Fall 2023

Teacher Perceptions of ADHD and the Impact of Using Modifications for Students Diagnosed with ADHD in a High School Mathematics Classroom

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TEACHER PERCEPTIONS OF ADHD AND THE IMPACT OF USING MODIFICATIONS FOR STUDENTS DIAGNOSED WITH ADHD IN A HIGH SCHOOL MATHEMATICS CLASSROOM

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A Dissertation Submitted to the
Gardner-Webb University College of Education
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Education

Gardner-Webb University
2023

Approval Page

This dissertation was submitted by Andrew McCully under the direction of the persons listed below. It was submitted to the Gardner-Webb University College of Education and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Gardner-Webb University.

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Abstract

TEACHER PERCEPTIONS OF ADHD AND IMPACT OF USING MODIFICATIONS FOR STUDENTS DIAGNOSED WITH ADHD IN A HIGH SCHOOL MATHEMATICS CLASSROOM. McCully, Andrew, 2023: Dissertation, Gardner-Webb University.

This study was designed to examine the instructional modifications teachers use with students who have been diagnosed with attention-deficit hyperactivity disorder (ADHD). It determined teacher perceptions of students with ADHD and the impact those perceptions had on participants' implementation of instructional modifications designed for students diagnosed with ADHD. This study also considered what effect instructional modifications have on the academic achievement of students diagnosed with ADHD within the context of a traditional high school mathematics classroom. Data were collected through participant interviews, classroom observations, and statistical analysis of pre and post-assessment scores. The results of the study showed a lack of foundational knowledge in the symptoms of ADHD and their impact on the academic performance of students diagnosed with ADHD in the classroom as well as the instructional modifications designed to aid students diagnosed with ADHD. The goal of this study was to show the need for formal training and continued professional development for teachers on the instructional modifications needed to help students diagnosed with ADHD be successful and the impact those modifications had on academic achievement.

Keywords: ADHD, student achievement, instructional modifications, high school math teachers

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Chapter 1: Introduction

Every professional educator faces the daily challenge of determining how to meet the needs of students. Teachers are constantly adjusting instructional methods; tweaking classroom activities; writing new, more engaging lessons; and writing new assessments to do everything in their power to ensure every student in their classroom has the best opportunity to learn and achieve their full potential (Moore et al., 2018). One of the biggest challenges professional educators tackle is understanding that not all students learn the same way, nor do they enter school with the same prior knowledge or have the same academic support at home (DuFour et al., 2016). Some students struggle to learn and, as a result, require additional time and support to succeed, especially in a traditional classroom structure of direct instruction (DuFour et al., 2016). One specific subgroup of students who often require additional time, support, and instructional modifications are those diagnosed with attention-deficit hyperactivity disorder (ADHD; Moore et al., 2018).

ADHD is defined as a neurodevelopmental disorder characterized by a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development (American Psychiatric Association, 2013). The characteristics of inattention and hyperactivity often translate into learning difficulties in the classroom (Moore et al., 2018). While ADHD is not considered a learning disability, one in every two students diagnosed with ADHD is also diagnosed with a specific learning disability (Barkley, 2020). Students diagnosed with ADHD are much more likely to have persistent academic difficulties, low academic marks, and higher dropout rates, and are seven times less likely to graduate high school than their peers (Henderson, 2020).

Background of the Problem

Eleven percent of children in the United States aged 4-17 have been diagnosed with ADHD (Centers for Disease Control and Prevention [CDC], 2022). Statistically speaking, every professional educator in America will likely have three students per class diagnosed with ADHD (Barkley, 2020). For this reason, it is imperative that every professional educator be well-versed in existing research on what instructional modifications and interventions have been shown to be successful in increasing the academic achievement of the ADHD student population (Moore et al., 2018).

Students with ADHD are at a much higher risk of both academic and social failures than their peers and are also much more likely to need special education services (Mahone & Denckla, 2017). In fact, underachievement and difficulties in school are some of the most overlooked side effects of ADHD. Students diagnosed with ADHD are also statistically much more likely to develop deficiencies in reading throughout their academic careers than their peers (Mahone & Denckla, 2017). The academic difficulties faced by students diagnosed with ADHD can also have a lasting impact on students' lives (Barkley et al., 2018). Academic struggles have a long-term impact on and place students at a greater risk for continued disadvantages such as the inability to secure a well-paying job, to establish a career, or to attend college (Barkley et al., 2018). The most alarming statistic for professional educators, however, is that 25% of students diagnosed with ADHD do not graduate high school, as compared to only 2% of their peers who have not been diagnosed (Henderson, 2020).

School-related difficulties for students with ADHD are not limited to academics. Students with ADHD are also much more likely to face social and behavioral difficulties

(Chaudhari, 2021). The behavioral difficulties associated with ADHD, such as the inability to maintain focus, fidgeting, or other disruptive behaviors, can lead students diagnosed with ADHD to be much more susceptible to disciplinary action and suspensions (Morin, 2023a). Students with ADHD often experience social difficulties, social rejection, and trouble making friends due to the hyperactive and impulsive behavior associated with the disorder (Children and Adults with Attention-Deficit/Hyperactive Disorder [CHADD], 2018). Impulsivity leads some students diagnosed with ADHD to make rash decisions before thinking about how their actions might be perceived by others, which may be another cause of social difficulties (CHADD, 2018).

The role of a professional educator is to inspire learning and the relevant skills necessary for their students to become productive members of society and be successful in life outside of the classroom (Martin, 2020). The social and academic difficulties faced by students diagnosed with ADHD can make it extremely difficult to adjust and succeed outside the classroom. For this reason, every professional educator should have the knowledge and ability to modify their instruction and employ both academic and social interventions to help students diagnosed with ADHD both inside and outside the classroom environment (Barkley, 2020).

Statement of the Problem

The majority of ADHD research has focused on the behavioral issues associated with the disorder. Little research has been done on the social and academic underachievement faced by students diagnosed with ADHD (Chaudhari, 2021). While there have been several interventions developed to address the behavioral difficulties

associated with ADHD, these interventions may have little impact on enhancing academic performance (Barkley et al., 2018). Interventions such as modifying the physical classroom environment and separating the student from distractions have a direct impact on hyperactive and disruptive behavior but have little to no effect on academic performance (Abramowitz & O'Leary, 2019). More research needs to be done on new interventions and or on the modification of existing interventions to determine their impact on students diagnosed with ADHDs' academic achievement (Barkley et al., 2018).

One subject where students diagnosed with ADHD have historically struggled is mathematics (Low, 2021a). The inability of students diagnosed with ADHD to maintain focus for an extended period of time sometimes makes the complex processes and multi-step problems difficult to grasp (Abramowitz & O'Leary, 2019). Students diagnosed with ADHD are more likely to receive special education services in mathematics than any other subject, which is a reason why more research is needed to determine effective strategies and methods for increasing math achievement specifically (Low, 2021a). In fact, it is estimated that nearly a third of students diagnosed with ADHD also have a math learning disability. While there are many reasons as to why that could be the case, there are multiple symptoms of ADHD that could also impact a student's math skills (Kennedy, 2020). For example, students with ADHD experience working memory impairments that impact their ability to remember previous steps in a problem and can make multi-step problems difficult. Another example would be executive functioning deficits that cause students diagnosed with ADHD to make irrelevant associations between topics or have difficulty switching between tasks. This would cause problems

for students diagnosed with ADHD in math specifically, because of the need for switching back and forth between different processes, i.e., one problem could require addition, subtraction, and division (Kennedy, 2020).

Another piece of the puzzle is that teachers have reported very little formal training in their prospective teacher education programs on how to help the ADHD student population (Chaudhari, 2021). Teachers receive formal training on instructional modifications and classroom strategies such as peer tutoring, choice-making, and computer-aided instruction; however, none of those strategies have been shown to be effective in increasing academic performance in students with ADHD (Abramowitz & O'Leary, 2019). In fact, the CDC (2022) noted that teachers are underprepared to address the learning difficulties faced by the ADHD student population.

Purpose of the Study

This study was designed to examine the instructional modifications teachers used with students who had been diagnosed with ADHD. It determined teacher perceptions and examined to what extent teachers had prior knowledge or formal training in working with students diagnosed with ADHD. Additionally, the study determined if prior knowledge or formal training impacted the teacher's willingness and/or ability to implement methods and strategies designed to help students diagnosed with ADHD. Finally, this study considered what effect instructional modifications had on the academic achievement of students diagnosed with ADHD within the context of a traditional high school mathematics classroom.

Research Questions

The following research questions guided this study:

1. What are high school mathematics teachers' perceptions of their abilities to work effectively to meet the needs of students diagnosed with ADHD?
2. What relationship exists between the utilization of instructional modifications not mandated by an IEP or 504 plan and the average engagement of students in a high school mathematics classroom?
3. What impact does the utilization of instructional modifications not mandated by an IEP or 504 plan have on the mathematics achievement of high school students who have been diagnosed with ADHD as measured by growth on pre and posttest scores?

Significance of the Study

This study provided tangible resources and strategies teachers could implement to help their students diagnosed with ADHD. This study also examined the effectiveness of specific strategies used with students diagnosed with ADHD on their academic performance through analysis of assessment data, classroom observations, and teacher interviews. This analysis of both qualitative and quantitative data gave teachers more tools and strategies to meet the needs of all learners, specifically those in the ADHD student population.

Limitations

While all possible measures were taken to ensure the validity of the study and limit personal bias and external factors, there were a few limitations to the study, one of which was the sample size. The study was conducted within the context of a single high school in a suburban South Carolina school district. While the sample for the study was representative of the majority of the ADHD population at Suburban High School, the site

of the study, it was difficult to determine if the results of the study could be generalized to apply to all students diagnosed with ADHD or if there were other external factors, such as curriculum taught, that could have had an impact on the results of the study. There were also some limitations surrounding the observations performed during the study. Being a single observer caused some issues, which made it difficult to verify reliability. Utilizing classroom observations as part of the data collection process could also be viewed as a limitation, as students may have acted or behaved differently when being observed during the study; however, since the participating teachers had been observed multiple times already by their administration, students seemed accustomed to being observed, so the influence of the observations on student behavior was considered to be minimal.

Another limitation of the study was that I was not allowed to know the specific identity of the students diagnosed with ADHD at the chosen site. I knew if there were students with ADHD in each class, as well as the number of students with ADHD in each class observed; however, I had no knowledge of the students' names or other identifying information that would have led me to know the identity of a specific student. Data were provided to me from the participating district, which consisted of the 91 students who had a reported ADHD diagnosis in a 504 or IEP plan; however, the only identifying information included with the students was their student identification number.

Definition of Terms

The following terms are used throughout the study when describing prior research and methods used.

504 Plan

A formal plan developed by schools to give students with disabilities the support they need. These plans were designed to prevent discrimination and were introduced in Section 504 of the Rehabilitation Act, a civil rights law designed to protect the rights of disabled students. 504s are developed separately from a school's special education department, and students do not have to be receiving special education services to receive one (Lee, 2022).

