). One teacher even reported recently learning new cooperative learning strategies and establishing a plan to pre-teach the strategy to an SWD who struggles with peer interactions so that he would be able to help teach his peers how to use the strategy.

Final emergent theme 4: Real-world integration. Teachers brought real-world concepts into the mathematics classroom to provide context and structure for SWDs. Teachers reported bringing the real world into mathematics by using realia, making cross-curricular connections, and using performance tasks and assessments to make mathematics come alive. One teacher reported bringing in real examples of misleading advertising to analyze and discuss during a statistics unit. Another teacher provided opportunities for students to create and share recipes to try at home and even scheduled time for the students to make pizza and cookies in the school kitchen to practice multiplying and dividing fractions. Teacher 6 asked parents to purchase an inexpensive digital or analog watch in advance of their time unit so that students could record the time of day they completed various tasks such as eating dinner, going to bed, or leaving for school. One teacher reported a perceived lack of real-world integration in their classroom due to a new curriculum cycle this year, but the same teacher also reported real-world integration strategies they had used in previous years and described ways they worked to incorporate student interests outside of school into the new curriculum.

Gap in Practice: Student Feedback and Student Self-Assessment

One area in the data that stood out as a gap in practice was that of student self-assessment and student feedback for learning. Only one teacher reported a regular, systemic approach to student feedback and self-assessment. Other teachers reported occasional instances of conducting self-assessment and/or times when feedback was solicited or received from students, but many participants reported student self-assessment and feedback as an area they felt was not a personal strength.

> And so that [choosing a preferred addition strategy] was I guess one of the ways where they can kind of give me feedback on what they prefer using in their addition strategies. But I haven't really used that in particularly any other areas. (Teacher 6)

> I don't really know. I suppose there's not a great deal of self-assessment. We will sometimes take up homework in class, or classwork, and go through the answers together. They will grade their own and I guess that will be self-assessment…, Apart from that, there's not a great deal of self-assessment. (Teacher 5)

> Once again I think this [self-assessment] is not something that I did very effectively to get their feedback. (Teacher 6)

Evidence of Trustworthiness

To establish trustworthiness in my study, I followed the procedures outlined in Chapter 3 for establishing credibility, transferability, dependability, and confirmability. The measures I took to establish trustworthiness included triangulating the data across multiple sites and participants, implementing member checking of my results, providing thick, rich descriptions of the setting, participants, and data, and working to acknowledge my own biases as a researcher and limit the impact of my bias on the interpretation of my results.

Credibility

As planned, I used multiple sites and participants to triangulate the data. My sample represented teachers in five different countries who have varying levels of education and years of experience yet share common characteristics relevant to my study. Each of the five schools operates independently and employs different curricula to reach a diverse student population. Finding common themes within the data from each teacher interview lent credibility to my results. I also looked for triangulation within the transcripts of individual participants and found specific themes that participants returned to repeatedly as they answered questions throughout the interview.

I implemented member checking with each participant by providing them a copy of my results, including quotes from participant transcripts, and requesting feedback. Participants were able to recognize their own voices and quotations from their transcripts within the results section and could provide clarification or correction if they deemed my interpretations incorrect or invalid. Two of the eight participants responded to my email requesting and indicated they agreed with my conclusions and had no concerns about being misrepresented in any way. Six of the eight participants declined to respond.

Transferability

To provide transferability I provided descriptions of the research settings and participants with as much detail as possible while still maintaining confidentiality for the sake of participant protection. As I wrote the results section my goal was to allow the voices of my participants to be heard by including quotes that supported each theme and gave solid examples of teachers' instructional practices for SWDs in the general education mathematics classroom.

Dependability

To establish dependability, I triangulated my data during data analysis by including any non-conforming data in each theme to reduce the weight of my own perspectives and biases. I also looked for agreement from most teachers within each theme to ensure that the emergent themes represented the practices of multiple teachers rather than only reflecting one or two voices.

Confirmability

Throughout the data collection and analysis process I kept notes in a notebook. The notebook also includes notes taken during interviews and notes regarding codes and themes I was identifying as I worked through the data. I reviewed my notes frequently to ensure that my findings were based on the data and that I could essentially back up my findings with information from the data set. Due to the subjective nature of an exploratory case study with qualitative data analysis, my goal was to focus on the facts as reported to me by participants rather than my own interpretations, until I had completed coding during data analysis and began looking for themes.

