TEACHER OBSERVATIONS ON THE SUCCESS OF HARD-OF-HEARING STUDENTS IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM: A CASE STUDY

by

Hannah Abbott McPherson

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University

2024

TEACHER OBSERVATIONS ON THE SUCCESS OF HARD-OF-HEARING STUDENTS IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM: A CASE STUDY

by Hannah Abbott McPherson

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University, Lynchburg, VA

2024

APPROVED BY:

Susan Stanley, Ed.D., Committee Chair

Traci Eshelman, Ph.D., Committee Member

Abstract

The purpose of this case study was to describe how deficits in foundational language among hard-of-hearing students influence mathematics instruction for general education middle school classroom teachers working to educate this student population in the South. The theory guiding this study was Paivio's theory on dual coding, as it supports learning the necessary concepts needed to perform successfully in mathematics. The central research question for this study was: What are the experiences of middle school mathematics teachers working with hard-of-hearing students? Methodology defined as a descriptive case study included individual interviews, a focus group, and journal prompts to collect data from teachers working at various middle school locations. 11 middle school content teachers with a minimum of one year of experience teaching math to a hard-of-hearing student were the participants for this study. Triangulation of the three data collection methods was completed using descriptive and pattern coding as outlined by Saldaña to characterize shared experiences within this bound group. Coding and triangulation of the data yielded two themes with two identified subthemes for each. The first theme was the instructional approach with the subthemes of daily routine and corrective instruction. The second theme was the encouragement of independence with subthemes of student motivation and hard-of-hearing student accommodations. Participants often reported class-wide academic accommodations as satisfactory to meet the hard-of-hearing students' needs and specific physical accommodations of preferential seating and sound amplification.

Keywords: hard-of-hearing, hearing impaired, middle school, mathematics

Copyright Page

Dedication

For my husband, Jeff, you listened as I shared my dream, cheered me on, and stood in the gap as I traveled this long path and fulfilled this dream. I am forever grateful! My children, Winnie and Ezra, dream big. Daddy and I are behind you. Also, thank you for the offer, but you do not have to call me Dr. Mama. A heartfelt thanks also must be given to my parents, Jimmy and Bonny, who showed me how to serve God and love others. The two of you modeled what it means to have a strong work ethic, which taught me that I could do great things if I put in the effort. Lastly, and inarguably the catalyst for this whole journey, Evelyn Dodd, you challenged me to step out of my comfort zone. I would not have taken the first step of this journey without your nudge.

Acknowledgments

It is with gratitude that I take this time to acknowledge the support of my committee chair, Dr. Susan Stanley, and my committee member, Dr. Traci Eshelman. Your guidance and reassurance allowed me to persevere through this doctoral journey. To the professors at Liberty University, thank you for praying and encouraging your students to step out in faith.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Deaf and hard-of-hearing (DHH)

Dual Coding Theory (DCT)

Hard-of-Hearing (HH)

Hearing Impaired (HI)

CHAPTER ONE: INTRODUCTION

Overview

Deaf and hard-of-hearing (DHH) students represent less than 1% of the public school population in the United States, with 77% of these children having an Individual Education Plan (IEP) to support identified academic deficits related to weakness in language and reading (Alasim, 2020; National, 2022; Nelson et al., 2019). The education of DHH students is a fascinating piece of the public-school education system. Due to the low-incidence nature of this population, teachers, administration, and support personnel may never knowingly come in contact with a member of this student group (Alasim, 2020; National, 2022). Historically, these students were educated in separate schools and later contained in a separate educational space within a local school building (Dorn, 2019; Paul, 2022). However, social changes led by legislation have markedly altered this educational practice in the past 20 years (Dorn, 2019; Francisco et al., 2020; Paul, 2022). As these students integrate with the larger hearing population, teachers work to ensure their educational needs are met (Dorn, 2019; Johnson et al., 2022; Strogilos et al., 2019). Delays in foundational language, most readily seen as delays in reading comprehension and writing ability, are the typically discussed challenges that this student group must overcome (Alasim, 2020; National, 2022; Nelson et al., 2019). However, the mathematics classroom is one environment where language plays a key but often overlooked, role (Chen, 2022; Henner et al., 2021; Rodrigues et al., 2022; Suarsana et al., 2021; Thom et al., 2022). The following chapter will discuss the historical, social, and theoretical contexts of the challenge facing DHH students in a public school setting.

Background

Understanding the arrival at this point where DHH students are educated in the general education classroom and the potential challenges faced by those living in this moment requires a look back at the history leading up to this educational landscape. Supplemental information should also be collected to detail the social setting of this academic topic. Challenges can be described from many angles, and a look at the theoretical lenses previously used to describe or effect change upon this situation guides how current research can move forward to expand further the knowledge base connected to the education of DHH students in the public education system.

Historical Context

With the passing of the Education for All Handicapped Children Act of 1975, public school systems in America ramped up their provision of special education services to meet the needs of a wide variety of students entering their doors (Francisco et al., 2020; Paul, 2022). DHH students who, before 1975, would have attended separate state-run schools to receive instruction via American Sign Language became a highly visible group transitioning to their local public school (Dorn, 2019; Paul, 2022). DHH student numbers also saw an increase locally. Those who may have discontinued their education due to the constant struggle to access a fast-paced, auditorily presented, general education curriculum in a previously unaccommodating local academic environment sought to continue their education as expectation for support became the norm. Separate classes were developed to meet this student population's needs. DHH teachers educated many of these signing and non-signing students in a small group setting for academic content subjects (Dorn, 2019; Francisco et al., 2020).

The educational landscape shifted once again in the early 2000s with the reauthorization of the Individuals with Disabilities Education Improvement Act and enactment of the No Child Left Behind Act, now re-authorized as the Every Student Succeeds Act (Bolourian et al., 2020; Dorn, 2019; Francisco et al., 2020; Lim, 2020). Due to this legislation's focus on including special education students in the general education classroom and the demand for rigorous standards-based education for all students, with or without an identified disability, few separate DHH classrooms remain (Dorn, 2019; Francisco et al., 2020). These closures have given rise to itinerant DHH teachers who provide consultation to general education teachers and short intervention sessions with DHH students weekly or monthly.

External factors such as early intervention continue to influence the educational journey of DHH students (Alasim, 2020; Meinzen-Derr et al., 2022). While required newborn screenings have increased the number of children identified as having a hearing loss shortly after birth, rural and low-socioeconomic communities continue to see a large percentage of their DHH population arriving at school without proper hearing loss identification (Robinson et al., 2023; Tucci et al., 2021). Advances in technology have also provided support to DHH students in the way of increased accessibility to sound amplification, which combats the struggle to access spoken language in noisy environments at a distance from the speaker (Alasim, 2020; Nelson et al., 2019). The educational effect of permanent or fluctuating hearing loss requires ongoing, targeted interventions to overcome the challenges faced by those within this group.

Social Context

Within each public school, general education K-12 classroom, a variety of students representing diverse learning needs are served (Dorn, 2019; Farmer et al., 2019; Francisco et al., 2020). While support personnel in the form of special education teachers, DHH teachers, and

paraprofessionals are provided, much of the responsibility for lesson preparation and presentation falls to the general education teacher (Dorn, 2019; Johnson et al., 2022; Strogilos et al., 2019). Co-teaching, the practice of having a general education teacher and a special education teacher in charge of a single classroom, has become the standard model for special education support, especially in the English language arts and mathematics classrooms (King-Sears et al., 2020; Johnson et al., 2022). Special education teachers support various students with learning deficits and general education teachers whose classrooms they share. General education teachers may not be familiar with necessary accommodations and educational best practices that provide scaffolding to access grade-level content for students with an identified learning challenge. Low-incidence student groups, such as DHH students, require even more targeted accommodations and support, which adds another layer of complexity for co-teachers, general education teachers, and the DHH teachers working to help them all (Dorn, 2019).

Theoretical Context

Academic support for DHH students, above and beyond physical sound amplification, works to overcome deficits faced due to limited literacy skills, poor social skills, delayed self-advocacy skills, and holes in their background schema, which causes difficulties assimilating new information (Dorn, 2019; Golos et al., 2021; Luckner, 2006). Focused research has detailed the need for early intervention (Meinzen-Derr et al., 2022; Tucci et al., 2021), the effect of language delays on all academic subjects (Alasim, 2020; Chen, 2022; Henner et al., 2021), and the outline of best practices to work with this small but heterogeneous population (Crowe et al., 2019; Nelson et al., 2019). DHH students transitioning to the independent middle school environment require reinforcements to overcome literacy and numerical processing difficulties as they encounter more advanced mathematical concepts (Santos et al., 2022; Suarsana et al., 2021).

The exploration of deficits in numerical magnitude processing completed by Chen (2022) assessed the DHH student's ability to mentally manipulate numerical quantities presented through numerals or quantitative representations such as an array. From the perspective of limited language access leading to math difficulties, Santos et al. (2022) discussed the connection between an unformed first language and mathematical challenges throughout a student's academic career. Suarsana et al. (2021) evaluated DHH students' mathematical skills and abilities. They concluded that reading comprehension had a more profound effect on problem-solving than the math calculation portion of a word problem. These studies highlight DHH students' challenges while learning and applying mathematical reasoning (Chen, 2022; Santos et al., 2022; Suarsana et al., 2021). A look at the challenges these students face and descriptions of support through dual coding incorporated in the classroom from the teacher's real-world perspective is needed to understand the dynamics in the middle school math environment (Enns, 2017; Yin, 2018).

Problem Statement

The problem is that middle school students identified academically as having a hearing impairment largely fall below grade level in the mathematics classroom (Chen, 2022; Henner et al., 2021; Suarsana et al., 2021). Math is often considered DHH students' strongest subject since there is less reading than other subjects such as language arts, science, or social studies (Henner et al., 2021; Rodrigues et al., 2022; Thom et al., 2022). Unfortunately, challenges arise as DHH students work to interact with and manipulate numerical concepts (Chen, 2022; Henner et al., 2021; Suarsana et al., 2021). Entering middle school, students are encouraged to be independent and rely on self-motivation to succeed (Adams et al., 2018). Unfortunately, students who begin to experience failure and frustration with the more challenging curriculum often become

disengaged. Disengagement leads to weaker performance and, in extreme cases, withdrawal from the educational environment altogether (Borman et al., 2019; Onetti et al., 2019).

Purpose Statement

The purpose of this case study is to describe how deficits in foundational language among students who are HH influence lesson presentation to increase mathematics comprehension for general education middle school classroom teachers working to educate this student population in central Georgia. At this stage of the research, how foundational language among HH students influences mathematics comprehension will generally be defined as students with a hearing level below the normal threshold not meeting expected grade level expectations. Specifically, HH students who do not use sign language as their primary mode of communication and who are served within the public school setting through an Individual Education Program (IEP) to support academic deficits (Alasim, 2020; Golos et al., 2021; Nelson et al., 2019).

Significance of the Study

As studies are performed, it is crucial to ensure that the data collected will broaden the knowledge base underpinning the topic of relevance. Areas to pay specific attention to are the theoretical, empirical, and practical implications that can be collected from a proposed investigation. The following sections outline the proposed contributions, historical foundations, and possible applications that can be drawn from this exploration into the education of DHH middle school students.

Theoretical

The theoretical significance of this study is grounded in the purposeful use of dual coding within the middle school mathematics classroom to support the acquisition of new concepts by HH students who struggle with language delays. Dual coding is the process by which a concept

is taught using multiple input formats such as auditory stimuli, visual representation, and tactile models to stimulate the transference of information from the working memory by creating numerous connections within the brain, allowing for increased potential recall of the learned information from the long-term memory (Crowe et al., 2019; Paivio, 1991; Sadoski et al., 2013). Information collected from teachers working daily to educate HH students will give a real-world view of this theoretical practice (Yin, 2018).

Empirical

Empirically, delays among DHH students in the mathematics arena K-12 are well documented (Chen, 2022; Henner et al., 2021; Rodrigues et al., 2022; Suarsana et al., 2021; Thom et al., 2022). There is a need, however, to step back and look at this challenge through the eyes of the educators working to meet the needs of this student population within the public school environment (Enns, 2017; Yin, 2018). DHH students represent a small, heterogeneous population, which creates the need for detailed accounts of interactions, successes, failures, and educational environments they participate in as described by the teachers working to educate these students (Enns, 2017; Golos et al., 2021; Reagan et al., 2021).

Practical

Practical significance can be found in explaining and expanding strategies used in middle school classrooms. Middle school represents a transitional time for all students as they work to develop their identity and become independent learners (Ardasheva et al., 2018; Borman et al., 2019; Huang et al., 2019; John et al., 2023; Onetti et al., 2019). Descriptions of the intentional use of dual coding within the middle school mathematics classroom and the perceptions of the teachers who employed these strategies will be documented (Yin, 2018). Increasing the body of work related to DHH students being served in the general education setting is needed to more

fully understand best practices that can be employed to meet their needs and the diverse student population they are being educated alongside (Dorn, 2019; Francisco et al., 2020). Strategies used to increase access for DHH students with language delays should also be considered when working with other populations struggling with language gaps (Arif et al., 2021; Crowe et al., 2019).

Research Questions

Due to the identified weakness in mathematics documented for many DHH students (Chen, 2022; Henner et al., 2021; Rodrigues et al., 2022; Suarsana et al., 2021; Thom et al., 2022), the transitional period represented by middle school (Ardasheva et al., 2018; Borman et al., 2019; Huang et al., 2019; John et al., 2023; Onetti et al., 2019) and the inclusion landscape now found in the public school system (Dorn, 2019; Paul, 2022), the research questions developed focus in on this arena. Dual coding theory is an evidence-based practice that has been shown to support DHH students in different academic environments through its practical and varied usage models (Clark et al., 2021). Dual coding has four main components: stimuli, senses, working memory, and long-term memory, which provide avenues for discussion of various implementation strategies within the classroom.

Central Research Question

What are the experiences of general education middle school mathematics teachers working with HH students?

With the diversity found within each general education classroom, descriptions of interactions with students are vital to understanding the dynamics occurring in middle school classrooms (Howley et al., 2017; Weiss et al., 2018). Specific attention is being focused on the low-incidence sub-population of HH students to create a clearer picture of the challenges and

successes found when working with this student group (Rodrigues et al., 2022). The long-held belief that mathematics is a visual subject and, therefore, more accessible to students with language deficits is a misconception that requires further investigation.

Sub-Question One

How do teachers utilize multi-sensory stimuli to teach mathematics to HH students?

Both visual and verbal stimuli can be taken in and processed simultaneously (Paivio, 1991). While verbal stimuli are linear and must be taken in one piece at a time, building to a whole concept, visual stimuli are taken in as a whole chunk of information without increasing cognitive strain. Developing targeted visual and verbal stimulus pairs increases access to concepts while reducing cognitive load. While math is considered to be visual as formulas and equations are written out following specific steps, there is also complex vocabulary, procedures, and numerical concepts that require integration for execution, especially once you arrive in middle school (Huang et al., 2019; John et al., 2023). This increased complexity of vocabulary and procedures to solve multistep equations requires visual scaffolding for DHH students (Chen, 2022). This scaffolding provides a path to follow as they apply previously learned skills to multipart problem-solving tasks.

Sub-Question Two

How do teachers facilitate connections between short-term and long-term memory for HH students?

Working memory is supported by previously learned material retrieved from long-term memory as students work to analyze and sort new material (Alasim, 2020; Zhang et al., 2017). Teachers must activate this previously learned material to foster connections to newly presented concepts. Explicitly making the connections for students reduces cognitive load as students who

struggle with reduced capacity in their working memory boost learning and encoding opportunities (Alasim, 2020; Sweller, 1988). Material presented in the classroom has no value unless it is encoded in a recallable location in a student's memory bank (Alexandrov et al., 2012; Zhang et al., 2017). Connecting new material to previously learned material allows for multiple access points for future retrieval. Teachers must guide students to recall previous information and link new information to background concepts (Bruce et al., 2018; Crowe et al., 2019).

Definitions

1. *Foundational Language Skills* – Oral language, decoding, reading comprehension, reading fluency, and writing (Alasim, 2019).
2. *Hard-of-hearing* – A person with an identified hearing level below normal thresholds that, due to need or choice, do not use sign language as their primary form of communication (Golos et al., 2021).
3. *Long-term Memory* – Infinite mental storage space where recallable information is categorized and accumulated for later recall (Paas et al., 2020).
4. *Senses* – Visual, auditory, tactile, and other perceptual qualities associated with a presented stimulus (Clark et al., 1991)
5. *Stimuli* – Verbal and non-verbal representations of an object or concept (Clark et al., 1991).
6. *Working Memory* – The limited mental space to process and extract meaning from newly presented information (Sweller, 1988).

Summary

DHH students represent a portion of the special education population receiving instruction in the general education classroom through the inclusion model (Dorn, 2019). These

students continue to score below the expected grade level norms in mathematics K-12 (Chen, 2022; Henner et al., 2021; Rodrigues et al., 2022; Suarsana et al., 2021; Thom et al., 2022). General education teachers work daily to meet the needs of their diverse student population using evidence-based support strategies (Dorn, 2019; Johnson et al., 2022; King-Sears et al., 2020). One theoretical practice to overcome language delays for the DHH population is dual coding (Crowe et al., 2019; Paivio, 1991). Dual coding is the presentation of academic stimuli through multiple sensory inputs to encourage processing through the working memory, creating a recallable information pocket in the long-term memory bank (Paivio, 1991). A closer look at dual coding within the middle school mathematics classroom is needed to expand the body of work describing the practical implementation of this strategy to support DHH students working to overcome foundational language delays (Alasim, 2019; Yin, 2018).

CHAPTER TWO: LITERATURE REVIEW

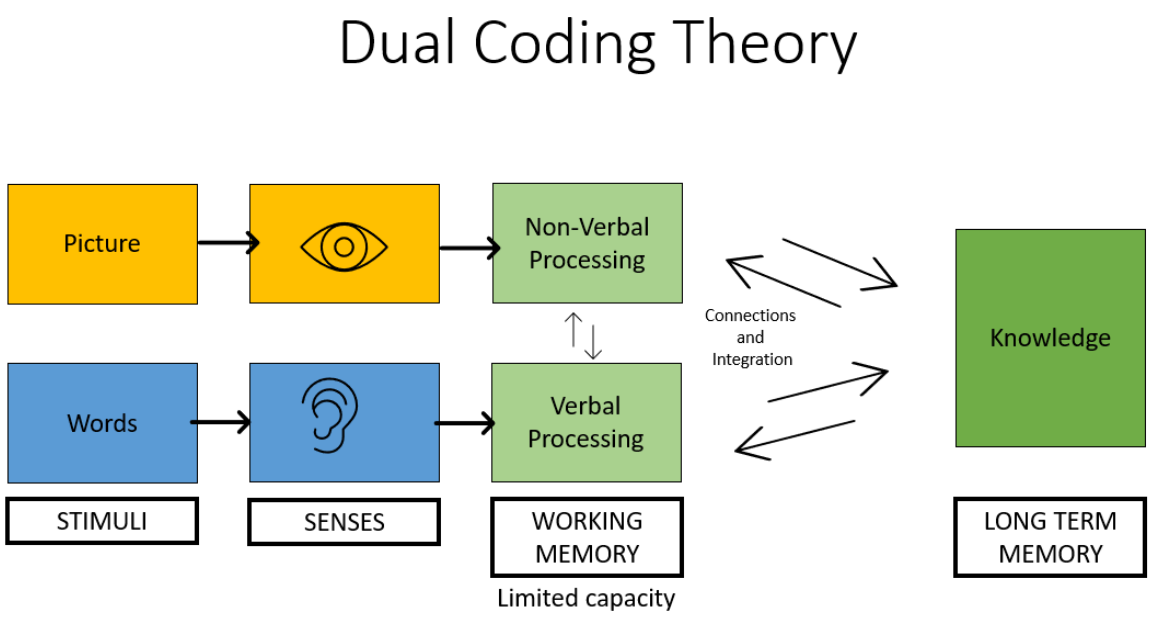
Overview

A systematic literature review explored the challenges DHH students face in mathematics once they reach middle school and the persistent effect of weak foundational language on math development. This chapter offers a review of the research on this topic. The theory of dual coding, presenting mathematical concepts through multiple mediums, such as auditory and orthographic representation, pictures, and video, will be discussed in the first section (Clark et al., 2021; Paivio, 1991). This theory introduction will be followed by a review of recent literature on the benefits of visual representation of mathematical concepts coupled with language scaffolding and providing classroom tools to reduce memory load as ideas become more complex in advanced grades. Next, the literature surrounding available strategies to boost student engagement will be identified, followed by a discussion of middle school mathematics teaching strategies used to support the learning of DHH students. Best practices for these supports are available for hearing students, and recent literature has begun to build the foundation to support these practices for deaf students. Information regarding general and special education teacher strategy knowledge to address the continuing impact of weak foundational language on the mathematic abilities of middle school DHH students requires more investigation.

Theoretical Framework

Figure 1

Allan Paivio's Dual Coding Theory



Note. This image was created based on Allan Paivio's work to demonstrate the separate pathways information takes into the working memory and how working and long-term memory overlap before new material is encoded.

The theoretical framework for this research study provides a place of orientation to view the following study and undergirds the foundation upon which the research is built. Paivio's (1971) work with dual coding has supported DHH student learning of academic concepts (Clark et al., 2021; Lederberg et al., 2022). As shown in Figure 1, dual coding theory encourages the simultaneous presentation of materials through different sensory inputs to provide the brain with multiple formats to increase learning opportunities (Paivio, 1971).

The theoretical use of dual coding, the presentation of classroom concepts in multiple formats simultaneously or consecutively, is a research-based educational support shown to increase student retention of information. (Bruce et al., 2018; Paivio, 1971; Sadoski et al., 2013).

The initial research completed by Paivio (1971) determined that presenting a picture alongside a vocabulary word allowed for higher levels of recall for the target vocabulary compared to only hearing the word. Multiple format presentation introduces information to the brain along different pathways, allowing numerous connections to be made to the presented material. Subsequent studies showed research-based benefits from the verbal presentation of information and a paired presentation that integrated nonverbal representations of classroom concepts (Bruce et al., 2018; Sadoski et al., 2013). This theory is used in a classroom setting by incorporating concrete depictions of concepts through visuals, allowing students to create an additional retrieval cue for the material (Paivio, 1991). Concrete information is more straightforward to retain and retrieve than abstract ideas (Paivio, 1971; Sadoski et al., 2013).