Achievement

For the purpose of this study, achievement was defined as engagement and participation in classroom instruction and activities as well as quantifiable growth in scores between the pretest and posttest assessments used.

ADHD

A neurodevelopmental disorder characterized by a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development (American Psychiatric Association, 2013).

Behavior Intervention Plan

A Behavior Intervention Plan (BIP) is a formal written plan designed to teach and reward good behavior. BIPs are used when a student consistently exhibits problem behaviors, and their intended purpose is to prevent and stop misbehavior. BIPs are also not associated with special education services, meaning any student can receive one (Morin, 2022).

Individual Education Plan

An Individual Education Plan (IEP) serves as a roadmap to help teachers support students with identified learning disabilities. IEPs are specific to students receiving

special education services and outline the reasons for those services as well as the accommodations the student requires to succeed in the classroom. Similar to 504s and BIPs, IEPs are protected by federal law and required to be followed by all stakeholders (Newcomer, 2021).

Instructional Modification

For this study, modifications referred to instructional decisions or changes that were not mandated by an IEP, BIP, or 504. Learner accommodations and instructional modifications used during the study were designed to support students who have learning problems within classroom settings. Accommodations and modifications included adaptations to the physical arrangement of the classroom as well as changes to instructional delivery. Such changes included modifications to lesson presentation, student responses, and evaluation and assessment techniques. Some accommodations and instructional modifications were teacher-oriented (e.g., changes in how the information is presented), and some were focused on changes in how the student engaged in and responded to the lesson (University of South Florida, 2019).

Learning Disability

A type of neurodevelopmental disorder that impedes the ability to learn or use specific academic skills such as reading, writing, or arithmetic, which are the foundation for academic learning. Learning disabilities were characterized by “unexpected” learning difficulties, as other aspects of development seemed to be fine (American Psychiatric Association, 2013).

Traditional Classroom

For the purpose of this study, a traditional classroom was defined as a classroom

where a teacher moderates and regulates the flow of information and knowledge. Students were expected to continue developing their knowledge of a subject outside of school through homework exercises. Here, the main resource of students was their instructor who only taught them face-to-face. A traditional classroom involved a standard curriculum delivered by a teacher in person. Standardized tests were administered at regular intervals to test student comprehension. This model was where the time, place, and pace of student learning remained constant (Top Hat, 2020).

Role of the Researcher

As the researcher, I coordinated and carried out all aspects of the study including choosing the participants and collecting and analyzing both the pre and postassessment data from each participant's students. I also conducted interviews with each participant to gather and analyze qualitative data to determine what formal training participants have in working with students diagnosed with ADHD; what strategies, modifications, and/or accommodations they used in their instruction, specifically with students diagnosed with ADHD; and their confidence level in working with students diagnosed with ADHD. I also used the interview data to perform classroom observations of participants who implemented instructional modifications, strategies, or accommodations, as well as to observe participants who did not.

Organization of Study

This study utilized both qualitative and quantitative data collection methods. Qualitative data collection was performed through the use of interviews and classroom observations, while quantitative data were collected in the form of pre and post-assessment data that were used to determine the effectiveness of instructional

modifications and accommodations on the academic performance of students diagnosed with ADHD in a traditional mathematics classroom. The remaining chapters discuss the existing literature on ADHD as a disorder and its impact on the ability of students to learn; a detailed description of the methodology used to perform the study; results of the study, including analysis of collected assessment, interview, and observation data; and an interpretation of the results with suggestions for further research.

Chapter 2: Literature Review

This literature review contains detailed commentary on the existing literature and research related to the learning, behavioral, and social difficulties of adolescents diagnosed with ADHD, specifically in a classroom or educational setting. ADHD as a disorder and medical condition is defined, along with a synopsis of the history of ADHD and how it is diagnosed. The review also contains commentary on the symptoms associated with ADHD and how they impact adolescents in a traditional classroom environment. Research on specific learning and behavioral disabilities and disorders associated with ADHD are also discussed, along with existing instructional strategies and modifications being used to help students with ADHD. The review ends with existing research on how formal training in teacher preparation programs for working with students diagnosed with ADHD impacts the effectiveness of instructional modifications and accommodations geared toward helping students diagnosed with ADHD succeed in the classroom.

Definition of ADHD

ADHD is defined as a neurodevelopmental disorder characterized by a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development (American Psychiatric Association, 2013). While the cause of ADHD is still unclear, scientists have presented growing evidence that genetics contribute to ADHD (Elmaghraby & Garayalde, 2022).

Symptoms of ADHD

The symptoms of ADHD can be characterized into three main categories: those related to inattention, hyperactivity, or impulsivity. Symptoms of ADHD related to

inattention are defined as any off-task behaviors or behaviors that lead to a loss of focus, without being caused by defiance or a lack of understanding (U.S. Department of Health and Human Services, 2019). Symptoms characterized within the category of hyperactivity include physical behaviors such as ticks, fidgets, taps, or excessive talking caused by extreme restlessness or anxiety (Dodson, 2022). Finally, symptoms of ADHD characterized within the category of impulsivity are defined as rash actions or decisions made with little to no thought of consequences and may carry a high potential for harm or be socially intrusive (Hasan, 2018).

Specific behaviors associated with ADHD are divided into two subcategories: inattentive and hyperactive-impulsive (Miller, 2019). While most children diagnosed with ADHD display a combination of both inattentive and hyperactive-impulsive behaviors, some children will exhibit one or the other (Hasan, 2020). Behaviors that fall into the inattentive category include making careless mistakes in schoolwork; being easily distracted or sidetracked; displaying difficulty following instructions; not listening when spoken to directly; having trouble organizing tasks; failing to finish work in school or at home; avoiding or resisting tasks that require sustained mental processing or thought, such as homework; and misplacing or losing possessions (Dodson, 2022). Hyperactive-impulsive behaviors associated with ADHD include fidgeting or squirming, being unable to stay in a seat, running or climbing where inappropriate, having trouble playing quietly, exhibiting extreme impatience, talking excessively, blurting out answers before the question is finished, and interrupting or intruding on other conversations (C. Miller, 2022). The most common symptoms associated with ADHD include a lack of attention to detail, inability to follow instructions, inability to focus on a task, and

inability to remain still (American Psychiatric Association, 2017). Other common symptoms of ADHD include difficulty maintaining focus, difficulty listening, and difficulty processing information, making learning and academic tasks difficult for students; thus, treatment methods for ADHD are relevant to education, and every teacher should have formal training in successful instructional methods for children and adults diagnosed with ADHD (American Psychiatric Association, 2017).

History of ADHD

Dr. George Still is credited with labeling ADHD as a behavioral disorder, as it is viewed today. Still reported students with what would later be described as ADHD-like symptoms. He speculated that issues such as having problems with sustained attention, excessive emotion, and impulsive behaviors could be linked to a genetic or biological disorder. Still was also the first researcher to suggest that the symptoms shown by his patients could be linked to nerve cell changes and could be a cause for learning disabilities as well (Holland, 2021); however, North American research interests in ADHD did not come until the early 20th century, after students who survived the encephalitis infection in the early 20th century often showed symptoms of a behavioral syndrome characterized by overactivity (Salo et al., 2013). The rise in the number of students presenting with hyperactive behavioral symptoms and learning disabilities led to a need for more research and sparked North American interest in ADHD (Gunnerson, 2022).

The use of medication to treat ADHD began in the 1930s when researchers discovered that the impulsive behavior often presented with students displaying symptoms of ADHD could be controlled with the use of amphetamines. This research

supported scientists' beliefs that ADHD is a neurological disorder and paved the way for the development of pharmaceutical research as treatments for students diagnosed with ADHD and the development of the medication used for the treatment of ADHD (Rodden, 2023). The late 1930s brought research on the origin of the label "brain-injured student syndrome" to describe some symptoms associated with ADHD. This label was used to describe students with limited mental processing abilities, but further research in the early 1940s caused a shift of focus toward the behavioral issues associated with what was then labeled "minimal brain damage syndrome." The focus on the behavioral symptoms research in the 1950s led to a new label of "hyperkinetic impulse disorder," which focused on the neurological defects specifically controlling impulse and motor control, leading to a better understanding of the neurological effects associated with students displaying hyperactive symptoms such as fidgeting, tapping, or excessive talking (Lange et al., 2010).

Research during the 1960s led to the adaptation of the term "minimal brain dysfunction" by the United States Public Health Services; however, later research in the decade performed by the task force established by the National Institute of Neurological Diseases and Blindness showed over 99 symptoms associated with minimal brain dysfunction. The term minimal brain dysfunction was phased out by the end of the 1960s after it was determined to be too vague and lacking neurological evidence (Lange et al., 2010). Further interest in the neurological effects of ADHD led to the origin of the terms "hyperkinetic behavior disorder" and "hyperkinetic impulse disorder" in the late 1960s. These diagnoses were associated with restlessness, hyperactivity, and inattention, which were treated with medication. The 1970s research coined the term "hyperactive student

syndrome" where hyperactivity was first considered as the main symptom of the disorder (Rodden, 2023).

In the early 1970s, a psychologist named Wender identified six groups of symptoms shown by students with hyperkinetic impulse disorder (Smith, 2017). Wender also presented the theory that the symptoms of hyperkinetic impulse disorder could be categorized into three groups: decreased experience of pleasure and pain, high and poorly modulated levels of activation, and extroversion (Smith, 2017). Wender suggested that the symptoms of hyperkinetic impulse disorder might develop in early adolescence and often before children reach school age, further supporting that there may be a genetic link in the neurological development of adolescents showing symptoms of hyperkinetic impulse disorder later linked to ADHD (Holland, 2021). Later research during the 1970s showed that the strongest deficit seen from hyperkinetic student syndrome was related to attention. This research led to the development of the concept of attention deficit disorder (ADD). The research in the late 1970s and early 1980s was a continuation of this research, which led to the split of ADD and hyperkinetic student syndrome as separate disorders, creating a distinction between attention deficit symptoms and neurological symptoms that were originally all associated with the same disorder (Smith, 2017).

In the 1980s, the American Psychiatric Association was the first to coin the modern terms of ADD and ADHD, which led to the distinction between ADD with and without hyperactivity (American Psychiatric Association, 2017). Research in the late 1990s and early 2000s on ADD and ADHD, has shown a connection between students diagnosed with ADD and ADHD and their parents' psychological disorders. This research also suggested that ADD and ADHD are caused by a genetic defect, and the

chances of a student being diagnosed dramatically increase if their parents have received a psychological or behavioral disorder diagnosis. Research in the early 2000s was also the first to suggest an alternative cause for ADD or ADHD other than a brain abnormality. Research done in the last 15 years also narrowed down the core symptoms of ADD and ADHD and the perceived differences and showed core symptoms of inattention and trouble focusing or staying on task for ADD and difficulties with excessive activity level, acting impulsively, and heightened sensitivity. Research in the last 10 years on ADD and ADHD has also led to the development of the diagnostic process and the development of diagnostic tools and tests that are used by medical professionals to diagnose students with ADD and/or ADHD (U.S. Department of Health and Human Services, 2019).