Summary

In this section I reported the results of my data collection and analysis, including a description of the research setting and participants, steps followed during data collection and analysis, a discussion of the results related to the research question, and evidence of trustworthiness for the study. The research question I explored was: RQ1: How do K-8 general education teachers in five international schools instruct SWDs to learn mathematics using social-constructivist principles? I discovered four emergent themes in the data regarding teacher instruction practices: Teachers establish relationships with SWDs to build a foundation for learning; teachers employ flexibility when implementing learning strategies to match support for SWDs to both the student and the task; teachers build efficacy for SWDs in the mathematics classroom; and teachers provide real world connections to help SWDs learn and use mathematics in context. I also discovered one area teachers identified as an area they do not currently implement in the mathematics classroom: teachers do not systematically provide opportunities for SWDs to self-assess and provide feedback to the teacher regarding their learning and their preferences for learning.

In Chapter 5, I will provide a discussion of my findings, my conclusions, and recommendations for future research and for practice, as well as implications for social change.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this qualitative exploratory case study was to explore how K-8 general education teachers in five international schools implement social-constructivist-based instructional practices for SWDs in the mathematics classroom. I collected qualitative data through open-ended teacher questionnaires and semistructured interviews with eight general education teachers from five schools in China, Korea, Malaysia, Peru, and Singapore. I identified four key themes that align with social-constructivist instructional practices: teachers build relationships with SWDs to inform instruction, teachers implement instruction flexibly, teachers build efficacy for SWDs, and teachers provide a real-world context for mathematics instruction. I also identified a gap in practice that teachers reported in student self-assessment and feedback.

In this chapter, I will provide an interpretation of the findings, describe the limitations of the study, and discuss recommendations for further research. I will also explain the implications and recommendations for future practice at the study sites based on my findings. I will end with a conclusion that describes the take away points from my study.

Interpretation of Findings

The key themes of relationship, flexibility, student efficacy, and real-world context represent social-constructivist practices that teachers reported implementing in their classrooms. The teachers implemented many social-constructivist principles both for whole class instruction and targeted interventions to support SWDs. These approaches align with best practices identified in the literature base as described in Chapter 2. Teachers also reported implementing best practices for early intervention, numeracy foundations, concrete to abstract instruction, technology-based learning opportunities, real-world applications, and explicit instruction in problem-solving approaches.

Theme 1 relates to teachers intentionally building relationships with SWDs to determine interventions, supports, and opportunities to push students to their full potential. Although this topic was not evident in the literature, the importance of matching interventions to student needs was noted by Burns et al. (2015) when first grade students displayed no growth after receiving contraindicated interventions but showed significant growth once appropriate interventions were implemented. Extending beyond matching interventions to areas of need, teachers in the current study reported building relationships to encourage SWDs to ask questions, participate in discussions, share their mathematical thinking, and improve motivation and engagement. One teacher also reported that SWODs who did not respond to attempts to develop relationships struggled more with mathematics than SWDs in her classroom who had developed a relationship with the teacher.

The use of flexibility in instruction is a primary component of social-constructivist learning. Teachers must be able to adjust instruction based on student response to ensure that instruction for SWDs is relevant, meaningful, and successful to meet the needs of the SWD. Learning must also begin at a student's current level and extend his or her thinking by bringing in new ideas that relate to the student's world (Gredler, 2012). Extending the literature reviewed in Chapter 2, teachers reported using flexibility along the concrete to abstract continuum by allowing student choice, prompting concrete and representational tools as needed, and reinforcing concepts using concrete objects after SWDs had displayed the ability to use abstract symbols. The flexibility that teachers implement with SWDs also applied to SWODs in their classrooms, which was confirmed in the literature when SWODs displayed less growth than SWDs following an intervention using representational problem-solving procedures (Zhu, 2015). Flexibility in implementing instructional strategies or allows students to receive what they need in a given lesson to achieve success with the content.

Building student efficacy was another theme that teachers described and is a contributing factor to measures such as student motivation and attitude toward learning. Past literature has also supported this theme. For example, student efficacy in mathematics was the primary predictor of mathematics literacy for high school students in a study conducted in Greece, with a stronger predictive relationship than other student- and school-level variables such as family economic status and school size (Cheema, 2018). To promote student engagement, motivation, and persistence when confronted with challenging tasks, the teachers in the current study taught collaborative skills, built a positive learning environment, and encouraged students to take risks. Further, in social-constructivism, learning occurs during a give-and-take exchange between teacher and pupil (Powell & Kalina, 2009). Student voice and choice play a role in building efficacy, as students must feel safe with the give-and-take format of social-constructivist learning to grasp and retain new mathematics concepts. The teachers in this study encouraged students to share their preferred approaches to solving problems and to identify which strategies and methods were most effective for them to use. One teacher also described teaching the difference between a fixed mindset and a growth mindset to support SWDs and SWODs in developing a positive attitude toward mathematics and building motivation and persistence.