Dual coding is not merely adding a picture for each word, integrating nonsense photos or videos into each lesson, or turning on the closed captioning to present the orthographic representation as the teacher lectures (Kanellopoulou et al., 2019; Kennedy et al., 2021). This over-saturation of visuals can confuse students. Instead, targeted and purposeful interaction is needed with visuals to maximize the benefits of the multimodal presentation of materials (Kanellopoulou et al., 2019).

The concepts in the middle school mathematics classroom extend beyond simple calculations to synthesizing and analyzing values to determine the necessary steps for calculations and problem-solving (Huang et al., 2019; John et al., 2023). For DHH students, who often lack the background knowledge and reading comprehension skills to access word problems, the visual representation offered by the theoretical use of dual coding is crucial. It gives these students the foundational support they need to fully participate in advanced mathematical courses (Ardasheva et al., 2018; Bruce et al., 2018; Crowe et al., 2019; Suarsana et

al., 2021). The targeted presentation of images or actions that guide students through the required steps to complete complex tasks is a valuable tool for teachers as they pre-teach, teach, and re-teach math concepts (Bruce et al., 2018; Kanellopoulou et al., 2019; Paivio, 1991).

Related Literature

DHH students, though they represent less than 1% of the public school population in the United States, are a diverse group with a wide range of hearing levels, spoken and written language abilities, language preferences, and educational backgrounds (Chen, 2022; Nelson et al., 2019). Integration and support of this small but diverse population are crucial for their ongoing academic success (Nelson et al., 2019). However, due to language deficits associated with hearing loss, DHH students often enter school with limited language, which poses challenges in each academic subject (Nelson et al., 2019; Thom et al., 2022). We must understand these challenges and work towards providing practical support to these students.

As the students advance grade levels, the challenges multiply as the focus becomes reading for analysis within assignments (Alasim, 2020; Nelson et al., 2019; Onetti et al., 2019). Understanding this population's potential diversity and the effect of language deficits across academic domains, especially the under-researched area of mathematics, is crucial to determining real-world strategies to use as support for this student group (Chen, 2022; Crowe et al., 2019; Henner et al., 2021).

Challenges to Identification of Hearing Loss

Universal newborn hearing screenings were not federally funded or required in the United States until the passage of the Newborn Infant and Hearing Screening Intervention Act of 1999 (Kanungo et al., 2016). Prior to this time, individual states had implemented universal hearing screenings and, through collected data presented to the Senate and House of

Representatives, concerned groups showed the educational and economic benefits of prompt identification that led to early intervention services, which resulted in federal funding for hospitals to purchase screening equipment across the U.S. (Grosse et al., 2018; Kanungo et al., 2016). Research has long supported the need for early intervention services for children with hearing loss due to the rapid expansion of language that occurs before three years old (Chen, 2022; Nelson et al., 2019; Santos et al., 2022; Tucci et al., 2021).

Twenty years after federal funds provided equipment for the implementation of universal hospital screenings, *The Diagnostic Dilemma* was presented to the governor of Georgia, outlining the challenges faced across the state, barring identification and subsequent implementation of early interventions for at-risk children with hearing loss (Tucci et al., 2021). This statewide investigation was initiated to seek explanations regarding Georgia DHH students' arrival at critical academic checkpoints throughout their educational careers well below the performance levels of their peers. Early identification and intervention for DHH children have been determined to be essential facets of these underperformance statistics.

Among the key outcomes from this statewide report are data showing that approximately 6% of Georgia infants did not receive the required screening before one month of age, and only 22% of infants needing further evaluation were reported as having a follow-up before three months of age. For interventions to begin and language loss to be prevented, diagnosis needs to come before three months, which, sadly, happened for only 38% of Georgia's infant DHH population in 2020. Many reasons for the delay have been considered, with geographical and financial barriers often associated with delays in identification. Geography coupled with financial limitations is frequently stated due to the scarcity of medical locations across the state to perform a complete audiological evaluation for an infant under six months of age. South

Georgia houses a single location available for this service, resulting in a 2-hour plus drive for rural families once an appointment can be secured (Georgia, n.d.). Insurance, reliable transportation, and, potentially, payment for overnight accommodations are all real-world challenges parents must overcome to reach the follow-up evaluation recommended for their child (Tucci et al., 2021).

Great strides have been made by using a mobile audiology vehicle, and these critical evaluations are now being provided across the state in rural areas (Georga, n.d.). This single unit traverses the state on a set route, and appointments can be made for evaluations in alternate locations when needed. Calling attention to the need for access to follow-up for infants who fail their hospital screening has caused an increase in identification, leading to increased provision of early intervention services for DHH infants in Georgia (Georgia, n.d.; Tucci et al., 2021).

Heterogeneity of the DHH Population

Most DHH children are born to hearing parents with identification of a permanent hearing loss coming anywhere from a few months to years after the child is born (Nelson et al., 2019; Santos et al., 2022). Early intervention is imperative to slow or close gaps that develop as language learning is delayed, impaired, or learned incorrectly due to a compromised hearing input mechanism (Chen, 2022; Nelson et al., 2019; Tucci et al., 2021). Due to the lag in time from identification to the implementation of a chosen intervention such as hearing aids, cochlear implants, speech therapy, or the introduction of sign language, many DHH children miss out on the development of critical foundational language before entering the public school system (Chen, 2022; Nelson et al., 2019; Santos et al., 2022; Tucci et al., 2021). This delay in communication development is called language deprivation (Tucci et al., 2021). Language deprivation occurs when the brain's communication center receives insufficient input to create

meaningful connections to the surrounding environment. Development of communication neural pathways is slowed or stopped, resulting in a decrease in overall cognitive functioning.

Compounding the language learning challenge is the addition of a secondary disability (Howley et al., 2017; Nelson et al., 2019; Tucci et al., 2021). While it is difficult to produce exact numbers, it is estimated that 50% of DHH students have an additional disability identifier that could impede their mastery of expected learning targets. These students may be Deaf/Blind, DHH with Autism, DHH with a learning disability, or DHH with Attention Deficit Hyperactivity Disorder. These dually identified students create subcategories within an already low-incidence population group, which increases the need for highly skilled professionals well-versed in strategies that directly reinforce communication and language deficits intensified by physical or cognitive barriers to their education (Bowman et al., 2019; Howley et al., 2017; Karlsson et al., 2018; Olson et al., 2020). Due to this diversity, identifying best practices that can be employed to meet a wide range of needs is critical.

Highlighting the Hard-of-Hearing Population

Professionals in the medical and educational fields tend to speak about hearing loss from the perspective of a deficit (Golos et al., 2021; Rodrigues et al., 2022). Services through the Special Education arm of the Department of Education for students with an academic weakness due to permanent or fluctuating hearing loss result in the student identifier hearing impairment on official documents such as their Individual Education Program (Georgia, 2022). HH students are medically classified as those having mild to moderate hearing loss present after completing a hearing evaluation performed by an audiologist (Golos et al., 2021). These students can often communicate without the use of amplification. However, adding amplification for some in the

mild range and many in the moderate hearing range is beneficial (Olusanya et al., 2019; Tronstad et al., 2022).

Within the DHH community, HH people are more loosely defined as those who do not use sign language as their primary mode of communication, with any level of hearing loss present (Golos et al., 2021). A person can choose the HH identifier even with a hearing level in the severe to profound range, which is characterized by a significant physical barrier to auditory communication. HH students identify and mingle with their typically hearing peers, participating in auditory and verbal interactions with varying levels of success depending on their hearing level, use of amplification, and the presence of multiple speakers or background noise (Golos et al., 2021; Qi et al., 2020).

The improvements made to available amplification methods for HH students have opened auditory access for students who previously would have struggled to integrate into an auditory-dependent society (Philips et al., 2023). While these technological advancements are of the utmost benefit, it is essential to state that students who are hearing through a compromised internal hearing mechanism are not fixed when amplification is added. Distorted sounds are only made louder. When tools are not charged, or batteries are dead without available replacements, the student returns to their unaided hearing level (Philips et al., 2023; Rodrigues et al., 2022; Tronstad et al., 2022). Even when amplification is in place, adequately cared for, and used with fidelity, HH students continue to self-report difficulties understanding when the classroom becomes noisy and when other students present information (Nelson et al., 2019). Classroom accommodation is necessary and must go beyond the inclusion of sound amplification.

Foundational Language Skills

The need to understand how children learn to communicate and a focused effort to increase the overall reading and reading comprehension ability of DHH children has led to identifying early literacy skills children with normal hearing levels possess as they enter elementary school (Lederberg et al., 2022). These language and literacy skills can be seen long before a child steps foot into a classroom. They develop naturally in hearing children through seemingly insignificant interactions. The activities of daily living create language learning lessons that children absorb as they listen and communicate with those around them. Literacy combines many skills for successful reading and writing (Rand et al., 2021). These skills can be broken into two skill sets: meaning-based and code-based (Lederberg et al., 2022). Acquiring both skill sets to the point of proficient application is essential for on-target communication and reading outcomes.

Meaning-Based Skills

Meaning-based skills result in expanded vocabulary and comprehension of auditory and written language (Lederberg et al., 2022; Tucci et al., 2021). Spoken language flows around us even before birth. Healthy babies are born with fully developed hearing, equating to immediate exposure to spoken language rhythms, patterns, and commonalities (Erickson et al., 2019; Tucci et al., 2021). Language exchange with family, peers, teachers, and television introduces children to vocabulary, creates familiarity with speech patterns, and prepares the brain to comprehend subsequent interactions (Karasu, 2020). Sounds and vocabulary are stored in children's memory banks as their oral language neurons fire and connect to conversations and daily experiences (Erickson et al., 2019). Strong oral language fuels later reading and listening comprehension.

DHH children may completely miss out on or have significantly fewer of these needed language-building interactions, which results in a smaller vocabulary to draw from as reading begins (Karasu, 2020; Meinzen-Derr et al., 2022). Vocabulary size is one of the principal predictors of reading success (Moody et al., 2018). Familiarity with background concepts opens opportunities for creating connections between concepts and integrating new material. Unfamiliarity with basic speech patterns affects comprehension of spoken words and weakens a child's ability to apply the complementary code-based skills needed for sounding out words and basic reading.

Code-Based Skills

Code-based skills are needed for decoding words (Karasu, 2020). These skills are phonological awareness, alphabet knowledge, and basic print concepts. Phonological awareness is developed as children learn to distinguish sounds within words, identify differences, and create similar sound patterns, such as rhyming silly sounds or nonsense words. The ability to sing the alphabet, say letter names, and consciously distinguish the difference between phonemes to make the letter sounds are all alphabet knowledge skills that begin developing before a child enters school (Karasu, 2020; Lederberg et al., 2022; Tucci et al., 2021). Distortions or incomplete words with missing syllables, a common factor in the language of DHH children, lead to a deficit in these basic skills. Larger vocabularies also coincide with the ability to pick out or imitate sound units commonly heard across many words (Moody et al., 2018). Basic print concepts can easily be overlooked as a necessary skill for language and literacy (Karasu, 2020). However, understanding that words are read from left to right and pictures placed on a book cover offer clues about the topic contained within are critical early literacy skills. Children with hearing loss miss out on these essential skills (Karasu, 2020; Tucci et al., 2021).

Effect of Language Deficits Across Academic Domains

Without the foundation of a fully formed first language, the coding and integrating of new information, as explained through the connections and integrations formed between short-term memory and long-term memory, is hard for DHH students as they enter the academic arena (Nelson et al., 2019; Thom et al., 2022). Language reaches far beyond the student's reading skills or comprehension of what they have read (Guan et al., 2022; Rudge et al., 2022; Tucci et al., 2021). Limited language affects conversation, making friends, developing a positive self-image, making connections between concepts, of course, learning to read and, after third grade, reading to learn independently (Harris et al., 2017; Nelson et al., 2019; Rudge et al., 2022; Tucci et al., 2021). As the student works to interact academically, this constant cognitive strain drains focus from developing a deeper understanding of concepts as they become increasingly complex (Alasim, 2020; Kennedy et al., 2021; Paas et al., 2020).

Language Arts, Science, and Social Studies

DHH students with an IEP typically have an identified area of weakness in language and reading (Alasim, 2020; Nelson et al., 2019). This weakness is a reading comprehension deficit and a listening comprehension challenge that cannot be accommodated simply by reading the text aloud (Alasim, 2020; Nelson et al., 2019; Rodrigues et al., 2022). Students who do not have the vocabulary for the world around them struggle as they hear concepts but cannot connect the new information to something they are already familiar with within their schema (Alasim, 2020; Rudge et al., 2022). Teachers and others around them may become frustrated as the student appears to hear the conversation and can repeat what was said, but the student cannot provide an on-topic response. The same can be seen when directions are given for an assignment. The

student takes in and repeats directions but cannot begin the assignment due to confusion about the meaning of the given directions.

Simple naming vocabulary can become a significant challenge if a student encounters an unknown word (Alasim, 2020). Take, for example, the word barn. Suppose a student has yet to learn the vocabulary for that building, what that is, where it would be located, who would work inside, or what would be inside. The text surrounding this word is muddled without this concept. A discussion culminating in a descriptive explanation would likely be offered during elementary school, especially in kindergarten through second grade (Grifenhagen et al., 2022). Classrooms with integrated technology also typically provide a visual image via online search to connect the discussion to a pictorial representation, further increasing the student's understanding. However, as students advance through their academic careers, teachers begin to presume that larger quantities of information are common knowledge. Discussions tied to background scenes or common vocabulary are not the norm in middle and high school, resulting in fragmented information for DHH students who have limited development of expected terminology due to insufficient language development in the critical birth to age five learning window (Alasim, 2020; Nelson et al., 2019; Rudge et al., 2022).

This language deficit results in segments of stories or problems that may be misunderstood due to this reduced vocabulary. Students must have sufficient background knowledge to create mental images needed to understand classroom texts (Alasim, 2020; Suarsana et al., 2021). Missing or partial vocabulary and background experiences are clear, understandable challenges regarding reading and comprehension in the language arts, science, and social studies classrooms (Alasim, 2020).

Mathematics

Limited language negatively affects DHH students' math classroom success (Chen, 2022; Santos et al., 2022; Thom et al., 2022). Math is often considered DHH students' strongest subject due to the decreased volume of reading required when compared to other subjects like language arts, science, or social studies (Henner et al., 2021; Rodrigues et al., 2022; Thom et al., 2022). Unfortunately, the challenges continue as DHH students work to interact with and manipulate numerical concepts (Chen, 2022; Henner et al., 2021; Suarsana et al., 2021).

Before students enter the classroom, there are mathematical language skills that develop during conversations with parents, friends, and siblings (Chen, 2022). Daily life has a multitude of conversations that revolve around the development of quantity and number sense (Chen, 2022; Santos et al., 2022; Thom et al., 2022). Conversations that include comparative language regarding price, size, and weight all work to develop the numerical concepts children apply from their real-world experiences in the classroom. DHH children miss these conversations, especially those not receiving early or consistent interventions (Alasim, 2020; Chen, 2022; Santos et al., 2022; Thom et al., 2022).

One critical facet of number sense is looking at a problem and realizing that the calculated answer is unreasonable (Santos et al., 2022; Thom et al., 2022). Using this reasoning skill is helpful to the learning of basic addition, subtraction, multiplication, and division facts. Students who can learn math facts to the point of automaticity, producing an answer with little to no cognitive strain, can focus on more advanced-level concepts (Chen, 2022; Nelson et al.; Thom et al., 2022).

DHH students who have missed out on developing real-world number sense are typically also at a disadvantage regarding reading comprehension (Nelson et al., 2019; Thom et al., 2022).

Even before students have mastered basic fact recall, word problems are introduced, which require reading to locate needed information, followed by identifying the operation needed to calculate and solve a problem (Santos et al., 2022; Thom et al., 2022; Suarsana et al., 2021). Special attention is needed to continue the improvement of number sense, reading and listening support, comprehension, and to solidify understanding of the relationship between written and spoken language for DHH students to go forward with confidence in the math classroom (Alasim, 2020; Chen, 2022; Thom et al., 2022).

Dual Coding Theory Components

Paivio (1971) presented the concept of two cognitive subsystems, verbal and nonverbal, working simultaneously to take in information for processing and encoding. Information is taken along these two pathways, which are verbal and nonverbal processing. Nonverbal representation can be assimilated simultaneously with verbal representation, creating two paths for mental evaluation and, possibly, storage for future recall.

Sensory Stimuli

Visual and verbal representations of a single stimulus can be stored in long-term memory to increase the chance for retrieval and use later (Paivio, 1971; Sadoski et al., 2013). A stimulus concept, such as a cat, triggers a recall chain. Recall results may be the text C-A-T for writing. Expanded memory access provides a mental representation of the animal's appearance, sound associations such as meowing and purring, and sensory information such as the feel of fur, the smell of the litter box, or the feel of claws. Each piece of this stimulus provides a wealth of information to experience and interact with in conjunction with that single stimulus concept.

Dual Coding closely focuses on the presentation of information through visual and verbal mediums (Paivio, 1971; Sadoski et al., 2013). Verbal representation can be through auditory

stimuli or via printed text. Verbal information is taken in sequentially. Each piece builds upon itself, and connections must be processed and made as each new bit of information is taken in. The intake of verbal information is mentally taxing. Verbal information follows specific patterns via speech and text in the presentation of material. All information must be held for mental processing to make sense of the presented concept.

Visual representations are taken into the working memory as a whole. There is no sequence in which the information is presented or processed. The brain can access the concept in one large chunk. Visual representation causes no additional strain on the working memory and increases the chance for later recall. This sequential information intake versus the visual intake of a scene can be best represented by example (Sadoski et al., 2013). Look at the image below, then close your eyes and recall the scene.

Figure 2

Newlywed Photo

Note. This image was obtained from stock images provided through Microsoft 365.

Visual intake and subsequent recall of this whole image require minimal focus or mental exertion for the viewer (Sadoski et al., 2013). In contrast, the text used to describe the entirety of the detail shown would necessitate more mental engagement and processing. Consider the following: After their wedding, the bride and groom gazed lovingly at each other as they walked down a freshly mowed path, surrounded by tall grass, away from the small gray barn where they shared their vows. Each piece builds linearly. We initially learn that a man and a woman were recently married. After their wedding, they leave the ceremony location and look at one another as they walk. While the two are walking, we learn that they are walking across a small area of grass that has just been mowed, but there is grass that has not been cut nearby. While mentally holding that information, we then learn that there is a small barn in the distance, which is gray. Since this is not the usual color associated with a barn, we can potentially assume it is older and weathered. At the end, we learn that the barn was where the wedding ceremony took place, which was referenced at the beginning of the description. The photograph clearly defines the look of the location and participants while supporting the intake of the textual representation (Paivio, 1991; Sadoski et al., 2013).

Background familiarity with multiple concepts is needed to follow the text. In addition to the required conceptual knowledge, the ability to hold pieces and mentally organize them into a scene is necessary. The bride and groom, walking, short grass, tall grass, and a gray barn, must come together to complete the image for a single sentence. Due to Paivio's work, later researchers built upon the dual subsystems to show that introducing graphics within text reduces the time needed to search for presented relationships (Sadoski et al., 2013; Sweller, 1988). This reduction in time also leads to a reduction in the overall effort needed to take in concepts when a visual is paired with text.

Working Memory

The amount of information our brain can take in, process, and pass on to be assigned a location in our long-term memory is finite (Kennedy et al., 2021; Paas et al., 2020). This process of taking in information and processing it is called working or short-term memory (Sweller, 1988). When the working memory becomes overloaded, information is lost, and it becomes likely that entire concepts will be missed in the educational setting.

Students who struggle to read a word problem in math will arrive at the action part of the problem already having used a more significant portion of their finite working memory dedicated to cognitive load capability, which is also called intrinsic load (Kennedy et al., 2021; Paas et al., 2020; Santos et al., 2022). Intrinsic load is the amount of work a student must complete before they come to the question that must be solved (Sweller, 1988; Paas et al., 2020). Steps should be taken to ensure that students can work through complex problems without using all their focus and working memory space on the introductory concepts (Kennedy et al., 2021). Determining sequential steps that build upon one another provides time for the working memory to analyze information and connect it to previous concepts, increasing the likelihood of encoding into long-term memory in a recallable position (Paas et al., 2020).

DHH children have a significantly decreased space in their working memory (Alasim, 2020; Zhang et al., 2017). This limited capacity to take in and process new information is a barrier for students as new concepts are presented in a classroom lesson. This limited working memory space directly relates to the previous background knowledge stored in the long-term memory.

Long Term Memory

Vast stores of knowledge and experiences available for recall and application to new environments are housed in long-term memory (Bruning et al., 2020). Long-term memories result from creating accessible synapses in the brain (Alexandrov et al., 2012; Zhang et al., 2017). Scientists have determined that connections between information create multiple pathways through which the stored memory can be accessed and expanded upon. The expansion of previously learned material is significant in education. Connections to prior concepts amplify learning, and multiple connections increase the chance of future recall by creating numerous access pathways instead of one access point for each piece of learned information.

Long-term memory influences the use of space in the working memory (Bruning et al., 2020). Stores of prior knowledge allow the working memory to dedicate fewer resources to encoded and retrievable information. Focus can be turned to the unknown information being taught, allowing for a more thorough examination of the new material while connecting it to the previously learned concepts. DHH students with limited background knowledge must contend with larger chunks of information that must be evaluated due to the lack of recallable knowledge from their long-term memory (Alasim, 2020; Bruning et al., 2020; Paas et al., 2020).

The amount of information stored in long-term memory continues to be debated (Zheng et al., 2020). For practical purposes, the capacity is large enough to hold all the memories and knowledge one amasses in a lifetime. Access to information is not guaranteed even once stored in long-term memory. Storage of non-accessible information occurs more often when large amounts of information are given quickly or stored in an isolated position. Each isolated pocket of information is without the benefit of connections to other material, which reduces the brain's routes to find and produce the needed concept at a future point.

Dual Coding in the Classroom

Dual coding theory is utilized in classrooms across the United States and is interwoven into various teaching strategies. Common representations are thinking maps, graphic organizers, and infographics (Bunt et al., 2022; Charsky, 2023; Fisher et al., 2018). This format of presenting the auditory or orthographic representation of vocabulary, paired with a simple image, has many practical avenues teachers can use when working with students to develop individual handwritten notes and anchor charts. Notes and posted anchor charts are constant touchpoints students can refer to if they become stuck. These reference points offer tools for students to build independence. Visual support eases the strain on working memory and can be used in multiple formats to nurture autonomy, especially during the transitional period of middle school (Alley, 2019).