The most current research, however, has labeled ADD as an outdated term and rather utilizes ADHD as an overarching diagnosis for all children, adolescents, and adults regardless of whether symptoms of hyperactivity are present (Dodson, 2022). ADHD is now divided into three subcategories including inattentive ADHD, hyperactive impulsive ADHD, and combined type ADHD. Patients diagnosed with inattentive ADHD have difficulty maintaining focus, zone out easily, have difficulty paying attention, avoid tasks that require sustained mental effort, have difficulty following through on instructions, and have limited organizational skills but display no hyperactive symptoms. A diagnosis of hyperactive impulsive ADHD results from a patient who displays only hyperactive symptoms such as talking excessively or fidgeting. Finally, a combined type ADHD diagnosis stems from children, adolescents, or adults who display multiple inattentive and hyperactive behaviors (Williams, 2022).

Diagnosing ADHD

The most universally accepted criteria for diagnosing ADHD are found in the Diagnostic and Statistical Manual for Mental Disorders developed by the American Psychiatric Association. Figure 1 shows those criteria.

Figure 1

DSM-5 Diagnostic Criteria for ADHD

Symptoms and/or behaviors that have persisted ≥ 6 months in ≥ 2 settings (e.g., school, home, church). Symptoms have negatively impacted academic, social, and/or occupational functioning. In patients aged < 17 years, ≥ 6 symptoms are necessary; in those aged ≥ 17 years, ≥ 5 symptoms are necessary.	
Inattentive Type Diagnosis Criteria	• Displays poor listening skills • Loses and/or misplaces items needed to complete activities or tasks • Sidetracked by external or unimportant stimuli • Forgets daily activities • Diminished attention span • Lacks ability to complete schoolwork and other assignments or to follow instructions • Avoids or is disinclined to begin homework or activities requiring concentration • Fails to focus on details and/or makes thoughtless mistakes in schoolwork or assignments
Hyperactive/ Impulsive Type Diagnosis Criteria	**Hyperactive Symptoms:** • Squirms when seated or fidgets with feet/hands • Marked restlessness that is difficult to control • Appears to be driven by "a motor" or is often "on the go" • Lacks ability to play and engage in leisure activities in a quiet manner • Incapable of staying seated in class • Overly talkative **Impulsive Symptoms:** • Difficulty waiting turn • Interrupts or intrudes into conversations and activities of others • Impulsively blurts out answers before questions completed
Additional Requirements for Diagnosis	• Symptoms present prior to age 12 years • Symptoms not better accounted for by a different psychiatric disorder (e.g., mood disorder, anxiety disorder) and do not occur exclusively during a psychotic disorder (e.g., schizophrenia) • Symptoms not exclusively a manifestation of oppositional behavior
Classification	**Combined Type:** • Patient meets both inattentive and hyperactive/impulsive criteria for the past 6 months **Predominantly Inattentive Type:** • Patient meets inattentive criterion, but not hyperactive/impulse criterion, for the past 6 months **Predominantly Hyperactive/Impulsive Type:** • Patient meets hyperactive/impulse criterion, but not inattentive criterion, for the past 6 months Symptoms may be classified as mild, moderate, or severe based on symptom severity

Note. From *DSM-5 Diagnostic and Statistical Manual of Mental Disorders* (5th edition.), by American Psychiatric Association, 2013.

The diagnostic tool teachers are most familiar with is a series of questionnaires developed by the American Academy of Pediatrics and the National Initiative for Children's Healthcare Quality (Wolraich, 2021). Although the reliability of subjective ratings has been called into question, The Vanderbilt Assessment Scales, provided in Appendix A, developed by AAP and NICHQ, are still used by healthcare providers because they provide a free resource and a consistent scale that can be given to parents, teachers, school counselors, or others who interact with the child on a daily basis to help determine what behaviors the child exhibits both inside and outside of the home (CDC, 2022). The Vanderbilt Assessment Scales provides separate initial and follow-up questionnaires for parents and teachers related to symptoms associated with ADHD as well as academic and behavioral performance. The teacher questionnaire asks teachers to assess how often students display behaviors and symptoms such as excessive talking and interrupting peers or adults, on a Likert scale ranging from never to very often, and also asks teachers to rate students' overall academic performance and relationship skills on a scale from excellent to problematic. The parent questionnaire poses similar questions to the teacher questionnaire but focuses more on behaviors and symptoms displayed at home rather than in a school environment. The follow-up questionnaires are given after an observation period, typically 6 months (Wolraich, 2021).

The ADHD diagnostic process starts with an initial consultation with an ADHD specialist, who can be either a physician or psychiatrist. The initial consultation involves a clinical interview surrounding the patient's social, medical, and family history (Seay et al., 2022). The initial consultation might also include a short educational session on the most recent research on ADHD and thoughts around managing symptoms (Yetman,

2021). Clinical interviews also include completing a series of ADHD rating scales such as the Vanderbilt Assessment Scales combined with another ADHD test (Miller et al., 2023). These tests could include anything from intelligence tests designed to detect specific learning disabilities often associated with ADHD to tests of specific abilities such as language development, memory recall, and motor skills to broad-spectrum scales designed to screen for social, emotional, and psychiatric problems (Seay et al., 2022). An ADHD diagnosis also requires a comprehensive analysis of any comorbidities that could exist outside the scope of ADHD. In other words, an official ADHD diagnosis only comes after all other possible explanations for the behavior have been ruled out; for example, a mood disorder or other social/emotional disorder (Yetman, 2021).

Several other factors can affect an ADHD diagnosis as well, such as age or gender. Recent studies have shown that children who are the youngest in their grades are 60% more likely to be diagnosed with ADHD than their older peers (C. Miller, 2022). That same disproportionality exists across all grade levels up to eighth grade, which is why it is important for parents, teachers, and healthcare providers to compare behaviors to children the same age and not to the range of ages present in the same grade level (C. Miller, 2022). Gender is another factor that should be considered before an ADHD diagnosis. Many girls exhibit only inattentive behaviors, making a diagnosis more difficult as inattentive behaviors could be attributed to a plethora of factors (Miller et al., 2023). Girls also possess the genetic risk factors associated with ADHD less frequently than boys, meaning girls often have a more clinically complex presentation of ADHD (Martin, 2018). In other words, because girls tend to display hyperactive behaviors less frequently, their symptoms can often be linked to several different diagnoses such as

depression or anxiety, making an ADHD diagnosis less obvious for medical professionals. For this reason, boys are significantly more likely to be diagnosed with ADHD at a young age, as they often display both inattentive and hyperactive-impulsive behaviors. In fact, a recent study showed that boys aged 3 to 17 are three times more likely to be diagnosed with ADHD than their female peers (CDC, 2022).

Once an ADHD specialist has performed a comprehensive evaluation, an ADHD diagnosis can be made based on the criteria outlined in Figure 1 from the DSM-5 (CDC, 2022). A diagnosis of ADHD with combined presentation will be given to children, adolescents, and adults who present with both inattentive and hyperactive-impulsive behaviors for the past 6 months. A diagnosis of ADHD with predominantly inattentive presentation is given to a child, adolescent, or adult who exhibited only inattentive behaviors in the past 6 months. A diagnosis of ADHD with predominantly hyperactive-impulsive presentation will be given to children, adolescents, or adults who exhibit only hyperactive-impulsive behaviors in the past 6 months (CDC, 2022). All three ADHD diagnoses can lead to both learning and social difficulties, making school a very challenging environment for children with ADHD (American Psychiatric Association, 2013).

Learning Challenges With ADHD

Difficulties in school are often associated with children diagnosed with ADHD, are often the cause for initial concern, and lead to an initial diagnosis. Approximately 11% of school-aged children worldwide are diagnosed with ADHD, making it one of the most common psychological disorders affecting adolescents, which is why it is imperative that teachers are aware of the impact an ADHD diagnosis can have on student

learning outcomes (American Psychiatric Association, 2017). Psychologists and medical professionals have conflicting beliefs when it comes to whether ADHD should also be considered a learning disability (American Psychiatric Association, 2017). Some psychologists believe that ADHD should not be considered a learning disability because ADHD does not have an impact on the ability to process written or spoken language, even though research has shown that as many as half of the students diagnosed with ADHD also have a learning disability associated with an ADHD diagnosis (Barkley, 2020).

While ADHD does not have a direct impact on language processing, students diagnosed with ADHD may present with some of the same symptoms of a learning disability due to their frequent inattentive and off-task behavior in the classroom (DuPaul & Volpe, 2019). Many psychologists and medical professionals agree that the behavioral manifestations associated with ADHD are considered a learning impairment (CHADD, 2017). Although it is worth noting that ADHD is considered a disability under the Americans With Disabilities Act, the learning challenges associated with ADHD such as trouble paying attention, listening, and following multiple directions can often be mistaken for a learning disorder. A learning disorder is defined as a biological impairment that impacts one or more of the basic psychological processes involved in understanding either spoken or written language. Learning disabilities affect an individual's ability to listen, think, speak, read, write, spell, or do mathematical calculations (Thenu, 2019). While these abilities are also impacted by the symptoms associated with ADHD, there are two trains of thought when it comes to classifying ADHD as a learning disability. Some psychologists and medical professionals argue that

students diagnosed with ADHD struggle with reading, writing, spelling, and mathematical calculations as a direct result of the impact the disorder has on executive functions such as the ability to focus rather than the foundational psychological processes, while other psychologists and medical professionals argue that ADHD impacts the foundational psychological processes directly and is therefore a learning disability in itself (Thenu, 2019).

While both ADHD and learning disabilities are considered neurodevelopmental disorders, ADHD specifically affects the prefrontal cortex of the brain (Thenu, 2019). The prefrontal cortex is the piece of the brain associated with regulating decision-making and behavior. When compared to students of the same age, students diagnosed with ADHD may be impulsive, easily distracted, have difficulty focusing, or struggle with controlling emotions, meaning ADHD is a developmental disorder of executive functioning and again not basic psychological processes affecting spoken and written language, as the definition of a learning disorder suggests (Moffitt et al., 2016).

Many psychologists and medical professionals who do not consider ADHD in itself a learning disorder believe that a student can be diagnosed with both ADHD and a learning disability (Thenu, 2019). Although many do not believe ADHD in itself is a learning disability, experts agree that there may be a comorbidity associated with the learning disability (CDC, 2022). Students who are diagnosed with both ADHD and a learning disability have academic difficulties driven more by inattentive than hyperactive-impulsive ADHD symptoms (CHADD, 2017). These students also have deficits in working memory and processing speed as well as mutations in multiple genes involved with the etiology of the ADHD and learning disability diagnosis (Hallowell &

Ratey, 2023).