Finally, real-world integration lends context to mathematics instruction to allow students to make meaning of what they are learning. Teachers in the study reported seeking ways to incorporate real-life examples and activities in their daily mathematics instruction for SWDs. Students have demonstrated a decline in their valuation of mathematics from beginning to end of year after reaching adolescence, but this decline has been reduced in classrooms where teachers provided real-world connections to mathematics concepts (Matthews, 2018). Real-world mathematics instruction may impact the lower grades the most while students are operating with greater cognitive flexibility, which is a significant predictor of mathematics valuation (Matthews, 2018). Mathematics instruction that builds meaning into the study of mathematics for SWDs could increase their valuation of mathematics and their ability to approach mathematics tasks with flexible cognitive functioning.

Limitations of the Study

There were three projected limitations to this study, which I outlined in Chapter 1. During recruiting, data collection, and data analysis a fourth limitation occurred. The first major limitation is the diversity of the research sites and participants. The study was conducted across five schools located in five different countries, and each school is highly diverse in student and teacher population, which limits transferability of the findings.

The second major limitation is the subjectivity of the methodology selected for the study. By collecting data through semistructured interviews and open-ended questionnaires, I was able to dig deeper into the instructional practices of teachers but was not able to quantify or statistically analyze the results. Since there is subjectivity at the participant level and the researcher level, the dependability of the study is limited.

The third limitation relates to my use of purposive sampling. My preference was to have greater representation from each school, and to include more than just five schools. Since the criteria for participants included only general education mathematics teachers in grade levels K-8, a few teachers from each school were automatically disqualified. Despite inviting 76 teachers, I was only able to include 8 teachers in my study who met the criteria, completed the questionnaire, and participated in the interviews. One teacher from a school site who teaches a related arts subject contacted me and requested to participate in the study, but she did not meet the criteria. The use of purposive sampling limited my final sample size and reduced the dependability of the study by reducing the weight of triangulation across participants and schools.

The fourth limitation related to the timing of recruitment, data collection, and data analysis. My original plan was to complete all questionnaires within a short window of time, and schedule interviews to follow data analysis of the questionnaires to allow me to add additional questions to the interview protocol based on the analysis of the questionnaire. After inviting teachers from the first three schools and receiving only two positive responses, I completed the questionnaire and interview process with both teachers while I began the process to invite additional teachers. As a result, I was only able to examine and analyze the data from the first two questionnaires before conducting interviews. I added one additional question to the overall interview protocol, and asked individual teachers probing follow-up questions if I required clarification for any of their questionnaire answers.

Recommendations for Further Research

Based on my findings in this study and the literature reviewed in Chapter 2, I recommend further research in two specific areas: social-constructivist instruction for SWDs in additional subject areas and the effect of teacher-student relationship on student achievement for SWDs. Effective social-constructivist instructional models increase teacher-student interaction so that SWDs can process at their current level of understanding and teachers are able to adjust instruction as needed. Further research should examine whether a social-constructivist approach to instruction could improve the performance of SWDs in subject areas other than mathematics. A second area for future research is the effect of positive or negative teacher-student relationship on achievement for SWDs in mathematics and in additional subjects. The importance of give and take in social-constructivist methods dictates a need for SWDs to feel comfortable discussing their learning with their teacher, which may not occur if SWDs do not have a positive relationship with their teacher. Further research may examine both the effect of teacher-student relationships on learning and strategies for teachers to successfully build positive relationships with SWDs.

Implications

Social Change Implications

The implications of this study for the local sites include the opportunity for individual teachers to improve their practice through self-reflection and to take a more active role in implementing social-constructivist practices in mathematics. Teachers reported a lack of regular self-assessment and feedback opportunities for SWDs to consider their own learning and report back to their teacher. After describing this gap in practice, most of the participants then began to reflect on ways they could implement a feedback strategy within their classrooms in the future. Administrators could increase and improve teacher self-reflection opportunities related to social-constructivist instruction in mathematics. As teachers increase and improve their professional self-reflection they are able to improve instruction for SWDs by incorporating the principles of self-reflection and self-assessment into mathematics instruction in the K-8 classroom. Student self-reflection and self-assessment in mathematics could lead to increased motivation, engagement, and learning for SWDs. Improving opportunities for SWDs to provide regular feedback regarding their learning could increase student valuation of mathematics, which has been linked to improved mathematics achievement for SWDs (Matthews, 2018).