Role of Visual Supports Coupled with Working Memory

As concepts are introduced in the classroom, a portion of the student's brain focuses on finding previously learned concepts to link new information to as it moves into long-term memory storage (Kennedy et al., 2021; Zheng et al., 2020). Unfortunately, DHH students have limited working memory capacity; their brains are so focused on figuring out what the new information represents and if they know what it means that they miss the opportunity to make the connection to previously learned material (Alasim, 2020; Kennedy et al., 2021; Paas et al., 2020; Santos et al., 2022). They may also work so hard to find the connection to background knowledge that once the new information is presented, their attention has waned, and the concept is forgotten due to strain. Visual support offers more information to the brain and allows faster recall of concepts needed for making new connections (Paas et al., 2020). DHH students benefit from explicitly being taught how to work through a problem (Alasim, 2020).

Best Practices in the Presentation of Visual Material

While teachers should focus on incorporating visual supports, it is critical to use the visuals meaningfully (Bruce et al., 2018; Henner et al., 2021). Allowing DHH students to hear and see the vocabulary word alongside the chosen pictorial representation is essential to the visual-verbal pairing needed for dual coding (Bruce et al., 2018; Paivio, 1971; Sadoski et al., 2013). DHH students may not hear the word clearly or are not able to identify enough individual sounds to match the word heard to vocabulary words presented later in the lesson the same or on subsequent days (Nelson et al., 2019; Rudge et al., 2022; Tucci et al., 2021). Allowing live closed captioning to run during a lesson does not provide vocabulary support for DHH students, either (Kanellopoulou et al., 2019; Kennedy et al., 2021). This constant stream of words overloads the student and provides no time for the student to make a conscious connection between what the teacher is saying and the words constantly streaming across a screen.

As the teacher presents concepts of focus, it is critical to pause and allow students to view the word, pictorial representation, or model before proceeding with the lesson (Bruce et al., 2018; Crowe et al., 2019). This momentary lag time allows the student to connect the concept with the representation and process it in their working memory before it can be moved into their long-term memory bank (Alasim, 2020; Kennedy et al., 2021; Paas et al., 2020). Choosing visuals that include the target vocabulary words and conceptual images decreases students' mental strain as they take in, evaluate, and connect to new concepts (Alasim, 2020; Bruce et al., 2018; Kennedy et al.).

Thinking Maps

Thinking maps were developed as a visual representation of the act of metacognition (Bunt et al., 2022). Thinking maps teach students to think about how they think. This is a

necessary skill students learn. Each of the eight maps models a specific thought process. DHH students struggle to put separately learned pieces together into a cohesive and meaningful overarching concept (Crowe et al., 2019; Thom et al., 2022; Tucci et al., 2021). These students need these explicit strategies to learn how to define, classify, describe, compare, sequence, determine cause and effect, break a whole into parts, and set up analogies (Bunt et al., 2022).

Graphic Organizers

Creating activities that encourage and guide in-depth discussion is critical as students work to integrate newly introduced information into the landscape of their long-term memory (Fisher et al., 2018; Kennedy et al., 2021; Paas et al., 2020; Ponce et al., 2018). Graphic organizers provide key points for students to identify and an area for students to add vocabulary, images, or definitions to expand concepts presented during a lesson (Fisher et al., 2018). This framework allows students to recognize essential pieces of the lesson to focus on and promotes dialogue, which helps the teacher to monitor understanding as students talk about what information needs to be added to the organizer (Boyle et al., 2021; Crowe et al., 2019; Fisher et al., 2018; Ponce et al., 2018). This student-expanded document allows the teacher to guide class discussion with learning opportunities and creates a physical study guide to support assignments throughout the unit of study (Grifenhagen et al., 2022; Ponce et al., 2018). Graphic organizers are flexible and should be tailored to each lesson (Fisher et al., 2018).

Infographics

Infographics visually represent information, data, or knowledge (Charsky, 2023). A central feature of the infographic is that it should be a stand-alone presentation. Incorporating text, graphics, and the design of the presentation should allow the learner to access the information independently. This format can be used to present complex information quickly and

thoroughly. Infographics have become a widely used medium in education, across social media platforms, and in the business world (Charsky, 2023; Monroe et al., 2022; Tarkhova et al., 2020). Due to the accessibility of this format, when created effectively, students can use this as a reference resource while completing assignments.

Practicing Dual Coding

Dual coding has been shown to increase student performance and decrease the stress level of students in academically challenging classrooms (Paas et al., 2020; Paivio, 1991; Sweller, 1988; Kennedy et al., 2021). Activation of prior knowledge through discussions, pictorial representation of concepts, explicit connections shown through graphic organizers, and access to tools for basic math fact calculations emerges as strategies well-documented in their ability to increase classroom understanding and student participation (Bruce et al., 2018; Crowe et al., 2019; Grifenhagen et al., 2022; Ponce et al., 2018). A description of this in the everyday classroom and the teacher's perceptions of its effectiveness are needed.

Dual coding has limitations. Researchers have shown that there are concepts and vocabulary for which visual representation is unavailable (Kousta et al., 2011; Vigliocco et al., 2013). Adding redundant or distracting images can increase mental strain or cause confusion. Care must also be taken to align the verbal information carefully with the representative image (Paivio, 2013). It does not support learning if the image relates to a previously discussed or upcoming topic.

Student Success in Middle School

Entering middle school marks the point where students are encouraged towards independence and reliance on self-motivation to succeed (Adams et al., 2018; Onetti et al., 2019). Unfortunately, students who begin to experience failure and frustration with the more

challenging curriculum often become disengaged, which leads to weaker performance and, in extreme cases, withdrawal from the educational environment altogether (Borman et al., 2019; Onetti et al., 2019). Teachers must be prepared to create an environment that encourages engagement, provides opportunities for success, and creates a feeling of openness where students can seek support without fear of embarrassment or scolding.

Middle School and Hard-of-Hearing Students

Historically, teachers in the public school system seldom worked with a DHH student; however, with legislation and the improvements in hearing amplification technology such as hearing aids and cochlear implants, the DHH student populations are increasing within local school districts nationwide (Golos et al., 2021; National, 2022; Reagan et al., 2021). These students are entering and staying within their assigned home school locations. With the inclusion of this student group, challenges to orient general and special education teachers to specific accommodations needed within the classroom fall to professionals, such as a DHH Teacher or parents, as the student enters each new grade or course (Golos et al., 2021).

Parent interactions with middle school teachers have a much more hands-off feel than during elementary school (Berryhill et al., 2022; Garbacz et al., 2021). In-person meetings are few and far between, with Open House being one of the few scheduled parent-teacher interactions yearly. This time is characterized by hundreds of parents and students coming in and out of the building, leaving little opportunity for in-depth discussion of academic support with multiple teachers. Parents who are well-versed in the accommodations their child receives can go through alternate forms of communication to reach teachers to discuss their child's needs.

DHH teachers are the school system professionals who are the building-level contact persons responsible for setting up and ensuring that accommodations are provided for HH

students (Dorn, 2019). Depending on the school system size and caseload of DHH students, DHH teachers are often itinerant, traveling between locations to provide equipment set-up, consultation support to teachers, and academic interventions to DHH students. This teacher is an active participant in each student's education, but the physical limitations of a traveling teacher create delays in the timeline of physical presence at all needed locations. Scheduling travel time requires prioritization of needs where the most pressing are met first. Southern itinerant DHH teachers report prioritizing time as a daily facet of a traveling teacher's reality (Compton et al., 2015). This reality can create gaps between identifying a service or support need and implementation. The establishment of relationships between the DHH teacher and student, as well as the DHH teacher and school staff, is also slowed due to the sporadic nature of the service.

A Hidden Student Population

Hearing loss, which has resulted in an academic weakness, is invisible but, more importantly, cumulative (Alasim, 2020; Crowe et al., 2019; Harris et al., 2017). HH students blend in seamlessly with hearing students (Golos et al., 2021). DHH students with academic or emotional delays may not be prepared for independence as they leave the close-knit elementary school environment (Chen, 2022; Nelson et al., 2019). Visible identifiers such as a hearing aid or cochlear implant may not be needed or used regularly, and an audible speech-language impairment, if one exists, can easily be missed by adults and peers not listening specifically for anomalies in word pronunciation (Golos et al., 2021; Reagan et al., 2021).

Typically, academic weakness related to hearing loss is recognized before a student arrives in middle school (Meinzen-Derr et al., 2022; Nelson et al., 2019). By this time, amplification needs have been determined, hearing levels have become stable, except in cases of a degenerative or fluctuating loss, interventions have been implemented, and progress toward

grade-level achievement has begun (Ardasheva et al., 2018; Huang et al., 2019). The lasting impact of language gaps may be dismissed due to the perception that the student has no difficulties hearing the teacher speak (Alasim, 2020; McKenna Benoit et al., 2019). Unfortunately, hearing spoken language does not equate to comprehension of meaning (Lederberg et al., 2022; Meinzen-Derr et al., 2022).

Middle school students who enter with normal or near normal hearing levels, achieved due to amplification or previous medical intervention, have no discernable feature that points to the missing foundation language, which will impact their academic performance. Comprehension requires background knowledge, vocabulary, and language skills beyond the physical act of auditorily receiving spoken words. The teacher's belief that the student heard me, therefore they understand and are choosing not to comply, can cause detrimental miscommunications that affect learning and relationship development.

Use of Accommodations

Middle school also brings about a host of challenges from a social standpoint for HH students (Holman et al., 2019; Philips et al., 2023; Qi et al., 2020). Students, being naturally curious about unfamiliar objects, ask questions of their classmates, which can result in embarrassment as an HH student is asked to explain a hearing aid, portable sound amplification system, or a cochlear implant (Borman et al., 2019; Holman et al., 2019). HH students wishing to fit in and divert attention from themselves may discontinue the use of visible amplification, refuse to ask for repetition of directions, or choose to move from their often-needed preferential seating (Borman et al., 2019; Crowe et al., 2019; Golos et al., 2021; Tronstad et al., 2022). Teachers may miss the student’s option to discontinue needed accommodation for several reasons (Tronstad et al., 2022). Unfamiliarity with the student, large class size, and limited

access to working equipment are all understandable situations that result in missed or partial access to information presented auditorily for the HH student.

Environmental Barriers to Physical Auditory Access

HH students in middle school classrooms with appropriate personal amplification such as hearing aids, cochlear implants, one-to-one ear level microphone support from the teacher, or class-wide sound amplification continue to have challenges in hearing verbal information presented by the teacher (Crowe et al., 2019). Classrooms are noisy (Caviola et al., 2021; Lamotte et al., 2021; Massonnié et al., 2022; Mogas Recalde et al., 2021). This noise is generated from quiet interactions such as side conversations, shifting a seat, sliding a chair, humming, tapping objects, hallway activities, outdoor activities, and even the air conditioner merging to become a detractor from learning.

Noisy classrooms are challenging for students with typical hearing and processing skills to access teacher lessons (Lamotte et al., 2021). The HH students face a more significant challenge when working through extraneous sounds in a noisy classroom (Bruce et al., 2018; Crowe et al., 2019; Mogas Recalde et al., 2021). Acoustics within a cinderblock classroom are less than ideal, echoing background noise while blocking the transference of vocal patterns (Lamotte et al., 2021). Hearing aids and cochlear implants have internal systems that filter out background noise. However, they cannot always discern which voice is preferred, targeting it for amplification at the exclusion of all other auditory options (Bruce et al., 2018; Crowe et al., 2019; Mogas Recalde et al., 2021). This potential lack of physical and auditory access couples with already weak processing and language skills to disrupt the acquisition of newly presented concepts, instructions, or banter between students and the teacher. This struggle is a daily real-world situation that cannot be eliminated. This issue requires flexibility and should be addressed

daily, often multiple times per class period, depending on the activity and noise level occurring within the classroom.

Continued Foundational Skill Building in Middle School Math

Entering sixth grade, the expectation in the math classroom is that students can fluently add, subtract, multiply, and divide with whole numbers from 0 – 12 using metal math (Allen-Lyall, 2018; Zhang et al., 2017). Students who need help to supply answers for basic facts quickly spend far more time completing assignments than those who memorize these facts (Kennedy et al., 2021; Morano et al., 2020; Paas et al., 2020; Santos et al., 2022). Students unable to memorize these basic facts need support to reduce their cognitive strain as they work through more complex problems (Kennedy et al., 2021; Paas et al., 2020).

This basic math fact support can come from a calculator, personal fact list, and continued reinforcement of basic fact practice (Kennedy et al., 2021; Paas et al., 2020; Santos et al., 2022). Supplying students with a method to access these basic fact responses allows them to utilize a more significant portion of their mental focus on more complex tasks instead of simple calculations (Kennedy et al., 2021; Paas et al., 2020). Mathematics standards no longer include computational fluency in middle or high school (Musti-Rao et al., 2022). Therefore, targeted development and support of these skills is critical before students exit middle school.

Classroom Diversity

With the reauthorization of the Individuals with Disabilities Education Improvement Act and the No Child Left Behind Act, the educational landscape within public schools across the United States looks much different than a scant ten years ago (Bolourian et al., 2020; Dorn, 2019; Francisco et al., 2020; Lim, 2020). Due to this legislation's focus, now re-authorized as the Every Student Succeeds Act, on the inclusion of special education students in the general

education classroom, general education classrooms have a much more diverse population. Rigorous standards-based education for all students, with or without an identified disability, has resulted in the closure of smaller classrooms (Bolourian et al., 2020; Dorn, 2019; Francisco et al., 2020).

These small group classes were designed to provide learning environments that target the needs of individual student groups. While resource classes aimed to meet specific needs and provide targeted instruction, this separation fostered feelings of isolation, and students were often met with lowered expectations (Tiwari, 2023). With the call for the least restrictive environment continuing to echo down the halls, educators face groups of students, both high and low-incidence populations, with varied educational needs and legally required accommodations, all to be provided within the same classroom (Bolourian et al., 2020; Francisco et al., 2020). In this study, *HH students* refer to students with mild to moderate hearing loss who may use hearing aids or other assistive listening devices to enhance their hearing.

Inclusion challenges the status quo of teaching and encourages the development of a learning environment utilizing educational strategies that meet the needs of all students (Tiwari, 2023). Multiple team members are often involved in the education of these students to varying degrees. Ultimately, though, the perception is that the bulk of lesson development and material presentation falls to the general education teacher certified in the academic subject (Robertson et al., 2022; Tiwari, 2023).

Support for the General Education Teacher

Following the shift from self-contained classrooms to the inclusive model predominantly used in public schools today, many students with disabilities receive all education and support inside the general education classroom (Tiwari, 2023). General education teachers, whose

teacher education program may or may not have prepared them to work with students with disabilities, now teach a diverse student population (King-Sears et al., 2020; Robertson et al., 2022; Tiwari, 2023). General education teachers report feeling unprepared or inadequately trained to address the needs of the diverse student population learning in their classrooms. The special education teachers that come alongside these classroom teachers fill a considerable gap (King-Sears et al., 2020; McKee et al., 2023; Weiss et al., 2018). Special education (SPED) teachers enter the inclusion setting to support the teaching and learning of the general educator and the students they serve. SPED teachers must now be well-versed in the support needed by multiple students with disability groups.

Potential Models of Support

Based on the Special Education Implementation Manual presented by the Georgia Department of Education, four service tiers are available at decreasing intervals for students being educated in the general education classroom (GADOE, 2019). The student(s) support often results in the introduction of another adult into the classroom environment. The time the second adult is in the classroom decreases based on student needs. With each tier, the general education teacher is more heavily responsible for providing individualized instruction for students in the classroom.

Co-teaching is the top tier of inclusion-aligned support, which uses two certified teachers for 100% of a learning segment (Johnson et al., 2020; King-Sears et al., 2020; Tiwari, 2023). The learning segment for middle and high school is a whole class period. Elementary schools define time for each academic subject on a master schedule. More often than not, the setup looks like one general education teacher in a stationary classroom and one special education teacher who comes into the general education setting working together to educate all the students within

(King-Sears et al., 2020). Co-teaching is challenging (Johnson et al., 2020; King-Sears, 2020; Tiwari, 2023). Introducing a second teacher is meant to share the burden of classroom responsibilities, but that does not always happen. The special education co-teacher often teaches multiple subjects across different grade levels in various classrooms throughout a single school day. The planning time needed to collaborate with each general education teacher to fully be a second teacher actively engaged in the presentation of the lessons daily is not available (Johnson et al., 2020; Tiwari, 2023; Young et al., 2020).

The second tier is the collaborative model of support. Collaborative classrooms have a special education teacher who comes in for less than 100% of a learning segment (GADOE, 2019). This model is a balancing act for many reasons. The teacher coming in has to determine if they will be present for the teaching portion of the class or the classwork portion. The collaborative model brings more logistical and planning challenges for educators in this setting. Planning time as a team is likely minimal (Johnson et al., 2020; Tiwari, 2023; Young et al., 2020).

Consultative services are direct instruction services inside the general education class but are not tied to a specific class segment (GADOE, 2019). During the team meeting, these service hours are determined on a student-by-student basis to develop their Individual Education Program. This second teacher would come in for daily, weekly, monthly, or yearly service, which provides minimal support for the general education teacher's daily responsibilities (Golos et al., 2021).

Supportive services use a paraprofessional, interpreter, occupational or physical therapist, or another general education teacher to help students during academic instruction and work time (GADOE, 2019). These employees do not provide specialized support from a special education

teacher because they are not trained in implementing educational strategies to meet the needs of the class's special education population. These supportive services also do not reduce the preparation and teaching responsibilities of the general content teacher.

Depending on the student population's needs, general education teachers should receive support from one of the tiers of service outlined above (GADOE, 2019). The development and implementation of strategies should be a collaborative effort, ideally discussed between the general education and special education teachers who present lessons and provide remediation within the same classroom (Johnson et al., 2022; King-Sears et al., 2020). This inclusive approach ensures that all voices are heard and all students' needs are met.

Summary

Deficits in foundational language skills are critical to DHH students' struggle in the general education classroom (Alasim, 2020; Tucci et al., 2021). The lasting influence of this limited language mastery can be seen throughout the student's academic career. With the classroom model having shifted to one focused more on inclusive education, general education teachers are called to find high-leverage practices that meet the needs of a broad spectrum of students.

Lagging mathematical abilities have long been a hallmark of DHH students K-12 (Chen, 2022; Santos et al., 2022; Thom et al., 2022). With the desire to identify best practices to close this gap, researchers continue to investigate strategies to shore up foundational skills lacking in this student population. As a student's knowledge gap widens, compounding yearly, identified mathematical weaknesses become more challenging to overcome for DHH students (Chen, 2022; Santos et al., 2022; Thom et al., 2022).

The presented literature showcased causes for language delays, best practices for

incorporating visual supports, and approaches to reduce disengagement, especially in the middle school setting, using the theoretical lens of dual coding. HH students were highlighted, and parameters identifying this focus group were outlined. More information is needed to understand the dynamics of middle school mathematics classrooms and teacher perceptions of the effectiveness of dual coding strategies used within the general education setting to meet the needs of HH students.

CHAPTER THREE: METHODS

Overview

The purpose of this case study was to describe how deficits in foundational language among HH students influence lesson presentation to increase mathematics comprehension for general education middle school classroom teachers as they worked to educate this student population in central Georgia. At this stage in the research, the participants were general education math teachers who have worked with the following student population: those identified educationally as hearing impaired, who do not use American Sign Language as their primary mode of communication, and who are educated in the general education setting with or without special education support from a co-teacher or supported instructor. Focused attention was given to the case study research design, development of the research questions, description of the setting and participants, researcher positionality and assumptions, and a clear outline of the data collection and analysis procedures.

Research Design

A collective case study research design was chosen to investigate how general education teachers support HH students in the middle school mathematics classroom. The collective case study design, known for providing detailed insights, examines interactions with individual HH students within a specifically designed context of general education middle school mathematics classrooms. This collective case study investigated 11 general education math teachers who have educated HH students across middle school grade levels at different school locations. These detailed descriptions were distilled into a fuller picture of this educational landscape. Due to the essential context of the public school setting, a case study design also allowed for the incorporation of descriptors such as classroom makeup (i.e., support from a special education

teacher, support from a teacher of the deaf and HH, or use of supported instruction), grade level, and classroom dynamics. By choosing the collective case study design, a more exhaustive depiction of the studied topic's supportive background details was obtained (Baxter & Jack, 2008). Interviews with teachers who have lived this experience provided a chance for extrapolation and expansion of details that may have been missed had a written survey or online questionnaire been solely utilized.

HH students represent a diverse student population. Each student brings their own social, cognitive, and physical needs into the classroom, which makes case study exploration particularly suited to this varied student population (Enns, 2017). By looking at individual classrooms, the teachers in charge, and descriptions of their experiences, this case study identified potential benefits and challenges for each HH student educated in these settings.

Research Questions

Central Research Question

What are the experiences of middle school general education mathematics teachers working with HH students?

Sub-Question One

How do teachers utilize multi-sensory stimuli to teach mathematics to HH students?

Sub-Question Two

How do teachers facilitate connections between their working short-term and long-term memory for HH students?

Setting and Participants

The sections below outline the participants for this study. In addition, basic information regarding the school districts where the participants were employed and defined participation

requirements set the context in which the interviewees work. All participants and places of employment are located within the state of Georgia. Interviews were not conducted on the school campus, nor did I visit the school location or classrooms of the participants. Since I did not research on the school campus, site permissions were not required.

Setting

Public middle school teachers working within a multi-county radius in Georgia were sought as participants for this collective case study. Due to the low-incidence nature of the HH student population, teachers from different schools across multiple counties were needed to ensure that the participants interviewed would have worked with various HH students. Convenience and purposeful sampling were used to identify teachers who have worked in the desired setting with this student population (Johnson et al., 2020). Once participants were found, two counties were identified as the working locations of all participants. The counties range in size from 9,000 – 100,000+ in total student population (GADOE, 2022). The smaller county houses four middle schools, while the larger has 28 middle school locations. Only public school locations were considered due to their adherence to the Georgia Standards of Excellence. These state-required educational standards promote homogenous mathematical content being taught from county to county. The Georgia Department of Education (GADOE) reports approximately 2,600 DHH students receiving special education services PreK – 12th grade with DHH as their primary disability (Tucci et al., 2021). Across the state, 58% of the 159 Counties are reported as having five or fewer DHH students. These numbers grossly underrepresent the population due to excluding students with DHH listed as a secondary or tertiary identifier on their IEP. Unfortunately, actual numbers in public schools were unavailable, but the population was believed to be more extensive than those reported by the GADOE. The central Georgia counties

targeted for this study contain reported numbers of 0-5 for the smaller county, while the larger county reported 200+ students with a primary DHH identifier. With the inclusion of secondary and tertiary identified DHH students, this number was expected to be higher for both counties represented.