The counterargument that ADHD is also a learning disorder involves the fact that learning disorders affect one or more specific cognitive processes, including executive functions (Thenu, 2019). Learning is a complex process that requires the use of multiple executive functions, specifically the ability to focus, pay attention, engage in tasks, and use working memory. Psychologists and medical professionals who consider ADHD a learning disability argue that both are considered neurodevelopmental disorders and genetic disorders and are both chronic disorders, meaning the disorder and the difficulties associated with it continue into adulthood (Moffitt et al., 2016). These groups of scientists also work from a slightly different definition of a learning disorder, referred to as a specific learning disorder, defined as a neurodevelopmental disorder of biological origin manifested in learning difficulty and problems in obtaining academic skills specifically in the early school years lasting for a period of at least 6 months and cannot be attributed to an intellectual disability, developmental disorder, or neurological or motor disorder (CHADD, 2017).

Regardless of whether ADHD should also be considered a learning disability or not, the impact ADHD has on a student's ability to learn and process information is undeniable. ADHD makes learning difficult for students, putting them at a disadvantage compared to their peers (Moffitt et al., 2016). The effect ADHD has on executive functions required for the learning process should be a cause for concern for all educators and should be considered when designing lessons and choosing instructional techniques, whether ADHD is defined as a learning disability or not (CHADD, 2017).

Social and Behavioral Challenges With ADHD

Students diagnosed with ADHD often face social and behavioral issues in the classroom (Willis et al., 2019). The development of social skills and relationships with peers are often affected by the symptoms associated with ADHD (Humphries et al., 2019). Students with ADHD can find it difficult to make and/or keep friends due to the executive functioning impairment resulting from the ADHD diagnosis (Gill & Hosker, 2021). Developing social skills and interacting with peers involve the use of both verbal and nonverbal communication skills including eye contact, facial expressions, body language, volume, and tone of voice. The executive functioning impairments associated with ADHD, including the inability to focus, direct actions, or control emotions, sometimes make communicating and picking up on social cues difficult. Compared to their peers, executive functioning in students with ADHD can be delayed as much as 30%, again making communicating with their peers challenging (Hallowell & Ratey, 2023).

Social difficulties can manifest in all three types of ADHD but present differently depending on the type. Students presenting with primarily inattentive behaviors can have difficulty listening to others, and may miss pieces of information in a conversation, get distracted by sounds or noises, miss social cues, or become overwhelmed or withdrawn (Gill & Hosker, 2021). All these behaviors could be interpreted by peers as a lack of engagement and, in turn, a lack of interest or respect during a conversation (Willis et al., 2019). Demonstrating a lack of interest during an interaction or conversation with a peer or becoming distracted can quickly end a conversation. Students and teachers want to feel like an equal partner in a conversation rather than an audience or sounding board (Knight,

2016). The difficulty students diagnosed with ADHD can have could impact their conversations and relationships with their teachers and other authoritative figures as well. Zoning out or getting distracted while communicating with teachers can also be perceived as disrespect, often leading teachers and other authoritative figures, such as administrators or school counselors, to be reluctant to help or engage in conversation with these students (Humphries et al., 2019).

Students diagnosed with ADHD presenting with mainly hyperactive behaviors can face different but equally damaging social challenges (Humphries et al., 2019). Students with the hyperactive form of ADHD can interrupt frequently during conversations, share scattered or seemingly unconnected trains of thought, become hyper focused on a single topic, or talk rapidly or excessively (Gill & Hosker, 2021). All these behaviors associated with hyperactivity can lead to communication difficulties with peers, teachers, and other adults students may encounter in the traditional classroom environment. Finally, students presenting with the impulsive form of ADHD can display unruly behavior at inopportune times, invade personal space during conversations, and try and initiate conversations at inappropriate times.

Regardless of the form of ADHD a student presents with, the social, behavioral, and communication challenges that result from the ADHD diagnosis can have a significant impact on the student's relationships and performance in school (Humphries et al., 2019). When students diagnosed with ADHD become distracted or dominate a conversation, their peers can view them as uninterested in their perspective or simply unkind. These perceptions developed by peers can limit opportunities for students with ADHD to practice their social skills and may result in them being avoided by their peers.

The consequences resulting from not having social interaction could have a domino effect, leading students to feel inadequate or associate social interaction with a negative emotional response. A negative view of social interaction could be detrimental to a student's confidence and cause them to avoid social interactions altogether out of fear of rejection (Gill & Hosker, 2021).

Social interaction and communication with peers play a significant role in academic success as well (Willis et al., 2019). Developing social skills and relationships with peers allows students the opportunity to cooperate, negotiate, and problem solve with others, all of which are skills required for academic success (Gill & Hosker, 2021). The skills students develop through social interaction teach students how to work in a group, solve problems, recognize and respect other points of view, manage and resolve conflict, and be accepting of diverse groups. The social difficulties students with ADHD face can make it challenging to stay on task in class or participate in class discussions, which can have a direct impact on academic performance. Social and communication challenges can also make it difficult for students to work in groups or present in front of others, making collaborative assignments and projects challenging. Students diagnosed with ADHD can also struggle with asking for help from their peers or teachers, leading to academic difficulties as well (Gill & Hosker, 2021).

The difficulties students diagnosed with ADHD face with building relationships with their peers and reading social cues also make them much more susceptible targets for bullying. Students diagnosed with ADHD are 50% more likely to be a victim of bullying than their peers due to their hyperactive, impulsive, or inattentive behaviors (Lung et al., 2019). Victims of bullying have also been linked to low academic

performance, creating yet another obstacle for students diagnosed with ADHD in the classroom. Students who are bullied develop less confidence in their academic abilities, leading to academic struggles (Ladd, 2017). Bullied students also are less likely to focus on academic studies because of the distractions bullying causes, putting students with ADHD who are also bullied at an even greater academic disadvantage. The social challenges students diagnosed with ADHD face can lead to much more serious emotional and mental challenges such as bullying, anxiety, or depression (Fletcher & Wolfe, 2009). For this reason, it is important for teachers to be aware of these challenges and be trained on intervention strategies and how to improve the social and academic skills of students with ADHD.

Common Practices for Classroom Intervention

While all students diagnosed with a learning disability because of an ADHD diagnosis are eligible for a 504 or IEP to ensure they receive special education services to help them succeed, there are many modifications, strategies, and tools that can used by any classroom teacher to help students with ADHD learn (DuPaul & Stoner, 2016). There are multiple instructional strategies and accommodations that have been identified, outside of modifications that require a formal special education plan, that have been shown to improve learning outcomes for students diagnosed with ADHD (Brock et al., 2010). Most of these identified modifications, accommodations, and strategies apply to general studies but can be modified to meet the needs of a specific subject of study. For example, there are several strategies and accommodations that can easily be adjusted to help students diagnosed with ADHD be more successful in math (C. Miller, 2022).

These accommodations include allowing students to use their own physical copies

of formula sheets or other math aids when working on practice problems, quizzes, or tests (Low, 2021a). By allowing students diagnosed with ADHD to utilize their own formula sheets at their desks, teachers can alleviate some of the memory and recall issues that are symptoms of ADHD while not giving the students an unfair advantage over their peers (Low, 2021a). Another strategy or accommodation that can be implemented in a math classroom is to provide students diagnosed with ADHD with detailed procedures or steps along with worked examples for multi-step problems to prevent them from feeling overwhelmed (Low, 2021a). Processing large amounts of information at a time is difficult for students with ADHD, and providing step-by-step instructions with worked examples can help students process information in more manageable chunks (DuPaul & Stoner, 2016). Some strategies and accommodations are focused more on a specific type of ADHD symptoms such as hyperactivity.

Another common learning intervention for students diagnosed with ADHD is general instruction on study and organizational skills (Dolin, 2022). Many students with ADHD struggle with basic organization and study skills due to the need for greater attention to detail than other tasks. A lack of organization and study skills has also been shown to compromise overall academic performance (Collins, 2021). Instruction in study and general organization skills is most effective when the following four criteria are met.

1. Initial instruction includes how to study for tests as well as tips and demonstrations on how to properly take notes during class. Instruction on note-taking and study skills has the greatest impact if implemented during the late elementary or early secondary years by the general education teacher or support staff such as guidance counselors or school psychologists.

2. Students with ADHD should be encouraged to keep homework journals as soon as homework begins to become a substantial component of the learning experience, i.e., more than 30 minutes a day. A homework or assignment journal should include both short- and long-term assignments such as projects and should be checked by teachers and parents daily.
3. Students diagnosed with ADHD should also be allowed to record lectures so they can revisit them later and ensure that their notes are adequately detailed. Students should also be allowed to keep a second set of textbooks at home to complete homework assignments and projects due to students diagnosed with ADHD being more susceptible to forgetting or misplacing materials than their peers.
4. Instruction on organizational and study skills should continue throughout a student's career and should be considered a priority for any student diagnosed with ADHD (DuPaul & Stoner, 2016).

Providing instruction on basic study and organizational skills such as note-taking helps to level the playing field for students diagnosed with ADHD and gives students tangible resources to help improve their overall academic performance, focus, and motivation in the classroom (Dolin, 2022).

Accommodations Specific to Hyperactivity/Inattention

Allowing students extra time on in-class assignments along with quizzes and tests allows students diagnosed with ADHD to take short breaks between sections or parts of an assessment to move around, recharge, or refocus (Low, 2021a). The extra time and short breaks help to counteract the executive functioning issues students with ADHD

experience, allowing students to work at their own pace and break down each problem into smaller and more manageable pieces (McReynolds, 2023). Teachers can also decrease the number of problems they assign to an ADHD student to help alleviate some of the anxiety associated with a large amount of work, as well as help maintain the student's attention and focus (C. Miller, 2022). By reducing the number of problems, students can still show mastery of the content while not feeling overwhelmed by the amount of work and not becoming distracted or sidetracked while working (DuPaul & Stoner, 2016). Another strategy to help alleviate some of the learning difficulties that come with hyperactivity in students diagnosed with ADHD is to provide frequent feedback and "check-ins" during classwork and other in-class assignments (Low, 2021a). By breaking an assignment into more manageable chunks and providing feedback frequently, students diagnosed with ADHD have an easier time maintaining focus, which also helps alleviate some of the frustration that can come with making errors (Chakraborty, 2021).