Recommendations for Practice

To improve mathematics instruction for SWDs in the general education classroom, teachers should implement self-reflection and feedback opportunities for SWDs to dialogue with their teachers about their learning. This could be in the form of written feedback, using a simple rating scale, or via one-on-one conversation. The opportunity for SWDs to think about their own learning and identify areas where they do well and areas where they struggle is an important part of the social-constructivist approach because it ensures that students are ready to learn the next step with the support of their teachers.

A second recommendation is for teachers to engage in reflection regarding how their teaching practices align with social-constructivist principles. Self-reflection is an important part of the growth process for teachers but may not always be given enough time with demanding schedules. During the interview process most participants commented on their need to improve a certain area of instruction and pointed out that the dialogue about their instruction within the interview process was what caused them to reflect and identify that area of improvement.

Conclusion

In this study I explored the instructional practices of K-8 general education mathematics teachers who provide instruction to SWDs. The role of positive teacher-student relationships on student engagement, motivation, and achievement are areas that should be explored more in the future. Teachers may not always be able to build a positive relationship with students who are resistant, but successful relationships with SWDs open doorways to allow teachers to improve instruction for individual students and may reduce the achievement gap between SWDs and SWODs.

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Appendix A: Initial Questionnaire

This questionnaire contains preliminary questions that relate to the mathematics instruction you provide to students with disabilities in the general education classroom. Please answer to the best of your knowledge. I may ask you to clarify any answers you have provided on the questionnaire during our one on one interview if needed. Please answer each question using full sentences. Please provide details and examples as much as you are able/feel comfortable doing. Please use pseudonyms for students or avoid using their names.

1. Please confirm your email address.
2. Please enter your full name.
3. At which school do you currently teach?
4. What grade level do you teach?
5. How many students with disabilities/special needs do you have in your classroom (please do not count students who are ELL/ESL, unless they have an additional area of need)?
6. Describe the mathematics content you teach and the mathematics skills students are expected to master.
7. How do you help students see the relationship between mathematics and the real world?
8. How do you help students deal with inconsistencies and multiple means of exploring and solving problems in mathematics?
9. How do you promote student voice in the mathematics classroom?
10. How do students participate in choosing learning content or activities in mathematics?
11. How do students collaborate and work together to actively solve problems in mathematics?

Appendix B: Interview Protocol

Participant Name: ___________________________ Grade Level: _______________

Date of Interview: ___________________________ Years of Teaching: __________

Interview Procedures:

1. Participants will be interviewed one-on-one.
2. All interviews will be audio recorded on my personal computer.
3. Interviews will focus on how teachers use social-constructivist-based instruction to teach mathematics to SWDs.
4. Ten primary questions will be used with each participant.
5. Follow-up questions will be used as deemed appropriate by the researcher.
6. Additional questions may be added/modified following analysis of data from the questionnaire (Appendix A).
7. Participants will be assigned a pseudonym to protect their privacy and confidentiality.

Primary Questions

1. Tell me about how SWDs learn about the real world in your mathematics classroom?
2. Describe how you help SWDs relate experiences in mathematics class to the world inside and outside of school?
3. How do you help SWDs learn about uncertainty in mathematics and deal with problems that have multiple possible solutions or outcomes?
4. How do you encourage SWDs to ask clarifying questions about mathematics content, activities, and practices in your classroom?

5. How do SWDs participate in planning or choosing what they will learn?
6. How do SWDs self-assess or give feedback regarding how well they are learning?
7. How do SWDs provide feedback regarding preferred or most effective activities?
8. Describe how an SWD might negotiate a deadline or due date with you to ensure they are able to complete a learning activity?
9. How do SWDs work with SWODs in class to negotiate and problem solve?
10. How do you ensure that SWDs have an opportunity to explain their ideas to you and to other students?
11. Describe the technology (devices and applications) that you use in the classroom and how you use these tools to engage students in learning mathematics content? *This question was added after analyzing the data from the first two questionnaire responses.

Sample Follow-up Questions

1. Could you tell me more about a time when…?
2. You mentioned… could you give a specific example of a time when…?
3. In the questionnaire you wrote… could you clarify or explain what you mean by…?