Participants

The criteria for selecting the 11 participants were teachers with one or more years of teaching experience, a minimum of one year teaching middle school content mathematics, and one year teaching an HH student in a general education mathematics classroom (Johnson et al., 2020). In addition, teachers were asked to confirm that the HH student taught had an Individual Education Plan. Teachers who worked with HH students with a 504 Education Plan or those identifiable only due to wearing hearing aids did not meet the criteria for the teacher's inclusion in this study. All requirements could be met simultaneously but must have been completed within the public school system. Interested participants completed a pre-study survey to ensure they met the required parameters to be included in the study (see Appendix F). Potential candidates were sought from known middle school teachers, through Facebook, and email addresses obtained from school system websites.

Recruitment Plan

Teachers who have worked in a public middle school teaching mathematics to HH students in Georgia represent the total sample pool. The recent workforce report identifies 40,496 certified middle school teachers as potential participants (Flamini et al., 2022). Georgia was identified as the total sample population due to the Georgia Standards of Excellence, which promotes standardized content taught from county to county. The convenience sample of 11 participants was identified from this sample pool. This allowed the researcher to meet with them

one-on-one, either in person or via Google Meets, followed by a focus group conducted using Google Meets (Johnson et al., 2020). The participants came from two geographically separate counties. The knowledge that larger counties would have more teachers recently working with multiple HH students was considered. Recruitment occurred initially using connections to known middle school teachers. Initial contact for recruitment was made through in-person conversations. Face-to-face recruitment was utilized as the first wave of participant recruitment (Appendix D). A recruitment flyer was posted on social media (see Appendix B). Emails were then sent to publicly available school email addresses for teachers listed as middle school math teachers found through school district websites across the state (Appendix E). Within the initial email contact, a link to an online survey in Google Forms (Appendix F) confirmed that each person met the requirements of the study. Once the study requirements were satisfied, initial interviews were scheduled. Before questioning, consent was explained, and the consent form was offered and signed (see Appendix C). The interview began only after the potential participant signed or gave verbal consent. Emailing was the preferred primary form of communication for all study information. Journal prompts were shared through an email attachment of a Word document or shared in a Google Document. Each teacher was provided with the rationale for the study, informed consent was requested, and the assurance that they could remove themselves from the study at any time was offered (Balon et al., 2019).

Researcher's Positionality

The following sections outline my lens for this study. Using my constructivist ideas (Schunk, 2016), personal beliefs, and professional knowledge, I investigated how teachers view HH students' struggles as they enter a new environment with missing or weak foundational language. Understanding the motivations and background of this study framed the outcomes with

the potential for a more profound appreciation of the challenges the students and teachers face in this academic arena.

Interpretive Framework

My interpretive framework as a qualitative researcher was presented through the constructivist lens. Deaf education actively seeks to make connections between previous knowledge or personal experiences and newly introduced information, which is the goal of constructivist teaching (Schunk, 2016). These connections are the basis for learning. Constructivism is the search to connect the world we encounter to the world we have experienced (Yin, 2018). Deaf students often arrive in middle school without chunks of background knowledge, which impacts their success across academic subjects (Nelson et al., 2019; Thom et al., 2022). Math was often thought to be the best subject for DHH students, but research has shown the academic challenges continue as DHH students work to understand and manipulate numerical concepts (Henner et al., 2021; Rodrigues et al., 2022; Thom et al., 2022).

Philosophical Assumptions

The following sections outline my schema, background experiences, beliefs, and perspectives, which are undoubtedly intertwined with the collected data as it was analyzed. Explaining the lens through which I examined this case study should help readers orient themselves to my viewpoint as they explore the data and outcomes. Acknowledging personal perceptions embraced the humanity I bring to this case study using myself as a human instrument (Yin, 2018).

Ontological Assumption

As a Christian researcher, it is my ontological position that, due to the nature of the omnipotent God’s creation, there can only be one singular reality in which we all exist. Earthly

experiences can alter how we view situations, and the impact of personal experience on our perspective may be identified and described. Qualitative research examines how people perceive, work through, and depart from a situation (Yin, 2018). By collecting and analyzing perceptions, we can then create a description of the human experience as it relates to the topic of study. As a Deaf educator, I sought to understand how DHH students are served in the mathematics classroom. Talking with math teachers with a working knowledge of serving these students, I have identified their perception of best practices that can be used to increase the potential of these and other students.

Epistemological Assumption

Teachers working to further knowledge about our field strongly represent epistemological assumptions, which are the acknowledgment that I will use my personal experience to interpret the findings of this case study (Creswell et al., 2018). Those who work in the school system are entwined in this world, which identifies our positionality (Creswell et al., 2018; Yin, 2018). I have 18 years' worth of experiences tucked into my memory banks that affected my interpretation of the data I collected. Listening to teachers speak about previous HH students, their successes, and, potentially, their failures, and my experiences working with this population, allow me to highlight best practices, potential outcomes, misconceptions, and missed opportunities. Integrating dual coding to increase the measurable success of DHH students in mathematics was the area I focused on. During this case study, I identified ways teachers support this student population and made connections to my understanding of best practices for serving this student group.

Axiological Assumption

The background knowledge I brought into my research study about DHH students is part

of my axiological assumption, which is my schema (Yin, 2018). As a Deaf educator and certified American Sign Language interpreter, I am familiar with the Deaf community, the barriers DHH students face, and American Sign Language, which can cause an additional challenge for students who do not use English as their first language. When talking to the general education teachers, my perception of best practices to teach DHH students, the knowledge of weak foundational language skills, and the belief that these students can meet grade-level expectations guided my analysis. Working primarily in the public school system, I do not have experience in residential deaf schools, private schools, or the resource class setting. My experience came from working as an interpreter and itinerant DHH teacher. Therefore, I focused on teachers in the public school setting, where I have the most personal experience.

Researcher's Role

As the researcher, I conducted each interview and acted as the human instrument through which the information flowed and was then analyzed (Yin, 2018). I wanted to hear the inflection and see the emotion on each participant's face to extrapolate contextual information for the case study design that this study followed. I understand that I may have impacted the answers by becoming involved with the participants during the interview and focus group. However, due to the equivalent nature of our positions, the participants and I are teachers; therefore, there was no authority issue involved in the interactions.

Procedures

The following section will outline the necessary Institutional Review Board process, site and participant permissions, and the data review process. This information provides the background steps to protect the participants and the procedures for collecting and triangulating data. The follow-through of these steps will allow for future replication of the process.

Data Collection Plan

Following a three-pronged approach, this collective case study collected data on teachers working with HH students in middle school mathematics classrooms (Yin, 2018). The investigation into various classrooms, meticulous data recording, triangulation of multiple data sources, stringent analysis, and detailed interpretation of the findings made this case study scientifically rigorous (Johnson et al., 2020; Kyburz-Graber, 2004). The data collection methods, which included a one-on-one interview, a focus group, and an online journal prompt, allowed for the triangulation of conclusions, assertions, and themes. This, in turn, allowed for the development of a narrative depicting the interactions between teachers and HH students in middle schools across central Georgia (Johnson et al., 2020; Yin, 2018).

Individual Interviews

One-on-one interviews are the hallmark of qualitative research design (Braun et al., 2021; Gill et al., 2018; McGrath et al., 2019). Sitting down with the teachers who have worked in the middle school mathematics classroom provided insight into the classroom environment and how the HH students interacted with their peers, the teacher, and the academic material. The intertwined nature of students within the classroom context guided my choice of a case study investigation (Kyburz-Graber, 2004; Yin, 2018). The success of HH students in the mathematics classroom requires that the surrounding environment be acknowledged and defined as related background information.

Due to the equal status of the participant and researcher as teachers, no power imbalance caused the interviewee to feel stressed or under undue pressure (McGrath et al., 2019; Creswell et al., 2018). The interview followed a semi-structured approach with questions developed to guide the conversation and ensure that focused data was collected from each participant (Yin,

2018). Using a semi-structured interview allowed for building rapport and a natural evolvement of topics, allowing for a deeper dive into unforeseen themes as needed while staying on or near the desired thematic path (McGrath et al., 2019).

Audio and video were used with permission to record the interviews. This allowed the researcher to focus on the conversation instead of taking notes. The digital recording provided confidence that all information would be accessible for review during analysis (McGrath et al., 2019; Yin, 2018). The interview transcript was made available to the involved participants. This allowed for member checking, permitting review of the transcript by the participant to check for errors (Johnson et al., 2020). Utilizing guidance from foundational works and the doctoral committee, questions were written to support the accumulation of data related to the defined research questions this study looked to expand upon (Jiménez et al., 2021).

Table 1

Individual Interview Questions

1. Please describe your educational background and career through your current position. CRQ
2. Describe your challenges when working with an HH student in your classes. SQ1
3. Describe successful practices you use when working with HH students in your classes. SQ1
4. What professional development experiences have prepared you to work with HH students as a teacher? SQ1
5. How did these students do with word problems? CRQ
6. Were there instructional accommodations in place for these students? (Examples: anchor charts, graphic organizers, assistive technology). SQ2

7. Did you implement any class-wide or individual instructional accommodations that improved the performance of your HH students? SQ2
8. Were other support personnel in your classroom when the HH student was being served? (Teacher of the Deaf/Hard-of-Hearing, Special Education Teacher, Supported instruction para-professional) SQ2
9. What was the biggest obstacle you remember the student facing in your class? What did you or the student do to get past that challenge? CRQ
10. What support is a student offered if they are not fluent in basic math facts? SQ2
11. Were there other classroom supports that were not available that you feel could have increased their success? CRQ
12. What testing accommodations were offered to these students? SQ2
13. Are there any other ideas that you have that we have not already discussed that you feel were important to support these students in your class? SQ1

The preceding interview questions were developed to connect back to the overarching research questions laid out previously. Dual coding highlights four significant areas as this study's guiding framework: stimuli, senses, working memory, and long-term memory. The questions are focused on identifying how the teachers either purposefully or unconsciously support the facets of this framework as they promote the learning of DHH students in their mathematics classroom.

Focus Group

Following the individual interviews, a day and time were chosen and communicated with the participants for a live, online meeting via Google Meets. The proximity of the participants required an online platform to encourage participation by minimizing the time impact that would

be felt if an in-person meeting had been requested (Richard et al., 2021). Due to the prevalence of remote meetings for work, education, and some social engagements, the virtual setting has become a much more prevalent and accepted form of research interaction (Gill et al., 2018; Richard et al., 2021). While in-person interactions more often create a larger word count, it has been shown that in the analysis phase, in-person groups made a similar number of thematic ideas as groups that were conducted via online platforms (Richard et al., 2021). During the session, the researcher moderated the discussion, posed questions, and drove the focus of the conversation but did not offer any opinions or contradictions to statements made by participants due to the bias this would have created within the group, thereby skewing the focus of the conversations (Gill et al., 2018). Guidelines were presented to smooth the meeting process. These guidelines included instituting a one-speaker-at-a-time rule, participation was encouraged for all involved, and student and county names were omitted to protect all involved (Gill et al., 2018; Richard et al., 2021; Yin, 2018).

By design, focus group questions slightly differed from those presented in the one-on-one interviews (Yin, 2018). The group questions were developed to promote participant discussion (Gill et al., 2018; Richard et al., 2021; Yin, 2018). These discussions were encouraged to confirm similar experiences or highlight different methods employed and the level of success that resulted in each classroom.

Table 2

Focus Group Questions

1. Please describe your typical classroom makeup. Approximately how many students? Are the students grouped by my support needs or a general mix?
2. Thinking about your HH students, describe their performance in your classroom

compared to their peers.

3. What visual supports do you universally design into your classroom presentations?
4. Describe how you perceive the visual supports provided throughout your lessons.
5. What supports did you use to ensure the HH student could access your class auditorily?
6. How did you know to use these supports, or what made these supports seem successful?
7. Did you feel that the students needed or used the support they were given?
8. How fast do you feel your lessons proceed? Are you following a district pacing guide, or can you move on when ready?

Journal Prompts

The final data collection phase was through a digital journal prompt using Google Docs or an emailed Word document attachment. The prompts were open-ended questions asking the teacher to describe their perception of how interactions flowed within their classroom. Teacher perceptions of HH students' learning styles and overall learning capabilities. Online surveys have become a standard tool for collecting qualitative research data (Braun et al., 2021). Open-ended questions allowed for detailed responses, which, when presented clearly, elicited multifaceted information that was triangulated with other data collection modes in the analysis phase. The online questions were sent before the in-person interview. Contact was made to set the interview date, and a reminder email was sent a day or two prior. A follow-up to remind participants to return their journal prompts was done as needed at the end of the one-on-one interview, following the focus group and then through an email for those who utilized extra time for completion (Yin, 2018).

Table 3

Journal Prompts

Please respond to the following questions with a minimum of 200 words each.

1. How do you typically present a lesson in your classroom? (Walk me through the process.) Where do you stand? Do you include visuals? Video representations?
2. What do you use to remind students of the lesson taught for support during their independent work session?
3. During lessons, do you create anchor charts, refer back to a previously created chart, depend on the students to take notes, or what is posted for students to refer back to as they work?
4. What are the students typically doing while the lesson is presented? Are the students asked to take notes? If yes to taking notes, are the notes guided notes via a graphic organizer or free writing on notebook paper?
5. Describe the supports you implemented to work with HH students. If you did not engage in specific support for that student, which supports did you feel were the most impactful on their learning experience?

Data Analysis

Following each interview, notations were made by the researcher to encourage later recall of impressions or statements verbalized that made a strong impact during the interview (Saldaña, 2021). Failure to take time to make interview notes would have resulted in a loss of valuable contextual data. The interviews were transcribed verbatim, cleaned to remove extraneous words such as umm and so as well as interviewer affirmations such as yes, yeah, or interesting, and then transcripts were analyzed line by line using descriptive coding, beginning with an anchor code

connected to the central research question and the two sub-questions. These anchor codes were teaching or integration and sensory stimuli directly linked to this study's research questions.

Descriptive coding provides researchers with multiple interview transcriptions and clearly defined research questions to index their information and create a format for easy access to specific emerging topics. Emerging codes were placed into a spreadsheet and categorized by the anchor code connected to the data. The subcode connected to the anchor code was used to provide preliminary codes as the raw data was analyzed through this first cycle of descriptive coding. This line-by-line descriptive subcode labeled experiences, setting details, and feelings for each interview. The second cycle of coding was completed using pattern coding. Pattern codes grouped the line-by-line labels made during descriptive coding into broader themes and categories. Color coding of the emerging themes was used to connect smaller ideas to more significant themes. Condensing the interviews through first and second-cycle coding took the large volume of information in the transcriptions and distilled it into manageable descriptors for the final analysis.

The focus group data analysis followed the same format as the individual interview process. As the participants shared, I took notes and jotted down impressions of the participants and their responses as the group interacted. Further impressions were recorded once the meeting time ended. These impressions gave the researcher contextual data that is easily forgotten when notes are not used to recall the emotions and vocal tones used during interactions. A written transcription of the questions and responses was created after the group session. The first coding cycle was completed using anchor codes and descriptive subcodes to identify the emerging topics. These topics were entered into a spreadsheet and used for the second cycle coding process, which used pattern coding. Pattern codes were emerging themes grouped under a more

encompassing umbrella of thought.

Following completing the journal prompt, I analyzed the collected data using the anchor code and descriptive subcodes. Descriptive coding gave a line-by-line summary of concepts identified by the researcher in the participants' answers. These descriptive codes were then manually categorized into themes using pattern coding. Pattern coding allowed for the distillation of information into focused, overarching themes or descriptors. Descriptive coding provided the initial data summaries, which were then grouped for further analysis during the pattern coding phase.

The interview, focus group, and online survey data underwent rigorous manual coding via first-cycle mixed-method and second-cycle pattern coding to identify concepts and themes related to each data set recorded by electronic spreadsheet. Color coding was employed to assist with the identification of connections between sub-themes. Once these individual data sets were complete, the researcher triangulated and identified broader themes that connected the three data sets. Orphan codes that stood alone and those not fully explored were identified and are explained in the future research section. This final synthesis step concluded with a single set of themes, concepts, and beliefs supported by the body of data.

Trustworthiness

Defined as the “assured reliance on the character, ability, strength, or truth of someone or something,” trust in the researcher is a fundamental facet of each study performed and presented to the scholarly community (Trust, 2011, p. 1). Best practice has been defined to ensure that qualitative research reaches the high rigor expected for doctoral research through credibility, transferability, dependability, and confirmability (Shenton, 2004). A clear explanation of the care taken to adhere to these identified best practices begins developing trust between readers and the

researcher presenting data.

Credibility

Researcher bias must be accounted for when reviewing reports generated from scholarly studies (Johnson et al., 2020). This study has identifiable procedures that safeguard against skewed data through triangulation, member checking, and frequent debriefing sessions. Upon completing a research study, the goal of expanding knowledge related to a specific subject with meaningful and insightful material was met.

Triangulation

Including multiple data sources has become standard in qualitative research (Johnson et al., 2020). These various data sets were aggregated to reduce bias or potential errors by providing multiple supports for developing themes. This research study used three methods to collect data: individual interviews, focus groups, and short journal responses for triangulation. This robust method offered reassurance regarding the credibility of the research.

Member Checking

Transparency with research participants was vital in creating a credible environment for this research study. Member checking allowed participants to review the transcripts of all interviews to certify that the transcription was complete and accurate (Johnson et al., 2020). This transcript also included emerging themes or patterns the participants could validate or provide their dissenting opinion of the initial evaluation (Shenton, 2004). This open dialogue with the participant was essential in expanding background knowledge of the described situation. Following transcription, the interview text was provided to participants in one of two ways. One group received their transcript via the shared document, where their short answer questions were answered in a Google document. The other group was sent an email with their transcript attached

for review. Each participant had the opportunity to review the transcript and resulting themes with an open chance to report back with any questions or concerns.

Frequent Debriefing Sessions

This study was completed as part of the researcher's doctoral program requirements, and results were presented in a final dissertation. Access to skilled professionals in the education field came through a doctoral chair and committee who evaluated the interpretations and scope of the data being collected (Shenton, 2004). Looking to available mentors for guidance was an essential part of the development of this study. Their invaluable wisdom provided periodic evaluations of my work to ensure that I stayed true to the expectations of Liberty University. Guidance from professors allows doctoral candidates to work within the parameters of the course of study with the assurance that work would not be accepted if it did not follow the school of education guidelines.

Transferability

The transferability principle is the ability to apply one study's outcomes to a different context. Qualitative research cherishes environmental descriptions that give context to each case under analysis (Shenton, 2004). Middle school classrooms, as well as HH students, are unique and varied between place and individual. Attention to providing thorough depictions of the case study environments, data analysis, and identified themes provided the basis for others to consider the possibility that best practices or similarities can be gleaned from this work. While HH students and the environments they were educated in are each unique, insight into real-world methods to increase involvement and success provides an introductory look to improve standardization of supports used to undergird learning opportunities for this student population.

Dependability

Dependability is the process by which a study can be replicated, but there is no guarantee that findings will be uniform due to the context in which case studies occur (Shenton, 2004). The study of the HH K-12 population is open for future research. The protocols used for the survey, interview, and observation are clearly described and provided should another researcher wish to repeat this study and confirm dependability (Johnson et al., 2020; Shenton, 2004).

Confirmability

Separating the researcher's bias is another essential component of trustworthiness that comes under the title *confirmability* (Johnson et al., 2020). Awareness of a bias and public identification of the researcher's bias are ways to establish confirmability (Johnson et al., 2020; Shenton, 2004). Triangulation of the data, described in the credibility section, was one of the most vital instruments to mitigate researcher bias (Shenton, 2004). Triangulation of data and acknowledgment of researcher bias were employed to lessen possible infringement of the researcher's beliefs in the data analysis.

Ethical Considerations

The heart of a case study through qualitative research is the investigation into people and the environments in which they exist (Yin, 2018). Protecting the participants, environments, and students interacting and learning at these locations is paramount. The Institutional Review Board (IRB) outlines detailed steps that must be satisfied by the governing academic entity before the study can begin at any location (Balon et al., 2019). These steps include prior written permission from the individual participants and a plan to store data confidentiality, whether hard copies or electronic files were kept.

Permissions

IRB permissions were obtained through Liberty University. Appendix A holds my IRB approval. All IRB requirements were rigorously met, and the required documentation was provided. My doctoral chair supported me in certifying that the appropriate protections were in place for participants to feel confident in their anonymity when participating in this study.

Other Participant Protections

The data collection and presentation used pseudonyms for locations and participants. I have ensured that no names, schools, or participants are included in available hard copies of the data. A coding system was used with a pseudonym for these names, with the pseudonym and real name matches kept in separate locations. Digital files were held in a password-protected cloud and on a personal computer. No data was stored on a public computer system, such as one used by a school system, which would allow all data and emails to be accessed by district technology. Discussions with the participants regarding potential issues, if their identities were discovered, were addressed, as well as my plan for using pseudonyms and redaction of easily identifiable descriptors that would point out a specific person or location to familiar readers (Balon et al., 2019). The protection of participants was of utmost importance.

Summary

General education teachers in the middle school mathematics classroom work with a varied population of students, including those identified as HH. A multiple case study process set forth by Yin (2018) was followed to collect multiple data sources, gather rich contextual descriptors, and acknowledge the impact of the researcher as a human instrument to describe this unique educational landscape. The sources were collected through online open-ended journal

prompt writing, individual interviews, and a focus group. Best practices for analyzing multiple data sources with triangulation outlined by Saldaña (2021) were utilized by identifying themes through the anchor, descriptive, pattern, and color coding of collected information. Adherence to this process allowed for a glimpse into the complex dynamics of these classroom interactions.

CHAPTER FOUR: FINDINGS

Overview

This collective case study aimed to understand the perspectives of general education mathematics teachers who taught HH students in the public middle school setting. Chapter Four of this study presented the data compiled through three separate data collection methods. The three data collection approaches were one-on-one interviews, a focus group, and journal prompt responses. Initial information was gathered through the individual interview, comprised of 13 open-ended questions probing the day-to-day experiences and activities in each participant's classroom. Five journal prompts, provided via email, allowed participants time to provide thoughtful and expansive answers to the questions related to the focus of this research. Data from the focus group was elicited by eight open-ended questions crafted to spark discussion amongst the participants. Chapter Four opened with a description of the participants. The following sections highlighted the study's findings, responded to the guiding research questions, and concluded with a synopsis of the results.