Another accommodation that can be used to address hyperactivity or inattention is reducing the amount of writing a student is required to do by providing students diagnosed with ADHD with handouts with problems already on them rather than asking them to copy them from the board or a textbook (Low, 2021a). Teachers can also provide students with review sheets before formative assessments that provide an organized breakdown of all the topics that will be covered in the assessments (C. Miller, 2022). Both strategies can be utilized by teachers to help students diagnosed with ADHD maintain their focus in class as well as again break the material into more manageable pieces to avoid feeling overwhelmed and losing focus, as well as help reduce the number

of careless errors students diagnosed with ADHD often make (Chakraborty, 2021). One other strategy for maintaining an ADHD student's focus during a lesson is to have them take notes on graph paper instead of notebook paper. By alternating notebook paper with graph paper, students diagnosed with ADHD have a grid to help them line up numbers and computations, allowing students to maintain focus throughout a problem, more easily identify each individual step, and create an organized pattern to reference later, as well as reduce careless errors (Chakraborty, 2021).

There are also several simple instructional practices and strategies that teachers can use to help alleviate some of the learning difficulties that come with hyperactivity and inattention, which are not necessarily accommodations but rather pedagogical techniques that can have a significant impact on ADHD student learning outcomes (Chakraborty, 2021). Some examples include allowing students with ADHD extra processing time when teachers ask them a question in class, allowing students to tape record the lesson, providing students with both written and oral directions, using visual cues and proximity when an ADHD student is starting to lose focus, utilizing mnemonic devices in instruction, obtaining a student’s attention before giving directions, and emphasizing grading on accuracy as opposed to speed. All of these pedagogical and instructional strategies can help students diagnosed with ADHD maintain their focus in the classroom and are strategies that can be easily implemented during instruction and have a significant impact on academic performance (Cherry, 2021). Strategies such as using mnemonic devices and allowing for extra processing time when asking a question provide a concrete way for students diagnosed with ADHD to organize and process information and recall it more easily later on (Cherry, 2021). Mnemonic devices also give

students diagnosed with ADHD the resources necessary to make large amounts of information more manageable and provide a creative way to process and remember information and maintain focus (Low, 2021a). While studies have been done to test the effectiveness of these accommodations in improving academic outcomes of students with ADHD specifically, the results have been mostly inconclusive (Jerome, 2018); however, all of the strategies and accommodations mentioned are widely accepted as beneficial in the educational community, because the theory behind them has been proven to be effective with other learning disabilities (Brooks, 2022).

Accommodations Specific to Impulsivity

Some experts have said that impulsive behaviors combined with physical reactions are both common warning signs and symptoms of ADHD in adolescents (Saylor & Amman, 2016). ADHD disrupts communication between different sections of the brain, which can lead students with ADHD to display impulsive behavior such as blurting out answers in class or not thinking before they speak, resulting in hurt feelings and other behavioral issues in the classroom (Rodden & Nigg, 2020). The disruption in the thalamus portion of the brain makes it difficult for students with ADHD to read social cues or pick up on body language or other communication signals (C. Miller, 2022). The impulsive behavior that many adolescents with ADHD display can result from comorbidities, such as oppositional defiant disorder, depression, anxiety, or bipolar disorder, but can also result from emotional sensitivity or frustration linked to the disorder itself (Low, 2021b). Regardless of how the impulsive behavior is diagnosed, these behaviors can cause serious problems for adolescents in the classroom (Gaastra et al., 2016). Impulsive behaviors can make it difficult for students diagnosed with ADHD

to interact with their peers and can strain relationships with their peers, teachers, and parents (Low, 2021b); however, there are several accommodations and strategies that can be implemented in the regular education classroom to address impulsivity issues (Rodden & Nigg, 2020).

Behavioral Interventions

Given that children and adolescents spend most of their time in school settings, it is important for educators and school leaders to be aware of evidence-based interventions and strategies to help students diagnosed with ADHD succeed (DuPaul & Stoner, 2016). Social and behavioral issues associated with ADHD are especially important for educators to know how to address because they often cause disruptions during class and can interrupt the learning of other students (Rodden & Nigg, 2020). Social and behavioral issues associated with ADHD are particularly troublesome in adolescents during the middle and high school years. Middle and high school students present a greater challenge to educators than their younger peers due to the increased academic and social pressures associated with adolescence (G. Miller, 2022). Middle and high school students with ADHD must deal with the symptoms and challenges of their disorder, while also coping with mounting expectations for greater behavioral independence and self-regulation (Gaastra et al., 2016). Due to increased societal and peer pressure during adolescence to develop social skills and become more independent, it is especially important for adolescent educators to be aware of and utilize behavioral management strategies and interventions in their classrooms (DuPaul & Stoner, 2016).

The most common and formal behavioral intervention strategy for students with ADHD with extreme behavior issues is the use of a BIP (Schwartz, 2022). A BIP is a

formal document that outlines the student's problem behaviors in the classroom, identifies possible motivations behind the behaviors, presents tangible intervention strategies for the student's teacher to implement, and determines measurable goals for reducing problem behaviors and reinforcing new behaviors (Gaastra et al., 2016). A BIP is developed in collaboration with the student, student's teacher, student's parents, special education teacher, and school administrator and contains multiple components to address the problem behaviors as well as their root causes (Morin, 2023a). The first component of a BIP contains a functional behavioral analysis that is broken down into four components: antecedent, behavior, consequence, and function (G. Miller, 2022). The antecedent addresses the predictable or controllable events that precede the identified problem behavior such as switching classes, starting class, or transitioning between class activities (Schwartz, 2022). The behavior component provides an actionable description of the problem behavior rather than trying to explain the cause. The consequence piece describes what results from the problem behavior and includes observations rather than analysis. Lastly, the function piece includes possible motivations or reasoning behind problem behaviors (Schwartz, 2022).

The second component of a BIP includes the behavior goal developed by the student and other stakeholders involved in the creation of the BIP (Morin, 2022). The behavior goal includes descriptions of replacement behaviors that stakeholders such as the student's teacher and parents will be responsible for teaching and reinforcing with the student (Morin, 2022). The most important piece of the behavior goal is its alignment with the function of the problem behavior. In other words, it is imperative that the goals of the BIP align with the function of the problem behavior. For example, if the problem

behavior is related to lashing out in class, the behavior goal should correlate with a specific intervention or new behavior designed to reduce outbursts (Colorado Department of Education, 2017). Stakeholders involved in the creation of the BIP should also ensure that realistic measures are available to gather data on the success of the goal. Data should also be gathered on both the problem and intervention behaviors to determine if there is a direct relationship between the two, i.e., are the intervention behaviors improving the problem behaviors (G. Miller, 2022).

The third component of a BIP describes how the problem behaviors will be corrected and how the student will be taught the new behaviors (Morin, 2022). This component also addresses who is responsible for teaching and reinforcing the identified interventions whether that be the student's teacher, parents, or both (G. Miller, 2022). Specific intervention strategies including assessment of prerequisite skills or direct one-on-one instruction with the student are also identified in this component of the BIP (Schwartz, 2022). Finally, the teaching component of the BIP also addresses the consequences associated with the student displaying the identified problem behavior as well as the rewards associated with improved behavior (Colorado Department of Education, 2017).

While BIPs are tools commonly used in school settings to address problem behaviors like those associated with ADHD, they are not always effective (Morin, 2022). For example, if the identified student also has an IEP or a 504 plan, the goals contained in either supplemental plan can interfere with or contradict the goals presented in the BIP, rendering the BIP ineffective (Schwartz, 2022). The goals in a BIP are also often too broad or not measurable, limiting the effectiveness of the identified interventions (G.

Miller, 2022). Since BIPs are not always the most effective approach to addressing problem behaviors in the classroom, there are several less formal strategies and interventions that teachers can implement in the classroom to address the problem behaviors associated with students diagnosed with ADHD (College of William & Mary, 2017). Some examples of these intervention strategies include nonverbal supports, using choice as a reward, utilizing periodic check-ins during a lesson, visual and environmental prompts, proximity, and music (College of William & Mary, 2017).

Nonverbal supports such as eye contact or hand gestures can serve to signal students diagnosed with ADHD without disrupting the flow of the class or singling out the student (Colorado Department of Education, 2017). Eye contact or hand gestures can be a subtle way to help students identify problem behaviors and eventually begin to self-regulate those behaviors when nonverbal supports are used consistently (College of William & Mary, 2017). Nonverbal support interventions can also be used to help students diagnosed with ADHD learn to be proactive in identifying their triggers and managing their problem behaviors on their own. For example, a student and teacher could develop nonverbal support for the student to signal to the teacher that they are getting restless and need a break from the current activity without interrupting the flow of the rest of the class or disrupting the teacher (G. Miller, 2022). Nonverbal support interventions also allow teachers to quickly address problem behaviors and defuse them before they escalate into a larger problem or disruption (Abramowitz & O'Leary, 2019).

Visual and environmental prompts such as proximity and music can also be effective behavior interventions for students diagnosed with ADHD (College of William & Mary, 2017). The use of visual prompts such as interactive whiteboards or document

cameras can help engage students diagnosed with ADHD and hold their attention more successfully than some other more traditional methods (College of William & Mary, 2017). Visual and environmental prompts can also help students identify problem behaviors as well as model what positive behaviors look like. Visual cues and music can also help students discreetly identify what behaviors may be appropriate for a particular task or activity and can also be used to model those behaviors (Grohol & Rowe, 2022). Playing or listening to music can help reduce the severity of many ADHD symptoms, as well as increase on-task behaviors by modulating emotional and cognitive states, allowing students to be more aware of their behavior and more easily focus on a task (Martin-Moratinos et al., 2023).

Self-regulation and self-management strategies can also help address the needs of students diagnosed with ADHD and help them identify their own problem behaviors and develop their own strategies on how to regulate them (DuPaul & Stoner, 2016). Self-regulation and self-management strategies are particularly beneficial for adolescent students with ADHD, due to their growing sense of independence and reduced willingness to have the teacher involved in their behavioral interventions due to social pressures and fear of ridicule (G. Miller, 2022). These strategies can also be used to address behaviors associated with being ill-prepared for class or not completing homework, a major issue for adolescents with ADHD (Jangmo et al., 2019). Self-regulation strategies can also be used in combination with academic interventions to improve students' time on task and help them identify what conditions cause them to become distracted or lose focus (Hasan, 2018).

Another formal intervention strategy for adolescents with ADHD that is often

used in conjunction with medication is cognitive behavior therapy (DuPaul & Stoner, 2016). The idea behind cognitive behavior therapy is that a person's actions are significantly influenced by their thoughts and emotions (Gordon & Raypole, 2021). Cognitive behavior therapy is designed to address specific thoughts and emotions that can lead to specific behaviors (Gordon & Raypole, 2021). The goal of cognitive behavior therapy with children and adolescents diagnosed with ADHD is to help students identify their specific emotions or thoughts that cause a particular coping pattern and develop problem-solving strategies to address those thoughts or emotions (DuPaul & Stoner, 2016). Cognitive behavior therapy addresses demoralizing or debilitating thoughts and emotions such as all-or-nothing thinking, overgeneralization, emotional reasoning, or comparative thinking (Sherman et al., 2022). All these thoughts and emotions are associated with negative thoughts that cause thoughts of inadequacy, an inaccurate depiction of reality, or an unfair comparison to another person's successes (Jangmo et al., 2019). Cognitive behavior therapy has been shown to help patients with ADHD identify these specific emotions, understand how they are impacting their decisions, and develop strategies to address identified emotions (G. Miller, 2022). Another piece or strategy associated with cognitive behavior therapy is coaching (DuPaul & Stoner, 2016). Coaching is an intervention strategy that involves helping students diagnosed with ADHD cope with the specific components of their disability that directly impact academic performance (Koemhong, 2020). Coaching utilizes self-regulation strategies to help students with ADHD develop goals to address problem behaviors, set expectations, and achieve both short- and long-term attainable outcomes (Wise, 2021).

Operant Conditioning. Operant conditioning is defined as a method of learning

that uses rewards and punishments to manage behavior. When applied to the classroom, operant conditioning utilizes positive reinforcement to recognize desired behaviors with the desired outcome being that the student continually repeats those preferred behaviors (Meyer et al., 2019). There are five different types of positive reinforcers teachers can utilize in the classroom, including natural and direct reinforcement, social reinforcement, activity reinforcers, tangible reinforcers, and token reinforcement (University of Minnesota, 2021). Natural or direct reinforcement refers to reinforcers that result directly from the positive behavior. For example, a student displaying what is viewed as a positive behavior during a social interaction with their peers will result in the direct reinforcement of more invitations to participate in more interactions. Social reinforcers are those instigated by teachers, other adults, or peers. Exclamations of "good job" or "you did really well" are all social reinforcers that can be especially effective in motivating students diagnosed with ADHD. Activity and tangible reinforcers both refer to external rewards as positive reinforcement for desired behavior. Being allowed to participate in a game or other activity because of a positive behavior or playing with a phone, tablet, or computer are all examples of activity or tangible reinforcers. Finally, token reinforcement refers to awarding points, coins, or tokens for positive behaviors, which have little value as a reward themselves but can be exchanged for something of greater value (University of Minnesota, 2021).

Other examples of operant conditioning might include developing a reward system and utilizing periodic check-ins throughout the course of a lesson. A reward system can help students diagnosed with ADHD reinforce positive behaviors with a tangible system that they can use to self-regulate as well (Grohol & Rowe, 2022). For

teachers, utilizing immediate praise and reward in the classroom with students diagnosed with ADHD is a way to help students identify and repeat positive behaviors (Abramowitz & O'Leary, 2019). Praise and reward in the classroom can also help teachers engage students before their attention starts to drift or other problem behaviors start to creep in (College of William & Mary, 2017). Periodic check-ins throughout the course of a lesson are also a good way to ensure that students diagnosed with ADHD are staying on task and not allowing problem behaviors to impact their focus, engagement, and attention (Grohol & Rowe, 2022). Periodic check-ins not only help regulate behavior but also allow teachers to ensure that students have an academic understanding of the task as well as do not have a lack of understanding of the task or content that is contributing to the lack of engagement or attention being given to the activity or assignment; however, check-ins must be done with precision, as giving an ADHD student attention while a negative behavior is occurring can reinforce that behavior (Abramowitz& O'Leary, 2019).

Positive reinforcement is also a common behavioral intervention for students with ADHD (Tripp, 2022). Students with ADHD differ from their neurotypical peers in their responses to positive reinforcement, punishment, and rewards (Tripp, 2022). Altered sensitivity to rewards and punishments is often a characteristic of ADHD; in other words, students diagnosed with ADHD are not motivated by promises of external rewards or punishments but rather respond best to immediate positive reinforcement (Meyer et al., 2019). Continuous positive reinforcement can be a powerful tool for helping students with ADHD maintain focus in the classroom as well as reinforce positive behaviors (Meyer et al., 2019).

Social Interventions

Students with ADHD often experience issues with inattention, impulse control, and activity levels across multiple environments including home, school, and community (DuPaul & Stoner, 2016). These issues often make peer interactions and developing social relationships difficult for students with ADHD, which is why intervention strategies to address lapses in social skills should also be implemented as part of a long-term treatment plan to address the chronic and potentially detrimental challenges associated with an ADHD diagnosis (G. Miller, 2022). Some strategies that are used to address lapses in social skills include modeling, behavioral reversal, and reinforced practice (Koemhong, 2020).

Modeling is a psychotherapy technique where students learn by watching others. Modeling can be used as an intervention strategy to address specific social behaviors that students with ADHD struggle with by demonstrating how to appropriately interact or behave in a specific social interaction or situation (Mcleod, 2023). Peers should also be used to model social skills in a school setting, as many social scenarios occur outside of the classroom away from adult interaction (DuPaul & Stoner, 2016). Behavior reversal or habit reversal training (HRT) can also be used to address some of the issues and behaviors that impact social interactions for students diagnosed with ADHD (Kelly, 2020).

While HRT is more commonly used to address tics associated with Tourette's syndrome, the strategies associated with HRT can be effective in addressing repeated behaviors as well (Kelly, 2020). HRT normally includes five components: awareness training, competing response training, motivation and compliance, relaxation training, and generalization training. Awareness training involves bringing attention to a specific

problem behavior so the student can develop better self-control, identify specific warning signs of the behavior, and identify situations where the behavior occurs most often (Glowiak, 2023). The next step in HRT competing response training involves coming up with a behavior to replace the problem behavior and developing strategies on how to implement it (Wise, 2021). After a new behavior has been developed, students identify a motivation for changing the behavior by thinking about a problem that results from the behavior (Koemhong, 2020). Relaxation and generalization training are the final steps in HRT to help students develop strategies such as deep breathing or mindfulness to help keep urges to display a behavior at bay and practice new skills in multiple contexts to get students comfortable with the new, less problematic behavior (Glowiak, 2023).

While there are several intervention strategies to address problem behaviors in students with ADHD, behavioral deficits and social deficits specifically are much more difficult to correct than deficits related to practical skills (DuPaul & Stoner, 2016). Social deficits are more difficult to ameliorate because most interventions address gaps in skills rather than performance, and social deficits are an issue across multiple contexts and environments including in the classroom, at home, in the neighborhood, or in other public settings (Wise, 2021). Since social deficits are so difficult to address, the interventions that do exist should be implemented within multiple contexts, including in the classroom and at home (Koemhong, 2020).

Teacher Perceptions of ADHD and Formal Training

Since the passage of the No Child Left Behind Act in 2001, there has been a significant shift in how public schools approach special education (Mader, 2017). Schools are facing mounting pressure from federal, state, and local education agencies to

provide equal opportunities for learning disabled students and to keep them in the general education classroom as much as possible (Smith, 2020). This shift away from learning disabled students receiving most of the instruction from special education teachers has come with limited change in teacher education, meaning general education teachers have more and more learning disabled students, with little to no formal training on strategies and interventions on how to teach learning disabled students. Within the last few decades, the number of special education students who are in general education classrooms for more than 80% of the school day has increased by over 30%, more greatly emphasizing the need for more formal training and education on how to individualize and differentiate instruction for learning disabled students (Mader, 2017). In contrast to the one course general education programs require for certification, teacher education programs in special education average a total of 11 courses in working with students with learning disabilities (Smith, 2020). Special education teachers are adequately equipped to address the unique and individual needs of learning disabled students. Putting learning disabled students in a general education classroom with a teacher who has no idea how to help them is doing a disservice to both the student and teacher because the teacher has limited knowledge and training on how to help these students be successful (Mitchell, 2019).

Less than 20% of general education teachers in a recent survey stated that they felt adequately prepared or equipped to meet the needs of mild or moderately disabled students, like those with ADHD (Mitchell, 2019). Furthermore, only 30% of general education teachers felt that they could adequately teach students with learning disabilities, and only 50% of general education teachers felt as though learning disabled students could perform on grade level. Mitchell's (2019) survey depicts a teaching corps

that feels ill-prepared to teach students with learning disabilities and continues to cling to the outdated notion that students with learning disabilities are not capable of learning (Ward et al., 2020). What is even more concerning is that most teacher education programs contain only one class on how to teach learning disabled students (Smith, 2020).

In another survey of over 1300 teachers, over 30% of respondents stated that they have never taken or received any professional development on how to teach learning disabled students (Smith, 2020). Teacher education programs in all 50 states are lacking the formal training and education to teach students with learning disabilities, especially in today's educational climate.

In a 2018 report compiled by the National Center for Learning Disabilities and Understood.org, including a survey of 1,900 teachers across all geographical regions of the United States, 25% of respondents stated that they believed an ADHD diagnosis was a result of poor parenting (Mitchell, 2019). This survey alone highlights the importance of general education teachers receiving accurate information and training on the learning disabilities and disorders they will face as well as how significant of an impact a teacher's opinions, perceptions, or beliefs can have on the quality of education students receive (Ward et al., 2020). A recent study found that general education teachers receive most of their training on differentiating instruction for students diagnosed with ADHD from personal experience and peer interaction (Lawrence et al., 2017). Teachers are receiving no formal training on working with students with ADHD and, as a result, have inaccurate opinions of these students and are unable to meet their needs in the classroom (Ward et al., 2020). Many teachers believe that students diagnosed with ADHD are

intentionally choosing to display inattentive or hyperactive behaviors, leading to strain on the student-teacher relationship and not providing the accommodations or interventions students need (Fabiano et al., 2013).

Chapter 3: Methodology

Introduction

This study was designed to examine the instructional modifications teachers used with students who had been diagnosed with ADHD. It determined teacher perceptions and examined the extent to which teachers have prior knowledge or formal training in working with these students. Additionally, the study sought to determine if that information impacted the teacher's willingness and/or ability to implement methods and strategies designed to help students diagnosed with ADHD. Finally, this study examined the effect instructional modifications had on the academic achievement of students diagnosed with ADHD within the context of a traditional high school mathematics classroom. The study was conducted using both qualitative and quantitative methods. The effectiveness of instructional modifications for students diagnosed with ADHD on academic performance was determined quantitatively using assessment data and observations and qualitatively using teacher interviews. Qualitative methods, such as teacher interviews, were used to determine what formal training teachers had in working with students diagnosed with ADHD and how that training impacted their ability and willingness to modify their instruction. This chapter discusses the setting for the study; the research design; the role I, as the researcher, played in the study; and the research methods used.

Setting

This study took place in the physical classroom environments of a public South Carolina high school. The school was in the largest school district in the state. The school was also the largest school under the umbrella of the school district. This school was

chosen as the setting for the study for several reasons. First, the school served the largest number of students who received special education services in the district. Second, the school also served the highest number of students in the district diagnosed with ADHD, as a subset of the largest special education population. Finally, the setting of this high school provided the most access to student records, participation from other teachers, and cooperation from administration. I have been a member of the faculty of the school for several years and am a current math teacher.