Participants

Public school teachers with knowledge of Georgia middle school mathematics content and standards were identified as the target population for participants. Seeking teachers to meet this requirement and further reducing this group to include only those who had experience working with HH students elicited 11 participants. This group, which all had the needed knowledge to teach middle school mathematics content to an HH student, represented a wide range of experience within public education. From first-year teachers to seasoned veterans, they all faced unique challenges in educating HH students in middle school mathematics content. The HH students had academic deficits outlined and served through an Individual Education

Program. Three participants stood apart with dual certification in both general and special education. This unique qualification was acknowledged and seen as a benefit for all the students they have served. Each participant was asked to complete a one-on-one interview, join a focus group for discussion, and provide written responses for journal prompts. Ten participants completed all three activities, while one, Wren, could only complete the one-on-one interview. Relevant participant characteristics identified by pseudonyms to ensure confidentiality can be viewed in Table 4.

Table 4

Teacher Participants

Teacher Participant	Years Taught	Highest Degree Earned	Dual Certification	Grade Level Experience
Avery	4	Bachelors	No	8th
Casey	22	Education Specialist	No	K – 8th
Felicity	1	Bachelors	No	8th
Harper	3	Masters	No	8th
Julia	22	Education Specialist	No	K – 8th
Matthew	22	Bachelors	Yes	6th-8th
Quinn	15	Masters	No	K – 8th
Silas	9	Doctorate	Yes	K – 8th
Twyla	16	Education Specialist	Yes	6th – 12th
Violet	24	Education Specialist	No	K – 8th
Wren	1	Masters	No	6th

Avery

Avery was a young woman just finishing her fourth full year of teaching. She completed her bachelor's degree in mathematics even though she planned to become a teacher. After graduation, she spent one semester as a long-term substitute teacher, then transitioned into a full-time teacher role via provisional certification through the Georgia Teacher Academy for Preparation and Pedagogy (GaTAPP). This program allows individuals with higher education degrees to become certified teachers while actively working in the classroom. She stated that she did have training on Universal Design for Learning, which aims to provide access to learning and demonstration of knowledge for all students within the GaTAPP and graduate classes she had taken. She worked with at least two HH students in just four years.

Casey

Casey has 22 years of teaching experience in the public school system, working in elementary and middle schools. Considering her years working with fourth, fifth, sixth, and seventh grades, she has determined that she most enjoys guiding student growth and development during sixth grade. She saw the introduction and fine-tuning of technological advancements that have become the norm for HH students, such as sound amplification systems that connect directly to the student's hearing aids and the proliferation of cochlear implants. Casey has had experience with many HH students. She had three HH students in two different classes this school year alone.

Felicity

Felicity was a first-year teacher working with 8th-grade math content. Her bachelor's degree prepared her for teaching certification in mathematics, grades 6-12. This teacher preparation program included multiple classes on inclusive education and the varied academic

abilities represented by students in the general education classroom. Felicity shared that during her first year, she spent too much time jumping between websites, worksheets, and practice programs, which left her feeling that the lessons were disjointed. She would love to learn how to streamline the transfer process between the required presentation and practice materials. Felicity had two HH students in the same mathematics class this year.

Harper

Harper transitioned from a successful career in corporate America to the school system three years ago. Armed with an undergraduate degree in economics, an accounting and finance MBA, and a Master of Arts in teaching, she imparted her knowledge to 8th-grade mathematics students during the most recent school year. Harper had one HH student she worked with. As a new teacher, it was evident that Harper was still developing self-confidence regarding her ability to instruct the diverse learners in her classroom. Harper spoke fondly about her students even as she described the academic challenges faced by many when asked to work with grade-level mathematics standards.

Julia

Julia just finished her 22nd year of teaching. She spoke about the "golden handcuffs" that veteran teachers wear as they approach their 30th year of service in public schools. That 30th year represents the opportunity to fully retire regardless of age. Julia has a specialist degree with state certification at the K-5 and 6-8 levels. Over the years, she has continued her education by working through endorsements for math, coaching, and gifted education. She has taught elementary and middle school. She shared that her teacher preparation program did not include best practices for working with diverse learners. Her training included one introductory college course that touched on possible disability identifiers but incorporated little to no training on

inclusive education practices implemented today. Julia has met and worked with several HH students during her career.

Matthew

Matthew was a 22-year veteran teacher whose entire career had focused on the middle school level. He had experience in the general education classroom but had devoted himself to serving exceptional students. His current middle school location followed a magnet school model. Regardless of zoning, this school model has DHH students from around the county who meet specific academic criteria clustered together at one location to receive instruction targeted to their specific DHH learning needs. Due to the nature of this magnet school and its comparatively large DHH population, all teachers are provided in-service training on specialized instruction because of the sizeable exceptional student population. Matthew has served the greatest number of Deaf and HH students.

Quinn

Quinn, a versatile educator with 15 years of teaching experience and a master's in education, had successfully navigated the elementary and middle school settings. Her experience with a Deaf student in the elementary school, who used American Sign Language as her primary mode of communication, and her recent interactions with HH students in the middle school demonstrated her adaptability and ability to connect with students. Quinn had recently had an HH student come through her middle school classroom.

Silas

Silas is a 9th-year teacher with a doctorate in education and holds dual general and special education certification. This year marks the eighth year he has taught in middle school, while his first year was spent at the elementary level. Throughout his career, Silas has worked as

a special education teacher but taught 7th-grade general education mathematics this school year. Silas focused on his experiences with three HH students he most recently had in his mathematics classroom.

Twyla

Twyla had just finished her 16th year in education. Her bachelor's degree was in business administration, and she also held a master's in accounting. She began working in accounting but transitioned to teaching, completing a master's in special education. At the time of this interview, she was close to completing an educational specialist's degree in special education. She had taught both general and special education mathematics courses. Recently, she transferred to work within a school district's central office to support teachers as they worked to create compliant and appropriate Individual Education Programs for the exceptional students served in the district. Twyla had had multiple HH students come through her general and special education classrooms throughout her career.

Violet

Violet was in her 24th year working in the public school system. She held a specialist degree in education. She had taught mathematics across multiple grade levels, most recently in the middle school setting. She transitioned to the position of mathematics coach and now serves as a mentor to math teachers in the building, modeling best practices and providing enrichment through in-service training for teachers and remediation classes for students who do not meet academic expectations. Recently, Violet had one HH student in her math classroom, and she used this experience as her basis for the responses she provided throughout the data collection process.

Wren

Wren just completed her first year of teaching while working to finish her master's degree in education. She spent this year in the 6th-grade mathematics classroom. Her experience working with a strong, mathematically minded co-teacher was hugely beneficial as she navigated this initial year of teaching. For personal reasons, she only completed the interview portion of the participant responses. She did not participate in the focus group or provide journal responses. Wren had one HH student this year, which presented unique challenges in the classroom.

Results

This section of Chapter Four presented the results extrapolated from data collected by the compilation and evaluation methods previously described in Chapter Three. Once the participants completed their interview, joined the focus group, and responded to the supplied journal prompts, the transcript, and written response analysis yielded two main themes. Within each theme, two sub-themes were often coded. The first theme was the instructional approach. The sub-themes were (a) routine and (b) corrective instruction. The second theme was the encouragement of independence. This theme also had two identified sub-themes, which were (a) student motivation and (b) HH student accommodations (See Table 5).

Table 5

Themes, Subthemes & Codes

Themes	Sub-Themes	Codes
Instructional Approach	Routine	Activation of Prior Knowledge, Teacher Check-ins, Explicit Teaching of Strategies, Visual Supports, Notes
	Corrective Instruction	Inappropriate Pacing, Low Reading Levels, Limited Reteaching Opportunities, Small Groups, Need for Co-teacher
Encouragement of Independence	Student Motivation	Partner Work, Social Opportunities, Student engagement, Attendance
	Hard-of-Hearing Student Accommodations	Preferential Seating, Sound Amplification, Knowledge of needs, Unnecessary supports, Development of Relationships, Equipment Issues

Instructional Approach

Teachers are highly educated professionals who enter the classroom daily, instructing a wide range of students during each class period. Throughout each interview, in the journal responses, and discussed in the focus group, these professionals continuously shared a breadth and depth of knowledge regarding best practices in education. Violet, the longest-working teacher interviewed, commented strongly when discussing what classrooms need to succeed: "I think the biggest gift that we could give teachers is, here are your standards. Here's what you have to teach and allow each teacher to do what they need to do for their particular class." These

teachers shared many educational best practices and instructional strategies to meet specific student needs throughout all data collected. The instructional approach was determined as the first overarching theme due to the often coded phrases that discussed the development of a class routine. The routine was a subtheme used to describe each teacher's use of identified best practices, such as activating prior knowledge, teacher check-ins, explicit teaching of strategies, incorporating visual supports, and using notes in the math classroom. The second subtheme, corrective instruction, was derived from the codes inappropriate pacing, low reading levels, limited reteaching opportunities, small groups, and the need for a co-teacher. These codes coalesced to form the subthemes of routine and corrective instruction, which were then merged and identified as the broader theme of the instructional approach.

Routine

The primary role of a teacher is to present academic content. The format of the presentation varies depending on the teacher facilitating classroom instruction. As the teachers discussed their classrooms, the most often mentioned concepts were developing context and connection to the material, visual presentation of concepts while creating reference materials, and checking in with the students while they practiced new skills. All participants discussed each component as they described their daily classroom activities. Teachers weave these concepts together to teach students new skills and how to apply them.

While only mentioned by name by one participant, activity description by multiple participants referenced the three-act tasks Georgia teachers employ to guide mathematics lessons according to the state-provided standards of excellence. An initial video or photograph is shown to the students along with the questions: *What do you notice? What do you wonder?* Multiple participants shared this activity's benefit, allowing all students to participate. As Quinn stated,

“This type of questioning allows each student access to the problem and allows everyone entry into the conversation.” All students could connect to this opening activity, which created an accessible and positive learning environment. Violet often allowed students to share life connections to this opening material, furthering the real-world understanding of the context in which the upcoming math concept will be rooted. Opening activities such as the one described by multiple participants pointed to the activation of prior knowledge to begin each learning segment.

Moving into the lesson portion of the class period, each teacher explained how they visually supported learning while creating reference materials. Visual supports used throughout the lessons became reference materials available for student use. Reference materials used were tangible and easily accessible, which aided the students in looking back for help as they began to work through practice problems independently or in partner groups. One visual support mentioned was anchor charts. All but two teachers stated they post anchor charts around the classroom. Avery and Felicity noted that, while anchor charts are not posted, the students are given smaller copies of charts to keep in their notebooks. Anchor charts may model a problem, define essential vocabulary, or remind students of formulas needed for the unit. The remaining teachers were split regarding whether they left the anchor charts up for the entire year or only posted them for the unit and removed them to limit confusion.

Notes about the lessons were another often-mentioned reference material and visual support. The most common teacher-guided forms of notetaking discussed were graphic organizers, interactive notebooks, and cloze notes. All participants mentioned some form of guided notes. Matthew explained that guided notes reduce stress on students as they are not worried about missing vital concepts. Casey explained sketch notetaking, which was a visual

form of notetaking that encouraged doodling pictures for ideas instead of writing sentences.

Within notes, modeling problems in a visually accessible way has become straightforward with the availability of smartboards and document cameras. All participants mentioned these two types of equipment, which were standard in each of their classrooms. Smartboards were essentially large touchscreen computer monitors. This allowed teachers to electronically write directly onto worksheets or over any visual displayed on the device. Document cameras enabled the students to view in real-time a large-scale version of whatever the teacher wrote on paper through a connection to the smartboard. Both smartboards and document cameras were discussed as beneficial equipment that aided in visually supporting learning. Ten teachers stated that they stayed in the front of the classroom during the teaching portion of the class and then began circulation once practice started. One teacher described walking throughout the classroom as she taught, referencing anchor charts, monitoring behavior, and connecting with students through proximity and eye contact as she delivered new concepts.

Visual support goes beyond straightforward modeling of problems on the smartboard or document camera. Eight participants noted the inclusion of pictorial representations of concepts related to the vocabulary or background of a scenario, not simply the steps to the math problem. While some educators, like Casey, may not add or show pictures related to a problem's concept or background information, they use visuals to aid student understanding. For instance, Casey would show photos of specific vocabulary on the smartboard if a student said they did not know what a word within a problem meant. On the other hand, Felicity did not add visuals to worksheets but noted that some creators included small visual prompts for each problem. Quinn and Violet often added small clip art visuals alongside word problems to orient students to the background or critical concept needed to understand the problem. These examples highlight the

role of visuals in aiding student understanding.

Throughout the class sessions, teachers described the practice opportunities students were provided and encouraged to participate in to demonstrate a prerequisite skill or apply a newly learned skill. Teachers used these opportunities to circulate amongst the students to check for understanding. Casey, Harper, and Silas had 360-degree classrooms with all walls covered in whiteboards. They often had students working in peer groups to solve problems. Casey explained how this reduces anxiety because it supports shared thinking. Students could see other students work through a problem and then apply the process to their assigned problem. She then could see who seeks support from different student groups and would step in for guidance if needed. During independent practice, all teachers described their process of walking the classroom to guide students and provide informal comprehension assessments. All teachers mentioned the need to work one-on-one with students. These one-on-one or small-group sessions were deemed necessary to help students grasp concepts, especially for HH students and those who enter the class multiple grade levels below expectation.

Each teacher described their routine for presenting a lesson. There was a clear progression from an opening activity to call students to focus on creating connections between previous material or real-life experiences and the upcoming content. By activating prior knowledge, connections could be made to the visually accessible lessons. Visually rich lessons with embedded reference materials were presented with the intent to make connections to previous learning. Finally, check-ins with each student were completed as the teacher circulated the classroom to confirm student understanding.

Corrective Instruction

All participants mentioned independent or small student group work sessions. During the

class period, these sessions allowed the students to complete practice problems related to the material introduced or expanded upon during the whole group lesson. Practice time was deemed critical, as it allowed teachers to monitor student learning and direct students to review the instructional reference materials created, displayed, or disseminated during the lesson to encourage problem-solving and self-motivation.

Without exception, all participants discussed the need to work one-on-one with the HH and other struggling students to increase student understanding. The collective agreement among all participants was that the general student population was entering middle school with a much lower reading level than previously seen or expected. Twyla highlighted the need for a second teacher in all classes other than perhaps Advanced Placement courses: “When you have 25 or 30 kids, it doesn't matter if it's a special ed class or general ed class; you can't make it to everybody to help clarify their understanding.” Matthew, Silas, and Wren specifically pointed out their use of the co-teacher to do individual check-ins and pull small groups during independent work sessions.

The Georgia statewide pacing guide was discussed, and each participant meticulously reiterated overwhelmingly disapproving commentary on this document. All participants echoed the harmful effects of this required progression through the standards. Quinn noted, “But in addition to the pace—and I mean it's breakneck sometimes, like Violet said—another deficit with the pacing guide is there's no time for remediation. Like Harper said, there's also no time for reteaching.” Each participant explained that the lack of built-in time for re-teaching and remediation caused students who had failed to master a concept to enter the next unit with additional missing prerequisite skills. The reiterated belief was the need for mastery before moving on.

Encouragement of Independence

Middle school represents an opportunity for students to increase their self-regulation skills. Each teacher spoke about students working alone or in a small group to complete assignments with minimal teacher guidance as an expected practice. Class sizes range from 18 – 35 students, necessitating that students be willing to engage in activities independently without direct adult supervision. This transitional time, where students are encouraged to find their inner determination, was a basic expectation that middle school teachers nurtured to prepare students for the transition to high school. As students progress through the middle school grade band, the expectation for independence increases. With the reiteration of these procedures yearly, the desire was that they become ingrained within the student as maturity develops. Student motivation was chosen as a sub-theme due to the codes of partner work, social opportunities, student engagement, and attendance. The second subtheme was identified by the context of this case study and the teacher's discussion of preferred seating, sound amplification, knowledge of student needs, unnecessary supports, development of relationships, and the realities of equipment issues.

Student Motivation

Teachers agreed that motivated students, no matter their academic challenges, were more likely to see growth in the classroom. Each participant who had worked with multiple HH students had examples of both motivated and unmotivated learners. Harper's sole HH student often struggled to learn new skills, but in her reflection on his work with word problems, she shared, "He actually probably does a little bit better because he's trying. So, as I said, he's actually just a joy student to have in class." The teachers often mentioned willingness to engage as one factor that increased student achievement. Each teacher dealt with different levels of

motivation from their HH students and the general student population. Despite learning challenges, Avery, Casey, Harper, Julia, Quinn, Matthew, and Wren described specific HH students with the desire and drive to do their best in class. Their willingness to sit and work with the teacher or co-teacher positively influenced their progress in the classroom. Their perseverance also inspired the teacher's memories of this student as they spoke proudly about the student and their learning journey. Matthew's student struggled with a self-confidence issue that caused her to worry when concepts took longer to understand than her peers, yet she persevered and worked hard to succeed. Julia shared the story of a student who worked hard to overcome his deficits due to his desire to be in the class with his friends. This group of friends helped tutor him, and during the school year, he caught up to the point that he could move into the class without a co-teacher for the following year. These students were committed to their education.

Casey, Felicity, Silas, Twyla, and Wren described their challenges when working with students with little to no self-motivation. Felicity shared that she had almost a whole class, including two HH students, lacking motivation. She had to push these students to start working. Many students regularly refused to begin an assignment without being given the first several steps. Silas's student posed a different challenge due to his multiple disability identifiers. This student not only had hearing loss but was visually impaired and autistic. His desire to have his sensory needs met led to tantrums, which had to be mitigated through the use of a one-to-one aid and other coping strategies instituted in the general education classroom. Twyla and Wren had students who would shut down and refuse to move forward with assignments once they became more difficult. Both students wanted the teacher to confirm that each step of a problem was correct before they were willing to move forward. This level of dependence was problematic to meet in a large class setting and was not the expectation for middle school students. Casey and

Twyla discussed class-wide instructional accommodations they implemented to increase student confidence, decrease stigmatization of accommodation usage, normalize getting answers wrong, and prioritize students asking for help.

Coupled with motivation was attendance. Avery, Felicity, and Wren all had chronically absent students. One student missed multiple days a week, another missed large chunks of instructional time, being absent five consecutive days several times during the year, and the third missed one or more days most weeks. They spoke about the amount of information missed in a single class period and the challenges these students faced when interacting with the curriculum. These absences, at their core, could be deemed the fault of the parents. On the other hand, Matthew commented on the bussing situation that his HH students faced, which caused them to arrive late many mornings at their magnet school location.

> So, they literally are bussed into our school specifically to be a part of this unit, and again, there's another situation: those kids usually come late. And so, we're kind of always catching them up because of the transportation issue. So that's yet another thing that has to happen, and it makes it kind of difficult to get them to where they need to be.

Student absenteeism was an added challenge for these four teachers when working with the HH student population. Whether absent or late, missed time influences student learning. Additionally, students entering late causes a class-wide disruption. They must locate their seat, access needed class materials, and be caught up as quickly as possible to join the class activity already in progress. Student desire and attendance were critical components of the development of independence that should occur in middle school.

Hard-of-Hearing Student Accommodations

Teachers must be aware of HH student needs before accommodating them. Multiple

teachers mentioned that they were unaware of the student's hearing loss as the year began. Avery said, "I didn't even realize she was having a hard time hearing me." Despite receiving accommodation sheets during pre-planning, many teachers pointed out that, due to the sheer volume of students and student needs, they had overlooked the statement that the student they worked with had a hearing loss. Most participants received direct notification of the accommodation needs from the DHH teacher, either by email with introductory information or, time permitting, from the DHH teacher in person as she gave a quick in-service about the HH student's needs. The timeline for this information varied for each participant. Once awareness of the need was communicated to the teacher, the general feeling was that it simply became part of the routine. Casey stated of the sound amplification, "I don't really have any challenges using it. If I have it on, I use it. Doesn't bother me." Other comments echoed the same level of confidence in integration. Twyla shared how she met HH students' needs, "I would just say purposefully designing your classroom so that you are accommodating their needs without making a big deal."

All participants discussed the importance of accommodation for the HH students. Each participant discussed preferential seating, which included providing clear sight lines to the teacher during lessons and sound amplification. Twyla made this point when talking about middle and high schoolers,

> I think the biggest thing is to pretend like you're not paying attention to it, but you work into your instruction and into your classroom routines. You purposely seat them where they need to be seated, but you don't make a big deal. You're discreet.

Most participants repeated this incorporation of sound amplification and preferential seating to ensure that the HH students were seated near the front of the class into their routine.

These two accommodations are commonplace for most HH students. Several teachers also had students who received read-aloud accommodation requiring small group administration, while others had students who also received extended time. The read-aloud accommodation received a favorable response from the teachers, but many felt that extended time was unnecessary. Two teachers mentioned the need for human reader accommodation. Students who depend on facial cues and lipreading do not have their needs met via the computer-generated voice available for online texts, the Georgia Milestones, and other web-based assignments or assessments. While understandably necessary, human reader accommodations were illustrated as labor-intensive and time-consuming. Due to the time required for this in-person presentation of the material, they shared that a co-teacher, DHH teacher, or supportive instructor was expected to be available for its provision.

The need for an explicit and direct explanation of classroom support HH students require connects to the development of independence that exponentially becomes expected in middle school. Independence while they complete assignments, yes, but it also means self-advocacy. Casey explained, “I think for Middle School, the thing I see the most is just that the kids need to be held accountable to make sure that they self-advocate.” Quinn explained the information she needs as a teacher from the student, “What is the student’s preference? How do they feel in the classroom?” While Felicity gave this insight,

> “It [preferential seating] allowed them to sit where they could hear and learn while also being around someone who they are comfortable with … [It] is so important so that students can have that comfort and safety that they need, even if they just need to ask for something to be repeated.”

Casey’s call for self-advocacy and Quinn’s defined questions, alongside Felicity’s

preferential seating observation, show the need for more profound thought than that student was HH. HH students must sit in the front row, near the teacher, where they can see the board. Feelings of safety and belonging are fundamental for developing and expanding the skills needed to self-advocate, especially under the hyper-focused social connections that are foremost on the minds of middle schoolers everywhere.

The inconsistent availability of the sound amplification system was a concern expressed by Casey, Harper, Silas, Quinn, and Wren. Harper's HH student did not have a personal sound amplification system assigned until the middle of the school year. Once the accommodation was added to his Individual Education Program, the system was either locked in another classroom or not charged, resulting in her never having the opportunity to use it during the last half of the school year. Silas shared that he often experienced students who had forgotten or brought in dead equipment. Two participants expressed frustration about the lack of responsibility for keeping this equipment in working order. They felt the students should add the morning pick-up and afternoon plugging in for charging to their daily routine. The participants then stated they understood accessing a locked classroom was often challenging due to the need to keep the microphone in a secure location overnight because of the expense of this equipment. Twyla and Wren's school district had universal sound amplification in all classrooms, but their challenge recently arose when seeking access to a dependable microphone. As the system had aged, replacements were no longer available, and access to functional equipment was limited.

Casey and Avery had model students fastidiously using their sound amplification systems daily. Casey's student was motivated, attentive, and meticulous about ensuring her equipment was ready to go. Avery's student was incredibly conscientious regarding her sound amplification system. Avery shared that it was life-changing for this student when the equipment arrived a

month into the school year. The universal sound amplification in the classroom was insufficient to meet this student's auditory needs. Further explanation of this accommodation's profound impact was given: "When she got her hearing aid [with connected microphone] …, that was much better. She was very different. It made a big difference, and she would remind me to turn it on." Discussion of this student highlighted how self-perception of need influenced the desire to use the equipment.

Avery, Casey, and Matthew referred to note-taking as an activity they had to accommodate. As discussed in the literature of Chapter 2, HH students have a limited working memory capacity, which means listening and writing simultaneously pose a significant challenge. Avery stated, "She had a hard time processing and couldn't listen and write." Casey acknowledged the challenge even her on-grade level HH student faced while taking notes, but she continued to expect him to try and then provided a full copy to the student once the lesson was complete. Matthew's special education background became apparent as he talked about working with another general education teacher who was frustrated with the quality of notes the students were taking.

> We had to move to cloze notes because I was like, it's [free-write notetaking] not working. That's not going to work. They need more structure, and it was a hard fight initially because you feel like these kids should know how to take notes. I'm like, no, they've got to have some support in order for them to make progress.

All participants acknowledged that student accommodation was essential for classroom access and success. Participants expressed varied opinions on the effectiveness of sound amplification, preferential seating, extended time, read-aloud, and small group testing for students. The students who used their accommodations consistently and effectively were praised

for their diligence and motivation for learning. Students who did not access the provided support and spoke out about their dislike for the amplification, special seating, extended time, or read-aloud were perceived differently based on their performance in the classroom. Some students were seen as not caring about their education. The teachers of students who were doing acceptably well felt that they did not need the accommodation. Other teachers stated that due to students becoming more independent at this age, they had the right to refuse the services offered.

Outlier Data and Findings

The collected data contained a subset of information about Deaf students being educated in the public school system. While this information was interesting and worth further exploration within the bounds of another study, it did not align with the central research question and sub-questions directly related to HH students. Four teachers, Casey, Julia, Matthew, and Quinn, had experience working with Deaf students who utilized interpreters in the classroom daily. Since this is a novel occurrence, they described interactions with these students and their interpreters. These two student populations are often grouped under the DHH umbrella, and they were all identified as hearing impaired academically. Teachers' discussions of their experiences with Deaf students are briefly outlined below.

Deaf Students in the General Education Setting

For some with significant hearing loss, American Sign Language (ASL) was chosen for clear communication. The more substantial hearing loss levels often manifest a more profound and noticeable spoken and written language deficit in the classroom than students with mild or moderate hearing loss. Participants shared that introducing an ASL Interpreter into a classroom created a learning curve as they became familiar with this additional adult providing a visible service.

Quinn described her initial concern about her Deaf student in terms of connection. She wanted to interact directly with the student without always depending on the interpreter. She also shared her learning process as she worked to present lessons at the correct speed for the interpreter. As Quinn developed relationships with the interpreter and student, they all became more comfortable reading cues from each other. Matthew shared insights about working with not only the staff interpreter but also experiences with substitute interpreters. The interpreter who worked daily with his Deaf student became familiar with her language needs, could more easily understand her, and could convey what the student was missing, saving time and frustration for all involved. Matthew also shared that the ASL interpreter was a good resource when determining how to present a concept using different verbiage for HH students. He said that interpreters can break down concepts in a way that can also meet HH student's needs. Interpreters showed skill in establishing concepts logically and visually to make a previously missing connection. Casey and Julia quickly touched on their Deaf student experiences but focused mainly on the students who satisfied this research criterion.

Research Question Responses

The following section addressed the central research question and sub-questions guiding this study. Data collected through individual interviews, the focus group, and journal prompt responses were reviewed and compiled to identify patterns. This data aggregation and triangulation looked to provide robust and meaningful conclusions to the questions presented. All teachers had distinctive experiences working with HH students, which they shared beautifully to create a glimpse into the inner workings of a middle school general education mathematics classroom. Their responses throughout the three data collection methods provided a broader understanding of the questions that directed this case study.

Central Research Question

What are the experiences of general education middle school mathematics teachers working with HH students?

Diverse student populations within each classroom present a challenge that general education teachers face and meet daily. Participants described interactions with HH students supported by the developed themes of instructional approach and the encouragement of independence. Flexibility was mentioned as a critical aspect for teachers as they worked to meet HH students' needs. Class-wide instructional accommodations, such as context building through visual aids and reference materials, are high-leverage practices used to meet various educational needs in mathematics classes. Teachers visually modeled problems, which provided students guidance during practice to monitor their success. Reteaching and remediation opportunities were another vital interaction between teachers and HH students. HH students benefited from one-on-one time with the teacher so that content could be presented gradually with repetition, visuals, and extended explanations embedded to aid in understanding. HH students significantly benefit from this personalized attention provided during corrective instruction.

All teachers noted that adhering to a statewide pacing guide was problematic. Many complications were due to the need for students to have prerequisite skills re-taught before new content was introduced. A discussion about adding fractions led Julia to make this statement:

> People take for granted how many prerequisites there are in that. It's not because kids can't add fractions. It's because kids don't know how to find a common denominator. They don't know their multiplication facts, so they don't know what the greatest common factor is.

Participant consensus requested this change: Students should master content skills before moving

on to courses requiring advanced-level application of multiple content skills.

Middle schoolers were actively being taught skills outside the state-required academic content. These middle school teachers encouraged students to exercise their ability to work independently and strive for success. Participants often lauded student desire as an underlying condition for reaching annual goals, especially for HH students who faced academic obstacles. Teachers who had worked with chronically absent or unmotivated students outlined the extra hardships these students would have to overcome to obtain basic proficiency in the obligatory content.

Teachers also mentioned simple awareness as essential to ensuring HH students receive basic accommodations. All teachers were informed at the beginning of the school year via different methods regarding HH student needs. Collaboration through email or in person with the DHH teacher, however brief, was the avenue most information came through to reach the general education teacher. Teachers worked seating and amplification accommodations into their daily routine, causing minimal disruption without drawing unnecessary attention to the HH student. Twyla somewhat remorsefully stated when discussing an introduction to the student and discovering their needs, “It's almost like they don't want anybody to know they're hard-of-hearing.”

Sub-Question One

How do teachers utilize multi-sensory stimuli to teach mathematics to HH students?

Instructional strategies were leveraged in various ways to meet HH student needs. Teachers' daily use of document cameras and smartboards allowed for easy interactions with worksheets and visuals to provide models for students to reference throughout lessons and practice sessions. Matthew encouraged HH students to prioritize attention to the lesson to

promote internalizing new content over writing down sample problems or struggling to identify and write down significant concepts during lessons. When working with a struggling HH student, he mentioned, “I had to draw it out for her.” Explanation paired with a drawing led to understanding. Harper explained her use of guided notes by sharing, “I’m speaking, and I’m explaining it, but I am also writing down the words. It’s just a fill-in-the-blank kind of thing, but the words are already there.” Participants shared that note-taking was a considerable portion of the learning segment. Participants felt that HH students should work to develop this skill.

The use of kinesthetic and collaborative learning was also noted. Classrooms with 360-degree whiteboards had students up and moving while working together to problem-solve and determine answers to posed questions. Casey shared, “It's been helpful in just getting them up and down and moving because kids have such short attention spans these days because of phones.” All teachers positively mentioned peer collaborations. These peer interactions can create social and emotional growth opportunities for HH students. HH students often shy away from peer groups due to lacking self-confidence. Casey noted that detectible speech variations caused hesitation when HH students were directed to engage in group work. Violet recalled of her student when discussing peer interactions, through active modeling and reassurance, “She became more independent and more engaged in math [class] ...” Teachers facilitated peer engagement to encourage understanding of the academic content and boost socialization and self-advocacy skills.

Sub-Question Two

How do teachers facilitate connections between short-term and long-term memory for HH students?

Teachers who follow the Georgia three-act task outline begin lessons with an activity to

activate prior knowledge. Activating prior knowledge activities allowed students to bring into focus what they knew about a concept. While these activities were noted as beneficial, participants shared that the expectation was that there was prior knowledge to activate. Quinn shared, “But when I have a sixth-grade student on the third-grade level, they kind of remember this before, but even trying to build on that is incredibly difficult.” Concepts, such as basic math facts, especially multiplication, were stated by participants to influence student success profoundly. Avery said, “They don't always see the patterns that happen in algebra as the concepts advance, and since they don't understand basic facts, it ends up being a big deal when you are looking for a way to simplify the problem.” Twyla echoed this when discussing calculator use: "So I'm one of those people who believes they need those facts. You can’t see the patterns once you get into simplifying equations. You can't factor equations. You can't do that in a calculator.” Frustration for participants stemmed from low reading levels seen not only among the HH student population but also across the overall student body.

All participants stated that guided notes are a beneficial tool in the classroom. Guided notes allowed students to focus on targeted concepts. The idea was that new concepts should connect in some way to previously learned material, and through guided notes, these connections were often explicitly laid out. Students asked to write free-form notes could focus on or write down the wrong portion of the lesson. By providing an outline through cloze notes or graphic organizers, students save time and mental energy struggling to determine the central concepts of a lesson. Teachers provide opportunities for students to strengthen their understanding of new material through guided practice. As teachers circulate, students can use classroom resources, such as anchor charts, peer discussion, and interactive notes, to solidify their integration of new information into a recallable mental location.

Summary

The preceding chapter presents the findings from the data gathered during the outlined collection process to answer the research questions proposed through this collective case study. Participant descriptions were outlined and included background information, years of service, and experience with HH students were provided. Due to their participation in the three data collection methods, two themes with two sub-themes for each were frequently coded. The two broad themes developed from the responses were the instructional approach and the encouragement of independence. Within the instructional approach, two subthemes developed: routine and corrective instruction. The encouragement of independence also yielded two subthemes: student motivation and HH student accommodations. With support from the themes and subthemes uncovered through the synthesis of collected data, the central research question and two sub-questions were addressed from the distinctive perspectives of the teachers involved.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this case study was to understand the experiences of general education mathematics teachers working to educate HH middle school students. Chapter Five includes a discussion of the conclusions drawn and a presentation of the data implications within five subsections. The first subsection interprets the findings discovered through thoroughly analyzing the data collected. The second subsection includes implications for practice related to the education of HH students in the middle school mathematics classroom. The findings' theoretical and empirical implications were outlined in the third subsection. Limitations and delimitations were then recognized in the fourth subsection. The fifth and final subsection proposes a path forward for future research to expand the knowledge base undergirding this topic. A conclusion was provided after the five subsections discussed the outcomes of this case study.

Discussion

This case study provided a method to investigate the perceptions of general education teachers working with HH students in the middle school mathematics classroom. The data collected through interviews, a focus group, and responses to journal prompts provided a glimpse into the participants' classroom interactions. The two themes that emerged were the instructional approach and the encouragement of independence. The instructional approach encompassed two subthemes: routine and corrective instruction. The encouragement of independence also included two subthemes: student motivation and HH student accommodations. The findings and implications of the themes are presented below.

Summary of Thematic Findings

This descriptive case study was designed to illustrate the teaching and learning

interactions between middle school mathematics teachers and HH students. Two themes and four sub-themes were identified as interwoven within this case study. The identified themes were instructional approach and encouragement of independence. The instructional approach theme yielded two sub-themes: routine and corrective instruction. Within encouragement of independence, the two emergent subthemes were student motivation and HH student accommodations. Analysis and triangulation of the participant responses led to the following interpretations.

Interpretation of Findings

This case study explored middle school teachers' perceptions of the needs of HH students in their classrooms as they introduced mathematics content. Findings suggest that middle school mathematics teachers incorporate class-wide instructional accommodations within each lesson to meet various student needs. These instructional accommodations incorporate visuals into lesson presentation, which aligns with Paivio's (1971) dual coding theory. The daily targeted accommodations the general education teacher employs to meet the needs of HH students are preferential seating and sound amplification. These physical accommodations give HH students a higher likelihood of simple access to the presented curriculum.

Balancing Diverse Requirements

Each general education teacher interviewed shared their daily instructional routine and how they met the needs of students within their classroom. All teachers interviewed placed the general education teacher as the main content presenter. These teachers provided all instruction to the classroom at large. With the incorporation of technology into all classes represented, the ability to project large-scale representations of worksheets, notes, and other visual lesson supplements was a routine activity. Teachers used a variety of note-taking techniques to support

their diverse learners. Notes were often accommodated by providing pre-filled or partially filled notes to students with explicit IEP accommodations or those the teacher felt needed extra assistance.

Teachers described presenting and working through content at a slower pace for classes representing more diverse or challenged learners. Additional time for discussion, increased peer group time, small group sessions, and time with a co-teacher were described as classroom-implemented accommodations used to meet the needs of lagging student groups. Teachers shared that it was not uncommon for classes learning the same subject to be days apart in the curriculum based on various factors. Factors that influenced the speed of the lessons were the student's needs, the time of day the class took place, and the involvement levels of the co-teachers assigned to the different classes. Balancing the extra time needed with the expectation that all standards should be covered within a specified timeframe was a challenge defined by teachers working with lagging student groups.

Looking Beyond Physical Needs

HH students in a general education classroom require support beyond correct desk placement and amplification of the auditory classroom content. Each participant detailed the use of these accommodations as their primary means of support for HH students. Listening to their descriptions, I determined that some classrooms took a step beyond the physical needs and strove for the authentic inclusion of HH students. These students were made to feel comfortable with teachers and classmates as they publicly owned a vulnerability. Hearing aids and sound amplification systems were visible. Positive adult reactions and smooth incorporation of new equipment were the crucial first steps described by all participants. Understanding the courage it takes for an HH student to admit that they do not know the meaning of a word, do not understand

a concept, or may have misheard a piece of information was identified as needed and cannot be stated strongly enough. Conversely, it needs to be understood that HH students miss information but are entirely unaware. Stated another way: if they did not hear it, they do not know they did not hear it. Participants described teachers checking in with students and allowing them to restate information to determine their understanding of concepts. The check-in strategy ensured the complete message was received correctly, lessening the chance that misinformation would persist.

Detailed descriptions that outlined the beginning of the school year when the HH student was first introduced to their class highlighted the importance of the DHH teacher. Each general education teacher could share how they received the information regarding the HH students' needs through email or an in-person visit from the DHH teacher. The accommodations most often remembered from the DHH teacher's briefing were preferential seating and amplification. While overarching, these accommodations are not all-encompassing. However brief, these connections between DHH and general education teachers were critical to ensure awareness of the HH student's needs. Several participants mentioned classroom activity struggles, such as the need for an extended time to process information during instruction and to formulate an answer after being asked a question. Note-taking was also a challenge for several described HH students. The concentration required to listen and write simultaneously was acknowledged as enormous (Boyle et al., 2021). The descriptions outlined pointed to the understanding that the working memory capacity of HH students was reduced in comparison to grade-level peers (Nelson et al., 2019; Thom et al., 2022).

Never Enough Time

Teachers understood the value of one-on-one and small-group teaching opportunities.

Some students, such as the HH students highlighted in this research, greatly benefitted from one-on-one time working with their teacher. The gains for HH students may stem from proximity, equating to more manageable access to what the teacher was saying. Fewer students closer to the teacher means a significant reduction in background noise. With or without hearing aids or sound amplification, background noise impedes HH students' access to the preferred speaker, the teacher. Some HH students may feel more comfortable privately admitting their struggles; some may need direct adult attention.

While one-on-one and small group time was stated as beneficial, it was also repeatedly mentioned that time for this was severely limited. Larger class sizes, state pacing guides, and a wide range of student needs within one classroom decrease the opportunities for these teacher-led small-group sessions. Discussion of time limits and small groups led to the awareness that competent co-teachers were highly valued. Teachers with active co-teachers shared that the students with IEPs often went to a separate classroom or pulled to a table in the back to work directly with the co-teacher once independent practice time started. The value of this second active teacher was communicated clearly by the general education teachers who were privileged to work with them. Descriptions of involved co-teachers pointed to their helpfulness to the general education teacher due to the reduction of continuous responsibilities felt when working with a classroom of diverse learners.

Has The Bar Been Lowered?

Throughout the collected data, participants commented that the HH student was not doing any worse than many other students in their classes. The overall decrease in student reading levels and ability to apply learned skills described by participants created many questions beyond this research's scope. Descriptions of students entering sixth grade with reading or math skills

more than two grade levels below expectation led to frustration from the participants. Without fully exploring these students' disability identifiers, accommodations, and backgrounds, specific statements about what should have happened before they arrived in middle school cannot be made. It can be stated, however, that the perception from the participants that student reading levels were at an all-time low led to HH students being seen as performing at or above the level teachers were anticipating. HH students' performance raised little to no alarms, which could be seen as excellent unless this was due to the bar for overall student achievement being lowered.

Implications for Policy and Practice

This section of Chapter Five discussed potential implications and suggestions for policies and practices to increase positive teacher/student interactions, leading to increased HH student success in middle school mathematics. Policy implications include teacher preparation programs, district-wide administrative staff, and building-level administration. Implications for practice are also intended to be implemented or acknowledged by these groups, including building-level teachers and staff instructing HH students.

Implications for Policy

The changing landscape of education means that a wide range of student needs can be found in each classroom. The call for the least restrictive environment and other inclusive policies have paved the way for most students to receive their education to the fullest extent possible within the general education classroom. The need for general education teachers to have special education or universally designed instruction training was apparent. Co-teachers did not stay in one general education classroom all day. Sometimes, depending on staffing and student numbers, general education teachers were required to provide instruction without aid from a special education teacher to assist in implementing accommodations or the redelivery of

information. General education teachers need targeted training in best practices for delivering content and scaffolding for all exceptional learners, especially low-incidence groups, such as HH students. This training should be embedded within current teacher preparation programs and created as additional district-wide professional development sessions.

Implications for Practice

The overarching themes of instructional approach and encouragement of independence were repeatedly supported throughout the collected data. Each teacher articulated their desire to see each student in their classroom succeed. They shared their frustrations with students who were unmotivated while lamenting the lack of time available to work with students who had fallen behind. Participants reflected on the classroom practices they used to work with HH students, strategies they used that seemed successful, and the challenges they or the students faced when working in the mathematics classroom. While it was clear that general education math teachers employed many class-wide instructional accommodations, it may be that increased visual content and training to incorporate visual vocabulary scaffolding are needed. Some students could use an increase in implementing these strategies beyond modeling problem steps to overcome the decreased background knowledge many HH students face. Clear visual representation benefited HH students who were working to interact with the background concepts surrounding mathematical content.

Supported by previous research (Strogilos et al., 2019), participants spoke of active and involved co-teachers in the classroom, which was emphasized as a great benefit. It may also be necessary to increase content training and expectations for these special education teachers entering the general education classroom to provide support. General education teachers spoke of the need for co-teachers who were content-aware. Content awareness or, at a minimum, a

willingness to learn and interact with the class concepts and the students was a definite requirement for a co-teacher to be seen as successful. DHH teachers were also identified as key to implementing needed accommodations and explaining the unique requirements of HH students.

Time limitations extend beyond instructing and re-instructing students. Time was an often-mentioned barrier to not only planning but also collaborative planning. Collaborative planning time between the general and special education teachers was non-existent. DHH teachers often follow a traveling schedule. Travel time limits timely interactions with general education teachers working with HH students. These interactions with all professionals working with this student population are critical (Strogilos et al., 2019). Determining how teachers can have additional time for teaching, planning, and collaboration is a suggestion for practice that the central office and building-level administration should investigate.

Empirical and Theoretical Implications

The following sections will outline the themes uncovered in this research from the perspective of the potential influence of the guiding theory and observed or implied practices discovered in the data. Research aims to expand the body of knowledge surrounding a specific topic. The topic discussed here was the education of HH students in middle school mathematics classrooms. Paivio's dual coding theory (DCT) (1971) guided the research within a scholarly and historical context. Theoretical implications for DCT are outlined in the following section. The empirical implications are findings that could influence the daily education of HH students. These real-world observations speak to educational practice and possible success outcomes.

Theoretical Implications

Paivio's (1971) dual coding theory (DCT) was the guiding theory undergirding this case study. Due to the reduced access to auditory input during language development often faced by HH students, resulting in limited vocabulary and accessible schema (Alasim, 2020; Rudge et al., 2022), DCT is a valuable premise to build upon for HH students, with its direct link to incorporating visuals into instruction (Alasim, 2020). DCT provides information through multiple sensory inputs simultaneously, for example, verbal and visual stimuli, to reduce cognitive overload and provide a clear access point to a large amount of information (Paivio, 1971). Visual and verbal presentation of classroom topics offers the opportunity to create multiple connections between new information and previously learned concepts, increasing the chance for future recall and productive interaction with the educational material. DCT also proposes its support of reduced cognitive load. Reduced cognitive load allows students to focus on learning new material without becoming overwhelmed as they work to remember previously learned concepts.

As outlined in the findings of this case study, the large-scale representations of the worksheets and notes directly correlate to the dual channels described by DCT. These large-scale representations provide visual input for the students with verbal explanations from the teacher as they process new information. This extends DCT to relevance within digital-age classrooms. Applicability within classrooms with diverse learners increases the potential for DCT to be used effortlessly for the simultaneous visual and verbal presentation of information. Specifically relating to HH students, DCT relies on the idea that auditory inputs must be amplified appropriately and visually presented in a manner that is accessible to the HH student. While taking notes, HH students must be given time to write and look down before new material is

presented and explained so that they can look up and have the opportunity to integrate the new material dually. Taking notes is a mentally taxing activity for HH students. Taking notes requires focus and can cause an increase in cognitive load despite the visual-verbal pairings provided through DCT. The guided notes described by participants in this study are one way that cognitive load can be reduced for HH students with a reduced working memory capacity. Decreasing the amount of information that must be written during lesson presentation and targeting critical information by leaving blank spaces within a provided writing prompt decreases strain on HH students. The careful evaluation of the benefit when presenting information in multiple formats must be constantly re-evaluated for HH students to decrease the risk that too much input in multiple formats may become detrimental. There are instances where one visual format with extended processing time may be most beneficial. The theoretical implications of this study's findings and its relevance to expanding the understanding of DCT are outlined in Table 6.