Using participants from this high school gave me access to the largest sample size feasible for the study, which hopefully equated to more accurate, viable, and reliable findings. Being a part of the school community also led to increased study participation and eliminated many of the hurdles that would have limited access. Being familiar with many of the participants also made the qualitative data analysis process easier because I could more easily pick up on verbal and nonverbal cues that provided more accurate and complete data than a researcher who was unfamiliar with the participants of the study.

Research Design and Rationale

This study aimed to answer three main research questions in relation to the impact of instructional modifications on academic achievement for students diagnosed with ADHD and high school mathematics teachers' perceptions of their abilities to implement instructional modifications effectively.

1. What are high school mathematics teachers' perceptions of their abilities to work effectively to meet the needs of students diagnosed with ADHD?
2. What relationship exists between the utilization of instructional modifications not mandated by an IEP or 504 plan and the average engagement of students

in a high school mathematics classroom?

3. What impact does the utilization of instructional modifications not mandated by an IEP or 504 plan have on the mathematics achievement of high school students who have been diagnosed with ADHD as measured by growth on pre and posttest scores?

The study considered only modifications and strategies not mandated by a 504 or IEP because teachers are required by federal law to implement any accommodation, modification, or strategy listed on a 504 or IEP. Considering modifications, strategies, and accommodations that were mandated would have created issues with data access and the validity of the study. The district where the study was completed would not allow access to IEPs or 504s of students who were not my own, so there would have been no way of knowing what strategies, modifications, or accommodations were mandated. Looking at non-mandated strategies and modifications also allowed me to make some generalizations about high school mathematics students in general rather than just the ADHD population. By employing both quantitative and qualitative methods for data collection, I could follow the most natural path for data collection and develop more complete answers to my research questions than could be accomplished from qualitative or quantitative methods alone. Using both qualitative and quantitative methods also gave a stronger voice to the participants, which allowed me to consider all variables that might have had an impact on student achievement (Almalki, 2016). Mixed methods also allowed me to look beyond the raw numerical data collected and develop a more complete and reliable picture of the findings, which increased the validity of the study. Using mixed methods for data collection also allowed for a better explanation and

understanding of the associations and contradictions presented between the qualitative and quantitative data (Wasti et al., 2022).

The first research question related to teacher perceptions of their abilities to implement instructional modifications for students with ADHD and work with students diagnosed with ADHD and was best answered with both qualitative and quantitative methods. Interviewing teachers who work with students diagnosed with ADHD, as well as observing the instruction of those same teachers, allowed me to experience all the possible variables that might have impacted the data collected firsthand. Qualitative data collected during interviews and quantitative data collected during observations helped me determine the relationship between teachers' perceptions of their abilities to work with students diagnosed with ADHD and the frequency with which teachers integrated instructional modifications into their lessons. Qualitative data collected from interviews and quantitative data collected from observations also provided a complete picture of the relationship between teachers' perceptions towards and prior experiences working with students diagnosed with ADHD and their willingness and ability to implement instructional modifications.

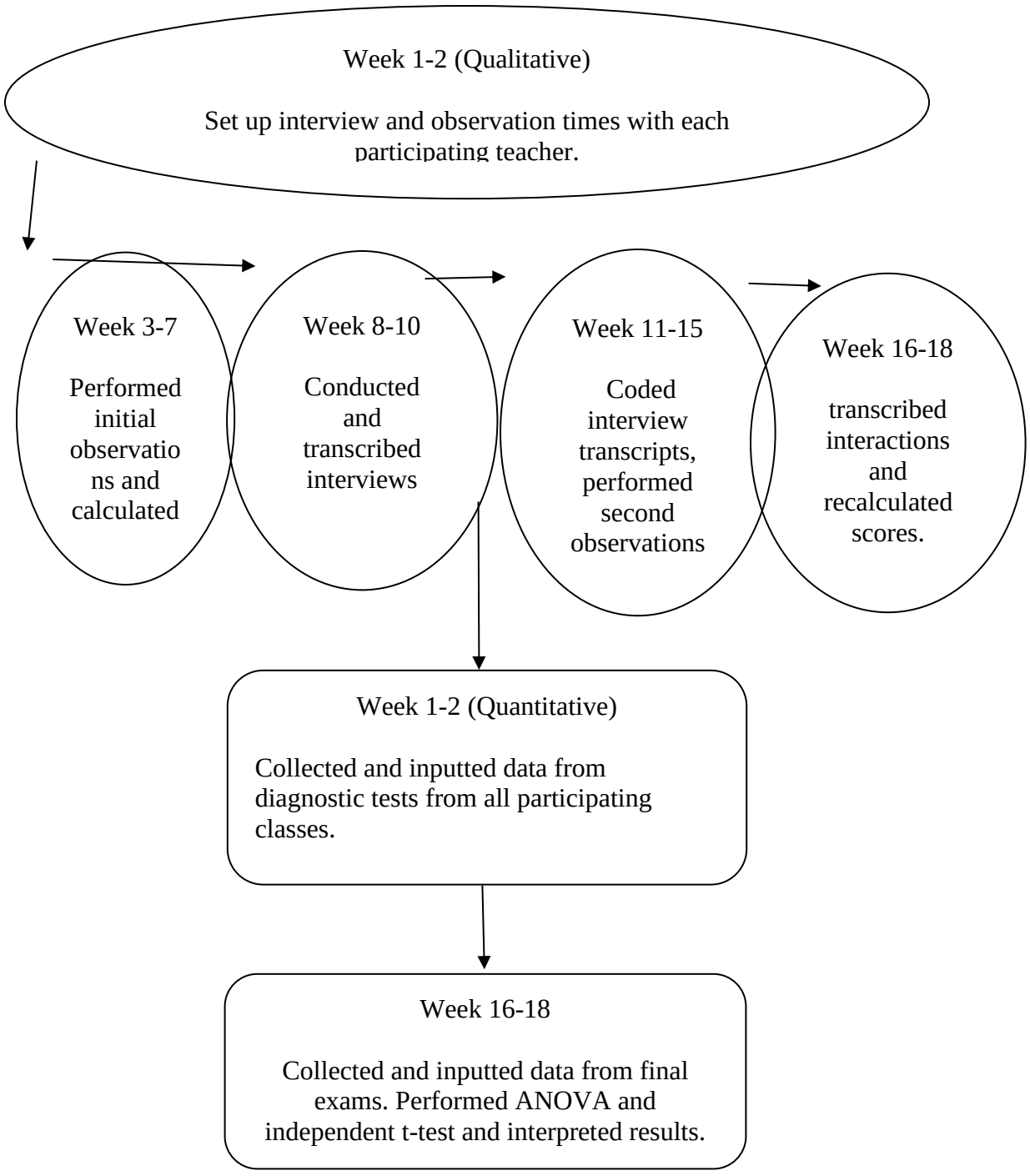
Quantitative methods were appropriate for addressing the second and third research questions dealing with specific modifications and the relationship those instructional modifications had with student achievement and engagement. Student achievement can take on many forms and was the reason multiple quantitative methods were necessary to fully answer the research questions. Average engagement scores collected using the BERI protocol during observations was one data collection method I utilized to collect data on some of the underlying factors of student achievement,

engagement, depth of knowledge, and retention. Since a direct positive relationship exists between engagement and student achievement, the data collected from observations were essential in determining if there was a positive relationship between instructional modifications and student achievement for students diagnosed with ADHD (Delfino, 2019).

The quantitative methodology for this study consisted of the collection and analysis of student scores on a pre and post-assessment, average engagement scores calculated during classroom observations, and the relationship between teachers' perceptions and the average number of modifications or strategies used during observations. The preassessment was the introductory diagnostic assessment given by every math teacher at the chosen site, regardless of the content of the course. All the preassessments from Algebra 1 to Calculus were designed the same way and contained the same type, number, and depth of knowledge questions. The preassessment was designed to help teachers understand students' foundational knowledge as well as what gaps in knowledge were present. The post-assessment was the final exam for each participating course, which was designed in the same way as the preassessment. An example of one of the preassessments used for the study can be found in Appendix B. Figure 2 summarizes the overall research process.

Figure 2

Summary of Research Process



Participant Selection

Math teachers at the chosen high school were invited to participate based on grade and subject taught as well as the number of students diagnosed with ADHD. All Algebra 1, Algebra 2, Algebra 3, Geometry, Pre-Calculus, and Probability and Statistics teachers were invited to participate. All remedial, college prep (CP), honors, and advanced placement (AP) level teachers were also invited to participate. To help ensure that I had the largest and most diverse sample size possible, I had at least one teacher from each subject who participated. I wanted to ensure that data were collected from each of the core math courses to increase the validity of the findings. With all those parameters, all 19 math teachers at the chosen site were invited to participate, and 15 of the 19 participated in the study. Participants were all volunteers and were not compensated for their participation.

Instrumentation

This study utilized a combination of data collection instruments to help ensure a complete, valid, and accurate picture of both quantitative and qualitative data collected. Table 1 provides a summary of the data collection instruments utilized to answer each of the identified research questions.

Table 1

Alignment Table

Research question	Instrument	How data were analyzed
1. What are high school mathematics teachers' perceptions of their abilities to work effectively to meet the needs of students diagnosed with ADHD?	One-on-one interviews Questions to address the research question: 1. Describe your understanding of ADHD. 2. Do you see ADHD as a barrier to a student learning math? If so, how would you describe that barrier? 3. What, if any, formal training did you have in your undergraduate or graduate degree in working with students diagnosed with ADHD? 4. What has been your experience working with students diagnosed with ADHD? 5. How prepared did you feel in your first few years teaching to meet the needs of your students diagnosed with ADHD? 6. Has your confidence level of working with students diagnosed with ADHD changed over the years? (If needed: What accounted for the change?) 7. Describe the strategies and instructional methods you have used in the past while working with students diagnosed with ADHD specifically. 8. Which strategies, if any, have you found to be effective, and why do you think that those strategies worked? 9. Can you describe the ways you think about instructional modifications to help your students diagnosed with ADHD when lesson planning?	Responses from interviews were coded to determine common themes and helped determine teachers' perceptions of ADHD as a disability and their ability and willingness to use instructional modifications for students diagnosed with ADHD.
2. What relationship exists between the utilization of instructional modifications not mandated by an IEP or 504 plan and the average engagement of students in a high	Classroom observations	Classroom observations were conducted using the BERI protocol and average engagement scores were calculated.

Research question	Instrument	How data were analyzed
school mathematics classroom?		
		(continued)
3. What impact does the utilization of instructional modifications not mandated by an IEP or 504 plan have on the mathematics achievement of high school students who have been diagnosed with ADHD as measured by growth on pre and posttest scores?	Statistical tests (One-way ANOVA and independent *t* tests)	Pretest and posttest data were compared to determine if there was a statistically significant difference between the academic achievement of students diagnosed with ADHD receiving modifications and those who did not.