Table 6

Theoretical Implications of Dual Coding Theory

Theoretical Component	Study Findings	Implications for DCT
Multi-sensory stimuli	Teachers consistently use visual and verbal stimuli in the mathematics classroom to engage student attention.	Visual and verbal stimuli increase student engagement but do not mitigate language gaps.
Multi-sensory input	HH students take notes during lectures using some form of guided notes.	When HH students take notes, they may miss the visual-verbal information parings, which are the foundation of DCT.
Working memory and long-term memory connections	Teachers consistently activate prior knowledge of previously learned concepts and situational information in mathematics problems.	Discussion paired with visual support increases student success, but students struggle without a strong understanding of prerequisite skills.

Empirical Implications

The concern for HH students in the middle school mathematics classroom is that vocabulary and background knowledge gaps influence their ability to perform at grade-level expectations (Chen, 2022; Santos et al., 2022; Thom et al., 2022). By listening to and reading each participant's responses, the themes of the instructional approach and the encouragement of independence can be connected back to DCT. Incorporating visuals throughout the classroom, through posted anchor charts or by providing the outline for graphic organizers or cloze notes, demonstrated that HH students were provided concepts through various mediums, increasing their chance of success (Charsky, 2023). Accessible resource material was used daily to promote learning and independence. Posted resources provided visual access to remind students of the needed steps to complete problems, define new vocabulary, and remind students of needed prerequisite skills. Practical application of DCT within the classrooms promotes the use of visual aids and explicit language, amplified as needed, for HH students. Empirical evidence collected through this case study emphasized that large-scale visual aids and slower-paced content delivery help to create an accessible and beneficial DCT environment. These strategies could increase the retention of new content, leading to higher chances of success when students must apply prior knowledge when working with advanced mathematical concepts.

Unfortunately, visuals detailing the situation surrounding word problems were minimally employed through pictures or video. Prior research has shown that diminished vocabulary impacts HH students' ability to interact with mathematical concepts (Chen, 2022; Santos et al., 2022). The vocabulary needed to understand what was happening within the context of a problem was critical for students to discern what they were being asked to calculate (Paas et al., 2020). Participants detailed how they added a static clip art image, provided an explanation or

image upon a student's request to define an unknown vocabulary word, or relied on worksheet manufacturers to provide additional visuals as they saw fit. Decreased reading levels for students mean an insufficient vocabulary and background knowledge to access grade-level content (Chen, 2022). Detailed pictures or videos could supply needed details to increase situational awareness of problems (Henner et al., 2021). Understanding the situation behind the problem would help students determine what is happening and what they are being asked to find out. Julia clearly described the limitations of vocabulary scaffolding and expansion for students who are significantly below grade level in reading, "We have support as far as explicit teaching of vocabulary and having the kids create student definitions and understanding of it, but that's not filling the gaping hole that's there." Once the students have arrived in middle school with identified and significant language deficits, there must be more targeted, specially designed instruction to meet student needs (King-Sears et al., 2020). Specially designed instruction is the realm of special education, which was touched on but not fully developed as the general education teachers spoke about the HH students in their classrooms. As described in Chapter 2, HH students represent a diverse population who require a broad spectrum of reinforcements within the mathematics classroom (Chen, 2022). The students who received special education support specifically for math were identified as having lower reading levels. Developing collaborative relationships between general and special education teachers is critical as classroom content's environment and lesson presentation are continuously monitored and evaluated to determine the benefits for all students (King-Sears et al., 2020). Collaboration with the DHH teacher was also seen as a benefit to optimize the learning environment and critically evaluate the accessibility of all visual and auditory information. Accessibility within the learning environment was critical for HH students to have every opportunity to take in the presented

material. General education teachers, even those who do not hold dual certification in special education, bring best practice strategies, such as monitoring for comprehension, activating prior knowledge, remediation, reteaching, developing classroom expectations, providing visual supports, employing strategies to increase student independence, and the belief that each student can succeed. Research has shown that preferential seating and hearing assistive technology are the basic building blocks that ground HH student integration into the general education classroom (Golos et al., 2021; Qi et al., 2020). DCT supports these best practices and can be beneficial to increase HH student success in the mathematics classroom.

Limitations and Delimitations

Each case study has limitations because all variations cannot be satisfied due to the researcher's time and physical ability (Saldaña, 2021). As the collection process began, participants were recruited, and snapshots of the student population represented through these interactions came into focus, and so, too, came the need to acknowledge the limitations of this study. Though participants were solicited from a large geographical area within the state, only two counties were represented in the final participant pool. One county represented an expansive urban district, while the other was a mid-sized suburban location. Rural educators were not represented. The majority of schools represented were classified as Georgia Title 1 schools. The explanation of Title 1 status means that the percentage of low-income families within the school district entitles them to additional federal funds and stringent evaluation of success for each school by the Department of Education.

The student interactions discussed represented a small portion of the HH students educated in Georgia. To fully explore this student population, representation of a wide variety of hearing levels, secondary disabilities, details regarding access to early intervention programs,

parental involvement, and other background factors would need to be explored in greater depth. The willingness of these teachers to participate guided the student population that would be included in the participant descriptions. Though not all students are represented, generalizations can be extrapolated from the provided situations, which can guide further discussion regarding practices in the classroom and their influence on student success.

Necessary parameters or delimitations were outlined before this collective case study began. A targeted group of participants was needed to receive information about the proposed research questions (Saldaña, 2021). As a DHH teacher, I desired to explore the educational arena and study the experiences of other teachers who work with this student population. Middle school represents a time of transition for students as they move towards independence, and interest in that area guided my focus on content taught in this grade band. Next, the academic content chosen was mathematics. The influence that language has on the understanding and application of mathematics for HH students requires further investigation. Content knowledge of mathematics standards was desired, so general education teachers were chosen. The pool for general education middle school mathematics teachers was restricted to only include public school teachers within Georgia. The Georgia standards of excellence guide all public school curricula, so private school teachers were excluded. Public middle school mathematics teachers in Georgia represented the target population. However, further parameters were imposed to reduce the number of potential participants to represent an even more exclusive group. Teachers were chosen based on their experience working with HH students. Clearly defining the difference between Deaf and HH students to the participants was crucial to identifying which teachers met the expressed criteria. Public middle school mathematics teachers who had worked with an HH student in Georgia were sought to provide responses and outline their distinctive

experiences teaching and interacting with this student population in the general education classroom.

Recommendations for Future Research

Following the findings of this study, along with the limitations and delimitations outlined previously, avenues for future research unfold. While critical to the presentation of the content material, general education teachers often may be unaware of the strategies and best practices employed by the special education teachers who come alongside them to educate the wide variety of students with academic needs in a single classroom setting. Exploration into the perspectives of special education teachers working with diverse student populations and how they support low-incidence groups, such as HH students, is needed. As HH students enter and progress through the grade bands, more investigation is required to determine how these students interact with teachers and curricula in the K-5 and 9-12 settings. Specific targeting of teachers, both general education and special education, working with distinctive student groups, such as those who utilize cochlear implants, Deaf students who choose American Sign Language as their primary form of communication, and HH students with identified secondary disabilities are needed specializations to expand this knowledge base. Due to technological advancements and relative safety since their introduction for children in 1990, Cochlear implants continue to influence language outcomes for DHH students (Zeitler et al., 2024). Investigation into the age of implantation and potential correlation to mathematical skill continues to be a need, as children receive cochlear implants at a wide age range beginning as early as 12 months. A larger number of participants would provide perspectives that would benefit understanding teachers' experiences with the HH and larger DHH population.

The choice of the guiding theory could also be another avenue to pursue further research

into this student population. Cognitive load theory (Sweller, 1988) focuses on reducing mental stress for HH students' working or short-term memory. While working memory is a component of dual coding theory, it would be beneficial to investigate further how teachers are working to specifically reduce cognitive strain to avoid mental overload for HH students. Expanding upon the research regarding the reduced capacity of working memory for HH students could benefit the educational realm. Multiple possibilities for future research are available to expand the knowledge base surrounding the education of DHH students.

Conclusion

The purpose of this case study was to explore the experiences of middle school mathematics teachers working with HH students in Georgia public schools. This qualitative case study data collection occurred in May 2024. The data collected came from individual interviews, a focus group, and journal prompt responses. Initially, 11 participants agreed to complete the above activities, but 10 committed and completed all three. One participant could only contribute her thoughts to the individual interview portion of the data. The 11 participants represented middle school mathematics content teachers at various stages of their educational careers. They came from diverse educational backgrounds and had experience teaching anywhere from one to 10 or more DHH students. After the data analysis, two themes emerged: instructional approach and encouragement of independence. Within the instructional approach, two subthemes were found: routine and corrective instruction. The second theme of encouragement of independence also provided two subthemes: student motivation and accommodations for HH students. A summary of these findings suggested that participants employ general class-wide accommodation to meet the wide variety of student needs now represented in general education classrooms. When educating HH students, teachers face barriers related to time, student

motivation, and professional collaborative opportunities. Physical accommodations for HH students are incorporated into classroom routines, while few HH-specific academic accommodations were employed for this low-incidence student group. General education teachers use a variety of strategies related to DCT to increase and engage HH students in the mathematics classroom.

References

Adams, C., & Khojasteh, J. (2018). Igniting students' inner determination: The role of a need-supportive climate. *Journal of Educational Administration, 56*(4), 382–397. https://doi.org/10.1108/JEA-04-2017-0036

Alasim. (2019). Reading development of students who are deaf and hard of hearing in inclusive education classrooms. *Education Sciences, 9*(3), 201. https://doi.org/10.3390/educsci9030201

Alasim, K. (2020). Understanding factors that affect the prior knowledge of deaf and hard of hearing students and their relation to reading comprehension. *Deafness & Education International, 22*(3), 232–250. https://doi.org/10.1080/14643154.2020.1780691

Allen-Lyall, B. (2018). Helping Students to Automatize Multiplication Facts: A Pilot Study. *International Electronic Journal of Elementary Education*, *10*(4), 391–396. https://doi.org/10.26822/iejee.2018438128

Alexandrov, A. K., & Fedoseev, L. M. (2012). Long-term memory: Mechanisms, types and disorders. Nova Science Publishers.

Alley, K. M. (2019). Fostering middle school students' autonomy to support motivation and engagement. *Middle School Journal, 50*(3), 5-14. https://doi.org/10.1080/00940771.2019.1603801

Ardasheva, Y., Carbonneau, K. J., Roo, A. K., & Wang, Z. (2018). Relationships among prior learning, anxiety, self-efficacy, and science vocabulary learning of middle school students with varied english language proficiency. *Learning and Individual Differences, 61*, 21-30. https://doi.org/10.1016/j.lindif.2017.11.008

Arif, S., Massey, M. D. B., Klinard, N., Charbonneau, J., Jabre, L., Martins, A. B., Gaitor, D., Kirton, R., Albury, C., & Nanglu, K. (2021). Ten simple rules for supporting historically underrepresented students in science. *PLoS computational biology*, *17*(9), e1009313. https://doi.org/10.1371/journal.pcbi.1009313

Balon, R., Guerrero, A. P. S., Coverdale, J. H., Brenner, A. M., Louie, A. K., Beresin, E. V., & Roberts, L. W. (2019). Institutional review board approval as an educational tool. *Academic Psychiatry, 43*(3), 285-289. https://doi.org/10.1007/s40596-019-01027-9

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*(4), 544-559.

Berryhill, B., Morgan, H., Wilson, E., & Ruggles, H. (2022). The challenge of effective Family/School partnerships: The middle school parent teacher leadership academy pilot program. *Journal of Community Engagement and Scholarship, 13*(1), 10. https://doi.org/10.54656/EGIR6081

Borman, G. D., Rozek, C. S., Pyne, J., & Hanselman, P. (2019). Reappraising academic and social adversity improves middle school students' academic achievement, behavior, and well-being. *Proceedings of the National Academy of Sciences - PNAS, 116*(33), 16286-16291. https://doi.org/10.1073/pnas.1820317116

Bolourian, Y., Tipton-Fisler, L. A., & Yassine, J. (2020). Special education placement trends: Least restrictive environment across five years in california. *Contemporary School Psychology*, *24*(2), 164-173. https://doi.org/10.1007/s40688-018-00214-z

Braun, V., Clarke, V., Boulton, E., Davey, L., & McEvoy, C. (2021). The online survey as a qualitative research tool. *International Journal of Social Research Methodology, 24*(6), 641-654. https://doi.org/10.1080/13645579.2020.1805550

Bruce, S. M., Luckner, J. L., & Ferrell, K. A. (2018). Assessment of students with sensory disabilities: Evidence-based practices. *Assessment for Effective Intervention, 43*(2), 79–89. https://doi.org/10.1177/1534508417708311

Bruning, A. L., & Lewis-Peacock, J. A. (2020). Long-term memory guides resource allocation in working memory. *Scientific Reports, 10*(1), 22161-22161. https://doi.org/10.1038/s41598-020-79108-1

Bowman, J. A., McDonnell, J., Ryan, J. H., & Fudge-Coleman, O. (2019). Effective mathematics instruction for students with moderate and severe disabilities: A review of the literature. *Focus on Autism and Other Developmental Disabilities*, *34*(4). https://doi.org/10.1177/1088357619827932

Boyle, J., & Joyce, R. (2021). Smartpens: Note-Taking Technology for Students with Learning Disabilities. *Learning Disabilities.*, *26*(1). https://doi.org/10.18666/LDMJ-2021-V26-I1-10363

Bunt, B. J., Grosser, M., & van Tonder, D. (2022). A novel proposal to use thinking maps to embed blooms' taxonomy within teaching, learning, and assessment. *Journal of Cognitive Education and Psychology*, *21*(2), 80-99. https://doi.org/10.1891/JCEP-2021-0030

Caviola, S., Visentin, C., Borella, E., Mammarella, I., & Prodi, N. (2021). Out of the noise: Effects of sound environment on maths performance in middle-school students. *Journal of Environmental Psychology, 73*, 101552. https://doi.org/10.1016/j.jenvp.2021.101552

Charsky, D. (2023). Infographics for learning and instruction. *Journal of Visual Literacy*, *42*(2), 130-145. https://doi.org/10.1080/1051144X.2023.2216115

Chen, L. (2022). The relation between numerical magnitude processing and mathematical performance in d/Deaf and hard of hearing children: The influence of fluency. *American*

Annals of the Deaf (Washington, D.C. 1886), 166(5), 621–637. https://doi.org/10.1353/aad.2022.0001

Clark, G. T., & Reuterskiöld, C. (2021). Orthographic support for word learning in clinical populations: A systematic review. *Language, Speech & Hearing Services in Schools, 52*(3), 937-948. https://doi.org/10.1044/2021_LSHSS-20-00123

Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review, 3*(3), 149-210. https://doi.org/10.1007/BF01320076

Compton, M. V., Appenzeller, M., Kemmery, M., & Gardiner-Walsh, S. (2015). Itinerant teachers' perspectives of using collaborative practices in serving students who are deaf or hard of hearing. *American Annals of the Deaf (Washington, D.C. 1886), 160*(3), 255-272. https://doi.org/10.1353/aad.2015.0023

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five* (4th ed.). SAGE Publications, Inc.

Crowe, K., & Guiberson, M. (2019). Evidence-based interventions for learners who are deaf and/or multilingual: A systematic quality review. *American Journal of Speech-Language Pathology, 28*(3), 964-983. https://doi.org/10.1044/2019_AJSLP-IDLL-19-0003

Dorn, B. (2019). The changing role of teachers of students who are deaf or hard of hearing: Consultation as an increasing part of the job. *Journal of Educational and Psychological Consultation*, 29:2, 237-254, DOI: 10.1080/10474412.2018.1502087

Enns, C. (2017). Making the case for case studies in deaf education research. In S. Cawthon & C. L. Garberoglio (Eds.), Research in deaf education: Contexts, challenges, and considerations (pp. 203-224). Oxford University Press.

Erickson, J. D., & Wharton-McDonald, R. (2019). Fostering autonomous motivation and early literacy skills. *The Reading Teacher, 72*(4), 475-483. https://doi.org/10.1002/trtr.1750

Farmer, T. W., Hamm, J. V., Dawes, M., Barko-Alva, K., & Cross, J. R. (2019). Promoting inclusive communities in diverse classrooms: Teacher attunement and social dynamics management. *Educational Psychologist, 54*(4), 286-rand

Fisher, D., & Frey, N. (2018). The uses and misuses of graphic organizers in content area learning. *The Reading Teacher, 71*(6), 763-766. https://doi.org/10.1002/trtr.1693

Flamini, M., & Steed, H. (2022). 2021 Georgia K-12 teacher & leader workforce report. 2021 Teacher Leader Workforce Report_Final 05.12.22.pdf

Francisco, M., Hartman, M., & Wang, Y. (2020). Inclusion and special education. *Education Sciences, 10*(9), 238. https://doi.org/10.3390/educsci10090238

Garbacz, S. A., Santiago, R. T., Kosty, D., Zahn, M., Stormshak, E. A., Smolkowski, K., & Seeley, J. R. (2021). Examining congruence in parent–teacher perceptions of middle school supports for students and families. *Psychology in the Schools, 58*(6), 1169-1184. https://doi.org/10.1002/pits.22495

Georgia Department of Education. (2019). Special education rules implementation manual: Service delivery & least restrictive environment. *Georgia Department of Education. https://www.gadoe.org/Curriculum-Instruction-and-Assessment/Special-Education-Services/Documents/Implementation%20Manual%202018-19/UPDATED%20FINAL%20Chapter%20Eight%20LRE%2010-1-19.pdf*

Georgia Department of Education, (2022). Deaf and hard of hearing. *Georgia Department of Education.* Refer to 34 CFR 300.7 (3), (5). https://www.gadoe.org/Curriculum-

Instruction-and-Assessment/Special-Education-Services/Pages/Deaf-and-Hard-of-Hearing.aspx

Georgia Mobile Audiology. (n.d.). Your baby failed the newborn hearing screening. What next? Let us walk you through the next steps. https://www.gamobileaudiology.org/infanthearing

Gill, P., & Baillie, J. (2018). Interviews and focus groups in qualitative research: An update for the digital age. *British Dental Journal, 225*(7), 668-672. https://doi.org/10.1038/sj.bdj.2018.815

Golos, D., Moses, A., Gale, E., & Berke, M. (2021). Building allies and sharing best practices: Cultural perspectives of deaf people and ASL can benefit all. *LEARNing Landscapes, 14*(1), 97-110. https://doi.org/10.36510/learnland.v14i1.1028

Grifenhagen, J. F., & Barnes, E. M. (2022). Reimagining discourse in the classroom. *The Reading Teacher, 75*(6), 739-748. https://doi.org/10.1002/trtr.2108

Grosse, S. D., Mason, C. A., Gaffney, M., Thomson, V., & White, K. R. (2018). What contribution did economic evidence make to adopting universal newborn hearing screening policies in the united states? *International Journal of Neonatal Screening*, *4*(3), 25–25. https://doi.org/10.3390/ijns4030025

Guan, C. Q., & Smolen, E. R. (2022). Visual-motor integration in language learning among deaf and hard of hearing children. *American Annals of the Deaf (Washington, D.C. 1886), 167*(3), 355-371. https://doi.org/10.1353/aad.2022.0032

Harris, M., Terlektsi, E., & Kyle, F. E. (2017). Concurrent and longitudinal predictors of reading for deaf and hard of hearing children in primary school. *Journal of Deaf Studies and Deaf Education*, *22*, 233–242. https://doi:10.1093/deafed/enw101

Henner, J., Pagliaro, C., Sullivan, S., & Hoeemeister, R. (2021). Counting differently: Assessing mathematics achievement of signing deaf and hard of hearing children through a unique lens. *American Annals of the Deaf, 166*(3), 322–345. https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/scholarly-journals/counting-differently-assessing-mathematics/docview/2624695531/se-2

Holman, J. A., Drummond, A., Hughes, S. E., & Naylor, G. (2019). Hearing impairment and daily-life fatigue: A qualitative study. *International Journal of Audiology, 58*(7), 408-416. https://doi.org/10.1080/14992027.2019.1597284

Howley, C., Howley, A., & Telfer, D. (2017). National provisions for certification and professional preparation in low-incidence sensory disabilities: A 50- state study. *American Annals of the Deaf, 162*(3), 277–294. https://doi.org/10.1353/aad.2017.0026

Huang, X., Zhang, J., & Hudson, L. (2019). Impact of math self-efficacy, math anxiety, and growth mindset on math and science career interest for middle school students: The gender moderating effect. *European Journal of Psychology of Education, 34*(3), 621-640. https://doi.org/10.1007/s10212-018-0403-z

Jiménez, T.,R., & Orozco, M. (2021). Prompts, not questions: Four techniques for crafting better interview protocols. *Qualitative Sociology, 44*(4), 507-528. https://doi.org/10.1007/s11133-021-09483-2

John, J. E., Insouvanh, K., & Robnett, R. D. (2023). The roles of gender identity, peer support, and math anxiety in middle school math achievement. *Journal of Research on Adolescence, 33*(1), 230-250. https://doi.org/10.1111/jora.12800

Johnson, J. L., Adkins, D., & Chauvin, S. (2020). A review of the quality indicators of rigor in qualitative research. *American Journal of Pharmaceutical Education, 84*(1), 7120–146. https://doi.org/10.5688/ajpe7120

Johnson, T. M., King-Sears, M. E., & Miller, A. D. (2022). High school co-teaching partners' self-efficacy, personal compatibility, and active involvement in instruction. *Learning Disability Quarterly, 45*(2), 96-107. https://doi.org/10.1177/0731948720919811

Kanellopoulou, C., Katia, L. K., & Giannakoulopoulos, A. (2019). The dual-coding and multimedia learning theories: film subtitles as a vocabulary teaching tool. *Education Sciences, 9*(3) https://doi-org.ezproxy.liberty.edu/10.3390/educsci9030210

Kanungo, S., & Patel, D. R. (2016). Universal newborn hearing screening in the united states. *International Public Health Journal, 8*(4), 421.

Karasu, H. P. (2020). Development of emergent literacy skills of a child with hearing loss: A longitudinal case study. *Educational Studies, 46*(5), 513-531. https://doi.org/10.1080/03055698.2020.1745623

Karlsson, P., Johnston, C., & Barker, K. (2018). Influences on students' assistive technology use at school: The views of classroom teachers, allied health professionals, students with cerebral palsy and their parents. *Disability and Rehabilitation: Assistive Technology*,*13*(8), 763–771. https://doi.org/10.1080/17483107.2017.1373307

Kennedy, M. J., & Romig, J. E. (2021). Cognitive load theory: An applied reintroduction for special and general educators. *Teaching Exceptional Children,* 4005992110482. https://doi.org/10.1177/00400599211048214

King-Sears, M. E., Jenkins, M. C., & Brawand, A. (2020). Co-teaching perspectives from middle school algebra co-teachers and their students with and without disabilities. *International*

Journal of Inclusive Education, *24*(4), 427-442. https://doi.org/10.1080/13603116.2018.1465134

Kousta, S.-T., Vigliocco, G., Del Campo, E., Vinson, D. P., & Andrews, M. (2011). The representation of abstract words: Why emotion matters. *Journal of Experimental Psychology: General*, *140*, 14 –34. doi:10.1037/ a0021446

Kyburz-Graber, R. (2004). Does case-study methodology lack rigour? the need for quality criteria for sound case-study research, as illustrated by a recent case in secondary and higher education. *Environmental Education Research, 10*(1), 53-65. https://doi.org/10.1080/1350462032000173706

Lamotte, A., Essadek, A., Shadili, G., Perez, J., & Raft, J. (2021). *The impact of classroom chatter noise on comprehension: A systematic review*. SAGE Publications. https://doi.org/10.1177/00315125211005935

Lederberg, A. R., Easterbrooks, S. R., & Tucci, S. L. (2022). Foundations for literacy: A research-based early reading program that improves outcomes for children who are deaf and hard of hearing. *The Volta Review, 122*(1), 31-47. https://doi.org/10.17955/tvr.122.1.symp3

Lim, S. (2020). The capabilities approach to inclusive education: Re-envisioning the individuals with disabilities education act's least restrictive environment. *Disability & Society, 35*(4), 570-588. https://doi.org/10.1080/09687599.2019.1649119

Luckner, J. L. (2006). Evidence-based practices with students who are deaf. *Communication Disorders Quarterly, 28*(1), 49-52. https://doi.org/10.1177/15257401060280010801

Meinzen-Derr, J., Altaye, M., Grove, W., Folger, A. T., & Wiley, S. (2022). Association of age of enrollment in early intervention with emergent literacy in children who are deaf or

hard of hearing. *Journal of Developmental and Behavioral Pediatrics, 43*(2), 104-110. https://doi.org/10.1097/DBP.0000000000000976

Massonnié, J., Mareschal, D., & Kirkham, N. Z. (2022). Individual differences in dealing with classroom noise disturbances. *Mind, Brain and Education, 16*(3), 252-262. https://doi.org/10.1111/mbe.12322

McGrath, C., Palmgren, P. J., & Liljedahl, M., (2019). Twelve tips for conducting qualitative research interviews. *Medical Teacher, 41*(9), 1002-1006. https://doi.org/10.1080/0142159X.2018.1497149

McKenna Benoit, M., Orlando, M., Henry, K., & Allen, P. (2019). Amplitude modulation detection in children with a history of temporary conductive hearing loss remains impaired for years after restoration of normal hearing. *Journal of the Association for Research in Otolaryngology, 20*(1), 89-98. https://doi.org/10.1007/s10162-018-00699-8

McKee, A., Myck-Wayne, J., & Lee, S. H. (2023). Inclusive mindedness: Evolving knowledge and beliefs of preservice educators in california. *Frontiers in Education (Lausanne), 8*https://doi.org/10.3389/feduc.2023.1142670

Mogas Recalde, J., Palau, R., & Márquez, M. (2021). How classroom acoustics influence students and teachers: A systematic literature review. *Journal of Technology and Science Education, 11*(2), 245-259. https://doi.org/10.3926/jotse.1098

Monroe, K. J., & Morrison, V. (2022). Creating accessible infographics: Describing scientific data in ways everyone can understand. *Assistive Technology Outcomes and Benefits, 16*(2), 56-73.

Moody S, Hu X, Kuo L-J, Jouhar M, Xu Z, Lee S. Vocabulary instruction: A critical analysis of theories, research, and practice. *Education Sciences*. 2018; *8*(4):180. https://doi.org/10.3390/educsci8040180

Morano, S., Randolph, K., Markelz, A. M., & Church, N. (2020). Combining explicit strategy instruction and mastery practice to build arithmetic fact fluency. *Teaching Exceptional Children*, *53*(1), 60–69. https://doi-org.ezproxy.uwa.edu/10.1177/0040059920906455

Musti-Rao, S., & Telesman, A. O. (2022). Comparing the effects of two practice conditions on the subtraction fact fluency of fifth-grade students. *Journal of Behavioral Education*, *31*(3), 484-502. https://doi.org/10.1007/s10864-020-09417-y

National Association of the Deaf. (2022). Position statement: Educating prek-12 deaf and hard of hearing students during the covid-19 outbreak. *National Association of the Deaf.* https://www.nad.org/position-statement-educating-prek-12-deaf-and-hard-of-hearing-students-during-the-covid-19-outbreak/

Nelson, C., & Bruce, S. M. (2019). Children who are deaf/hard of hearing with disabilities: paths to language and literacy. *Education Sciences*, *9*(2). https://doi.org/10.3390/educsci9020134

Olson, A. J., & Roberts, C. A. (2020). Navigating barriers as special education teacher educators. *Research and Practice for Persons with Severe Disabilities*, *45*(3), 161–177. https://doi.org/10.1177/1540796920914969

Olusanya, B. O., Davis, A. C., & Hoffman, H. J. (2019). Hearing loss: Rising prevalence and impact. *Bulletin of the World Health Organization*, *97*(10), 646-646A. https://doi.org/10.2471/BLT.19.224683

Onetti, W., Fernández-García, J. C., & Castillo-Rodríguez, A. (2019). Transition to middle school: Self-concept changes. *PloS One, 14*(2), e0212640-e0212640. https://doi.org/10.1371/journal.pone.0212640

Paas, & van Merrienboer, J. (2020). Cognitive load theory: Methods to manage cognitive load in the learning of complex tasks. *Current Directions in Psychological Science., 29*, 394–398.

Paivio, A. (1971). chapter 2 - imagery and language. *Imagery* (pp. 7-32). Elsevier Inc. https://doi.org/10.1016/B978-0-12-635450-8.50008-X

Paivio. (1991). Dual Coding Theory: Retrospect and Current Status. *Canadian Journal of Psychology. Revue Canadienne de Psychologie., 45*(3).

Paivio, A. (2013). Dual coding theory, word abstractness, and emotion: A critical review of kousta et al. (2011). *Journal of Experimental Psychology. General, 142*(1), 282-287. https://doi.org/10.1037/a0027004

Paul, P. V. (2022). The 175th Anniversary of the American Annals of the Deaf: Part III-1961 to the Present. *American Annals of the Deaf, 167*(4), 407–413. https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/scholarly-journals/175th-anniversary-american-annals-deaf-part-iii/docview/2747038281/se-2

Philips, C., Jacquemin, L., Lammers, M. J., Wouters, K., Moyaerts, J., Vanderveken, O., & Van Rompaey, V. (2023). Impact of hearing impairment and cochlear implantation on productivity and social well-being in a professionally active but severely hearing-impaired group: Protocol of the 'Hear again, work again' longitudinal prospective cohort study. *BMJ Open, 13*(3), e064514-e064514. https://doi.org/10.1136/bmjopen-2022-064514

Ponce, H. R., Mayer, R. E., López, M. J., & Loyola, M. S. (2018). Adding interactive graphic organizers to a whole-class slideshow lesson. *Instructional Science, 46*(6), 973-988. https://doi.org/10.1007/s11251-018-9465-1

Qi, L., Zhang, H., Nie, R., Xiao, A., Wang, J., & Du, Y. (2020). Quality of life of hearing-impaired middle school students: A cross-sectional study in hubei province, china. *Journal of Developmental and Physical Disabilities, 32*(5), 821-837. https://doi.org/10.1007/s10882-019-09722-z

Rand, M. K., & Morrow, L. M. (2021). The contribution of play experiences in early literacy: Expanding the science of reading. *Reading Research Quarterly, 56*(S1), S239-S248. https://doi.org/10.1002/rrq.383

Reagan, T., Matlins, P. E., & Pielick, C. D. (2021). Deaf epistemology, sign language and the education of d/Deaf children. *Educational Studies (Ames), 57*(1), 37-57. https://doi.org/10.1080/00131946.2021.1878178

Richard, B., Sivo, S. A., Orlowski, M., Ford, R. C., Murphy, J., Boote, D. N., & Witta, E. L. (2021). Qualitative research via focus groups: Will going online affect the diversity of your findings? *Cornell Hospitality Quarterly, 62*(1), 32-45. https://doi.org/10.1177/1938965520967769

Robertson, P., McCaleb, K. N., & McFarland, L. A. (2022). Preparing all educators to serve students with extensive support needs: An interdisciplinary approach. *The New Educator, 18*(1-2), 87-109. https://doi.org/10.1080/1547688X.2022.2055248

Robinson, T. L., Bowman, E. B., & Barker, B. A. (2023). Exploring the stories of parents' experiences with infant hearing-loss screening and diagnosis in the united states. *Ear and Hearing, 44*(3), 518-529. https://doi.org/10.1097/AUD.0000000000001294farmer

Rodrigues, F. M., Rato, J. R., Mineiro, A., & Holmström, I. (2022). Unveiling teachers' beliefs on visual cognition and learning styles of deaf and hard of hearing students: A Portuguese-Swedish study. *PloS One, 17*(2), e0263216-e0263216. https://doi.org/10.1371/journal.pone.0263216

Rudge, L. (2022). *Exploring british sign language via systemic functional linguistics: A metafunctional approach* (First ed.). Bloomsbury Academic.

Sadoski, M., & Paivio, A. (2013). *Imagery and text: A dual coding theory of reading and writing* (2nd ed.). Routledge. https://doi.org/10.4324/9780203801932

Saldaña, J. M. (2021). *The coding manual for qualitative researchers* (4th ed.). SAGE Publications.

Santos, & Cordes, S. (2022). Math abilities in deaf and hard of hearing children: The role of language in developing number concepts. *Psychological Review.*, *129*(1), 199–211. https://doi.org/10.1037/rev0000303

Schunk, D. H. (2016). *Learning theories: An educational perspective – With access* (7th ed.). Pearson.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63–75. https://doi.org/10.3233/EFI-2004-22201

Strogilos, V., & King-Sears, M. E. (2019). Co-teaching is extra help and fun: Perspectives on co-teaching from middle school students and co-teachers. *Journal of Research in Special Educational Needs, 19*(2), 92-102. https://doi.org/10.1111/1471-3802.12427

Suarsana, I. M., Sudatha, I. G. W., Mahayukti, G. A., & Apsari, R. A. (2021). Mathematical word problem solving abilities of hearing-impaired students. *Journal of Physics. Conference Series, 1778*(1), 12006. https://doi.org/10.1088/1742-6596/1778/1/012006

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257-285. https://doi.org/10.1016/0364-0213(88)90023-7

Tarkhova, L., Tarkhov, S., Nafikov, M., Akhmetyanov, I., Gusev, D., & Akhmarov, R. (2020). Infographics and their application in the educational process. *International Journal of Emerging Technologies in Learning, 15*(13), 63-80. https://doi.org/10.3991/ijet.v15i13.14647

Thom, J. S., & Hallenbeck, T. (2022). Spatial reasoning in mathematics: A cross-field perspective on deaf and general education research. *Deafness & Education International, 24*(2), 127-159. https://doi.org/10.1080/14643154.2020.1857539

Tiwari, A. (2023). How teachers view inclusion of special education students: A case from south Texas. *International Journal of Educational Reform, 32*(3), 314-331. https://doi.org/10.1177/10567879231159083

Tronstad, T. V., Gjessing, B., Ørland, I., Øderud, T., Mnyanyi, C., Myovela, I., & Øygarden, J. (2022). A case study of interventions to facilitate learning for pupils with hearing impairment in Tanzania. *African Journal of Disability, 11*(1), 1-9. https://doi.org/10.4102/ajod.v11i0.974

Trust. 2011. In *Merriam-Webster.com.* Retrieved June 21, 2023, from https://www.merriam-webster.com/dictionary/trust?src=search-dict-box

Tucci, S., Jenkins, K., Patterson, M., Galloway, J., Turner, T., Culpepper, B., & Lo, M. (2021). The diagnostic dilemma: Language and literacy outcomes for children who are deaf and

hard of hearing in the state of Georgia. *Report to the Governor and General Assembly as required by OCGA 30-1-5 (h).*

Vigliocco, G., Kousta, S., Vinson, D., Andrews, M., & Del Campo, E. (2013). The representation of abstract words: What matters? reply to paivio's (2013) comment on kousta et al. (2011). *Journal of Experimental Psychology. General, 142*(1), 288-291. https://doi.org/10.1037/a0028749

Weiss, S., Markowetz, R., & Kiel, E. (2018). How to teach students with moderate and severe intellectual disabilities in inclusive and special education settings: Teachers' perspectives on skills, knowledge and attitudes. *European Educational Research Journal EERJ*, 17(6), 837–856. https://doi.org/10.1177/1474904118780171

Yin, R. K. (2018). *Case study research and applications: Design and methods* (Sixth ed.). SAGE Publications, Inc.

Young, N. D., Fain, A., Citro, T. A., & Russo, K. (2020). Effective Co-Teaching Strategies That Work. In Mastering the art of co-teaching: Building more collaborative classrooms (pp. 1–12). essay, Vernon Press.

Zeitler, D. M., Prentiss, S. M., Sydlowski, S. A., & Dunn, C. C. (2024). American cochlear implant alliance task force: Recommendations for determining cochlear implant candidacy in adults. *The Laryngoscope, 134*(S3), S1-S14. https://doi.org/10.1002/lary.30879

Zhang, D., Ding, Y., Lee, S., & Chen, J. (2017). Strategic development of multiplication problem solving: Patterns of students' strategy choices. *The Journal of Educational Research (Washington, D.C.), 110*(2), 159–170. https://doi.org/10.1080/00220671.2015.1060928

Zheng, R., & Gardner, M. K. (2020;2019;). In Gardner M. K. (Ed.), *Memory in education* (1st ed.). Routledge. https://doi.org/10.4324/9780429019142

Appendix A

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

March 18, 2024

Hannah McPherson
Susan Stanley

Re: IRB Exemption - IRB-FY23-24-1360 TEACHER OBSERVATIONS ON THE SUCCESS OF HARD-OF-HEARING STUDENTS IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM: A CASE STUDY

Dear Hannah McPherson, Susan Stanley,

The Liberty University Institutional Review Board (IRB) has reviewed your application per the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data-safeguarding methods described in your IRB application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(ii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or

For a PDF of your exemption letter, click on your study number in the My Studies card on your Cayuse dashboard. Next, click the Submissions bar beside the Study Details bar on the Study Details page. Finally, click Initial under Submission Type and choose the Letters tab toward the bottom of the Submission Details page. Your information sheet and final versions of your study documents, **which you must use to conduct your study,** can also be found on the same page under the Attachments tab.

This exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

[redacted]

Administrative Chair
Research Ethics Office

Appendix B

Research Participant Flyer

Research Participants Needed

TEACHER OBSERVATIONS ON THE SUCCESS OF HARD-OF-HEARING STUDENTS IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM: A CASE STUDY

- Have you ever been a public middle school math teacher?
- Do you have one full year of experience teaching?
- Have you ever had a hard-of-hearing student in your math class?

If you answered **yes** to each of the questions listed above, you may be eligible to participate in a research study.

The purpose of this research study is to give voice to the perspectives of middle school math teachers who have worked with hard-of-hearing students in the public school setting, and I am requesting that you join my study.

Participants will be asked to be involved in a one-on-one interview, join one focus group session for discussion, and complete several short answer journal prompts. It should take approximately 3-4 hours to complete the procedures listed. Your name and other identifying information will be requested for this study, but participant identities will not be disclosed.

If you would be willing to participate, please click here

A consent document will be emailed to you. The consent document contains additional information about my research. If you choose to participate, a copy of the consent document be signed before our first interview session.

Hannah McPherson, a doctoral candidate in the School of Education at Liberty University, is conducting this study.
Please contact Hannah McPherson at [redacted] or [redacted] for more information.

Appendix C

IRB Participant Consent Document

Title of the Project: Teacher Observations on the Success of Hard-of-hearing Students in the Middle School Mathematics Classroom: A Case Study

Principal Investigator: Hannah McPherson, PhD. Candidate, School of Education, Liberty University

Invitation to be part of a Research Study

You are invited to participate in a research study. To participate, you must be a certified Georgia public school teacher with at least one year of experience teaching middle school mathematics. During your time in the mathematics classroom, you must have taught a hard-of-hearing student who had academic deficits that required the implementation of an IEP. Taking part in this research project is voluntary.

Please read this entire form and ask questions before deciding whether to participate in this research.

What is the study about, and why is it being done?

The purpose of the study is to document the perceptions of middle school general education math teachers as they work to educate hard-of-hearing students. Hard-of-hearing students often have language weaknesses that began during the development of their foundational language skills, which continue to influence their academic performance.

What will happen if you take part in this study?

If you agree to be in this study, I will ask you to do the following:

1. Participate in an in-person, audio-recorded interview lasting approximately 1 hour.
2. Participate in an online video and audio focus-group discussion lasting approximately 1 hour.
3. Complete an online journal response. Each response should be 200-300 words. Response time should take no more than 1 hour.
4. Participants will receive a copy of written transcripts via email from their individual interviews and the focus group. The themes that are developing will also be shared. Participants will be asked to review the transcripts and themes for accuracy and to confirm agreement. This participant involvement is termed member checking, which encourages transparency and accuracy in the research.

How could you or others benefit from this study?

Participants should not expect a direct benefit from participating in this study.
Benefits to society include expansion to the body of research describing the educational practices used to teach hard-of-hearing students in the public school setting.

What risks might you experience from being in this study?

The expected risks from participating in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records.

-
- Participant responses will be kept confidential by replacing names with pseudonyms.
- Interviews will be conducted in a location where others will not easily overhear the conversation.
- Confidentiality cannot be guaranteed in focus group settings. While discouraged, other focus group members may share what was discussed with people outside the group.
- Data will be stored [on a password-locked computer. After five years, all electronic records will be deleted, and all hardcopy records will be shredded.
- Recordings will be stored for five years or until participants have reviewed and confirmed the accuracy of the transcripts. After time or transcriptional accuracy is completed, the files will be deleted. The researcher and members of her doctoral committee have access to these recordings.

Is study participation voluntary?

Participation in this study is voluntary. Your participation will not affect your current or future relations with Liberty University. If you decide to participate, you are free not to answer any questions or withdraw at any time.

What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you, apart from focus group data, will be destroyed immediately and will not be included in this study. Focus group data will not be destroyed, but your contributions to the focus group will not be included in the study if you choose to withdraw.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Hannah McPherson. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at [redacted] or [redacted]. You may also contact the researcher's faculty sponsor, Susan Stanley, at [redacted].

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the IRB. Our physical address is Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA, 24515; our phone number is 434-592-5530, and our email address is irb@liberty.edu.

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent

By signing this document, you agree to be in this study. Make sure you understand what the study is about before you sign. You will be given a copy of this document for your records. The researcher will keep a copy of this consent with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ The researcher has my permission to audio-record/video-record me as part of my participation in this study.

_____

Printed Subject Name

_____

Signature & Date

Appendix D

Recruitment Template: Verbal Script (Phone or In Person)

Hello [Potential Participant],

As a doctoral candidate at the School of Education at Liberty University, I am conducting research as part of the requirements for a Ph.D. in Special Education. The purpose of my research is to give voice to the perspectives of middle school math teachers who have worked with hard-of-hearing students in the public school setting, and I am requesting that you join my study.
Participants must be certified Georgia public school teachers with at least one year of experience teaching middle school mathematics. During your time in the mathematics classroom, you must have taught a hard-of-hearing student who had academic deficits that required the implementation of an IEP. Participants will be asked to be involved in a one-on-one interview, join one focus group session for discussion, and complete several short answer journal prompts. It should take approximately 3-4 hours to complete the procedures listed. Your name and other identifying information will be requested for this study, but participant identities will not be disclosed.

Would you be willing to participate? Yes. Great, could I get your email address so I can send you the link to the survey? It is a Google form, so I can send you the link by text message, whichever you prefer.

If No: I understand. Thank you for your time. [Conclude the conversation.]

If you meet the study criteria, a consent document will be emailed to you. The consent document contains additional information about my research. If you choose to participate, a copy of the consent document will be provided for you to sign at our first interview session.

Thank you for your time. Do you have any questions?

Appendix E

Email and Facebook Messenger Initial Contact

Dear Potential Participant,

As a doctoral candidate at the School of Education at Liberty University, I am conducting research as part of the requirements for a Ph.D. in Special Education. The purpose of my research is to give voice to the perspectives of middle school math teachers who have worked with hard-of-hearing students in the public school setting, and I am requesting that you join my study.

Participants must be certified Georgia public school teachers with at least one year of experience teaching middle school mathematics. During your time in the mathematics classroom, you must have taught a hard-of-hearing student who had academic deficits that required the implementation of an IEP. Participants will be asked to be involved in a one-on-one interview, join one focus group session for discussion, and complete several short answer journal prompts. It should take approximately 3-4 hours to complete the procedures listed. Your name and other identifying information will be requested for this study, but participant identities will not be disclosed.

To participate, please CLICK HERE to complete the screening survey. Your responses will be returned automatically to me by email. Once your willingness to participate and the required conditions are confirmed, I will contact you to schedule the initial interview via your preferred method. Your journal prompts will be sent at that time with a requested 2-week return window.

If you meet the study criteria, a consent document will be emailed to you. The consent document contains additional information about my research. If you choose to participate, a copy of the consent document will be provided for you to sign at our first interview session.

Sincerely,

Hannah McPherson
Doctoral Candidate, Liberty University
[redacted]

Appendix F

Research Participant Information Survey

Email:
Name:
How many years of teaching experience do you have
1-5 years
6-10 years
11-15 years
16+ years

Have you taught middle school in a public school in Georgia?
Yes
No

Have you taught a hard-of-hearing student in your math class?
Yes
No

Did the hard-of-hearing student have an IEP?
Yes
No

Telephone # (Optional):

Preferred method of communication (Choose all that apply)
Phone Call
Text Message
Email