Classroom Observations

During each observation completed for the study, I knew if there were students with ADHD in each class as well as the number of students with ADHD in each class observed; however, I had no knowledge of the students' names or other identifying information that would have led me to know the identity of a specific student. Data were provided to me from the participating district, which consisted of 91 students who had a reported ADHD diagnosis in a 504 or IEP plan. The only identifying information included with the students was their student identification number. Before the start of observations, each participant was asked for a list of student identification numbers for each of the observed classes, with all other identifying information removed. I then cross-referenced the list provided by the participants with the list provided by the district, so that I again knew the number of students with ADHD in each class. All data provided by the district were only reported cases, so there was a possibility that there were students in the class who had an ADHD diagnosis but no 504 plan or IEP.

Classroom observations took place before participants were interviewed to help

limit any observational bias that might have resulted from participants' interview responses. Classroom observations were also used as an additional quantitative data collection instrument in the study because observing students and teachers in the most natural and comfortable environment ensured the most valid and unbiased data collection possible. Classroom observations also served as the most direct form of data collection and addressed the limitations of more indirect methods such as surveys or questionnaires (Choudhury, 2021). Classroom observations also provided the most complete picture of the impact instructional methods had on student achievement, as I was a direct observer of the implementation and was able to collect relevant data immediately. Observing teacher participants in action also allowed me to address the subtle differences in instructional delivery and pedagogical decisions that could have impacted the effectiveness of instructional modifications. In other words, while the modifications being implemented may be the same, there could have been differences in the way they were implemented that could have affected student achievement, which could only be observed and not measured by other methods (Helaine, 2020). The purpose of the classroom observations was to observe instructional modifications in action and determine if there was a relationship between the modifications and student achievement, as defined as engagement and active participation in instruction. The observational data were also used to determine if there was a relationship between teachers' perceptions of the social, emotional, and academic struggles of students with ADHD and the frequency with which they implemented instructional modifications.

I used the Behavioral Engagement Related to Instruction (BERI) observation protocol developed by Lane and Harris (2016) as the observational protocol (see

Appendix C). It was chosen based on the simplicity of implementation and its validity. The BERI was developed by professional educators based on previous research related to student thinking and behavior. The BERI also followed a rigorous editing process in which observations were conducted by multiple observers and discrepancies were discussed and used to modify items included in the protocol. The BERI was also included in multiple peer-reviewed publications and has been implemented in several other research studies (Madsen et al., 2021). Data obtained using the BERI from over 2,000 individual judgments from multiple observers and educational settings resulted in an inter-rater agreement of 96.5%. Its validity was also tested by observing classes of various sizes, 10 to 300 students; varying content areas and levels; and multiple instructors, age groups, and grade levels (Madsen, 2016). There was also a level of familiarity with the BERI as it was used as a piece of my formal evaluations and was included as part of the district's master and mentor teacher training program, in which I participated. I have been trained in the use of the BERI and have used it to complete multiple peer observations in varying content areas. I have also used the BERI to give feedback to a first-year teacher whom I was chosen to mentor, after the district's observational focus for that semester was determined to be student engagement.

Prior to conducting each observation, I requested a copy of the teachers' notes or lesson plans to familiarize myself with the topics being discussed and activities being implemented prior to the observation. Having access to lesson plans prior to the observation also allowed me to lay out a general plan for the observation. For example, if a participant was utilizing a group activity, I could be prepared to observe engagement between students in the group as well as between the teacher and students. I also

completed the observation coversheet included in the BERI (see Appendix D) prior to each observation, which provided notes on my position in the class, the physical classroom environment, a brief description of the instructional methods used, and notes on the students being observed. During each observation, I cycled through each of the students being observed, recording engaged, disengaged, or uncertain behaviors based on the guidelines outlined in the BERI as shown in Tables 2 and 3.

Table 2

Descriptions of Student In-Class Behaviors That Indicate They Are Engaged

	Engaged
Listening	Student is listening to lecture. Eye contact is focused on the instructor or activity and the student makes appropriate facial expressions, gestures, and posture shifts (i.e., smiling, nodding in agreement, leaning forward).
Writing	Student is taking notes on in-class material, the timing of which relates to the instructor's presentation or statements.
Reading	Student is reading material related to class. Eye contact is focused on and following the material presented in the lecture or prepared notes. When a question is posed in class, the student flips through their notes or textbook.
Engaged computer use	Student is following along with the lecture on computer or taking class notes in a word processor or on the presentation. Screen content matches lecture content.
Engaged student interaction	Student discussion relates to class material. Student verbal and nonverbal behavior indicates he or she is listening or explaining lecture content. Student is using hand gestures or pointing at notes or screen.
Engaged interaction with instructor	Student is asking or answering a question or participating in an in-class discussion.

Note. From S. Harris & E. Lane (2015), A New Tool for Measuring Student

Behavioral Engagement in Large University Classes, *Research and Teaching*, *44*(6), 83-91.

Table 3 shows the descriptions and guidelines of disengaged behaviors as determined by the BERI.

Table 3

Descriptions of Student In-Class Behaviors That Indicate They Are Disengaged

	Disengaged
Settling in or packing up	Student is unpacking, downloading class material, organizing notes, finding a seat, or packing up and leaving classroom.
Unresponsive	Student is not responsive to lecture. Eyes are closed or not focused on instructor or lecture material. Student is slouched or sleeping, and student's facial expressions are unresponsive to instructor's cues.
Off-task	Student is working on homework or studying for another course, playing with phone, listening to music, or reading non-class related material.
Disengaged computer use	Student is surfing web, playing game, chatting online, checking email.
Disengaged student interaction	Student discussion does not relate to class material
Distracted by another student	Student is observing other student(s) and is distracted by an off-task conversation or by another student's computer or phone.

Note. From S. Harris & E. Lane (2015), A New Tool for Measuring Student Behavioral Engagement in Large University Classes. *Research and Teaching*, *44*(6), 83-91.

Classroom observations were conducted at the beginning of each quarter or 9-week grading period throughout the study to gather data on student performance. I

observed each participating class twice during the study with 9-week gaps in between observations and utilized the BERI each time. The observational focus was different during each observation. The first observation focused mainly on student behavior and calculating average student engagement scores, while the second observation focused on student-teacher interactions and the teachers' implementation of identified modifications. I also observed classes that utilized the modifications and those that did not. I also looked for a connection between the instructional modifications teachers used and their relationship to participant engagement in each class, as well as compared those connections with classes that did not utilize the instructional modifications for students diagnosed with ADHD. I also emphasized participant engagement during my observations because of their direct link to student learning. When students displayed a high level of engagement in the classroom, they were more likely to excel academically, utilize higher-order thinking skills, and make connections to prior learning experiences. Students who were engaged in a lesson were much more likely to make deep connections to the material and content as well as develop the ability to apply those connections to future content and material (Sutton, 2021). I also looked for several specific accommodations and modifications during the classroom observations. For example, I looked for teachers who gave participants guided notes, allowed additional time to process when questioning, provided both oral and written directions before an activity, and allowed for an element of participant choice. I also looked for behavioral interventions as well using the BERI to observe how and how often teachers redirected disengaged behaviors identified in the BERI and what impact redirection had on student performance. All these modifications, accommodations, and interventions have been

linked to increased engagement and academic performance in the ADHD student population (Boyle et al., 2015).

Interviews

While this study utilized a mixed methods approach to help ensure the most accurate and complete information possible, the qualitative methods included one-on-one interviews. One-on-one interviews were deemed appropriate for this study because of their ability to provide detailed context to highly personal, open-ended questions (Houston, 2022). Structured individual interviews also allowed for more flexibility in the data collection process and allowed me to gather a more complete picture of the participants' responses, as opposed to a survey or questionnaire. The use of in-person interviews in this study allowed me to observe and catalog additional data such as body language, tone of voice, and behavior that would have been otherwise unobservable by alternative qualitative methods. By conducting in-person and individual interviews, I was able to gather more complete and valid data from participants while also allowing for a controlled environment and more reliable results than other qualitative methods such as a phone interview, survey, or questionnaire. A structured interview format was also determined to be most appropriate since every participant was given the same questions to ensure that the same type of data was gathered from each participant. Using a less structured interview format could have provided incomplete or inconsistent data that would have impacted the validity of the findings (Clements, 2021).

Development of Interview Questions. I began the process of developing the interview questions by analyzing the research questions and narrowing down exactly what answers and information I was trying to gain from the participants. The standard

process for qualitative research using interviews of beta testing the questions or consulting a panel of experts was not feasible for this study for two reasons. First, I was not able to find a similar study to draw from, and the study had to be completed within a single academic semester, making testing the interview questions not a viable option. By narrowing the focus of the interviews to determining what formal training teachers had received, their personal experiences with working with students diagnosed with ADHD, and their familiarity with strategies to help these students, I was able to develop simple, straightforward questions that elicited longer responses. By designing questions to elicit longer than one- or two-word responses, the interviews become more of a conversation than a formal question and answer (Jain, 2021). By encouraging a natural conversation, the hope was that the participants would feel more at ease and, in turn, give more honest and complete answers. I also designed the questions with follow-up questions built in to encourage lengthier and more elaborate responses. I also designed the questions to be as direct and simple as possible to limit the confusion of the participants and any unusable data that might have resulted from a poorly worded or overly technical question (Clements, 2021).

The questions used for the in-person interviews were developed with the intended purpose in mind: to gather data from high school math teachers about their experiences and formal training in instructing students with ADHD. Since the goal of the interviews was to gather insight into teachers' knowledge and personal experiences with a specific subset of students, broad open-ended questions were determined to be most appropriate (Jain, 2021). Open-ended questions allowed me to gather insight into each participant's personal experiences and a more complete picture of how each teacher's background may

have impacted their interactions with their students diagnosed with ADHD (Lassen, 2021). Table 4 shows the interview questions asked of each participant.

Table 4

Interview Questions

Questions asked of participants
1. Describe your understanding of ADHD.
2. Do you see ADHD as a barrier to a student learning math? If so, how would you describe that barrier?
3. What, if any, formal training did you have in your undergraduate or graduate degree in working with students diagnosed with ADHD?
4. What has been your experience working with students diagnosed with ADHD?
5. How prepared did you feel in your first few years teaching to meet the needs of your students diagnosed with ADHD?
6. Has your confidence level of working with students diagnosed with ADHD changed over the years? (If needed: What accounted for the change?)
7. Describe the strategies and instructional methods you have used in the past while working with students diagnosed with ADHD specifically.
8. Which strategies, if any, have you found to be effective, and why do you think that those strategies worked?
9. Can you describe the ways you think about instructional modifications to help your students diagnosed with ADHD when lesson planning?

Establishing a comfortable and safe environment for participants was also a consideration during the interview process. All interviews were conducted at a time of the participants' choosing and were conducted in the participants' classrooms, allowing for a more familiar environment. Creating a safe and comfortable environment was important to encourage complete and honest responses without the fear of judgment or repercussions. All interviews were also conducted in private spaces, with only me and the

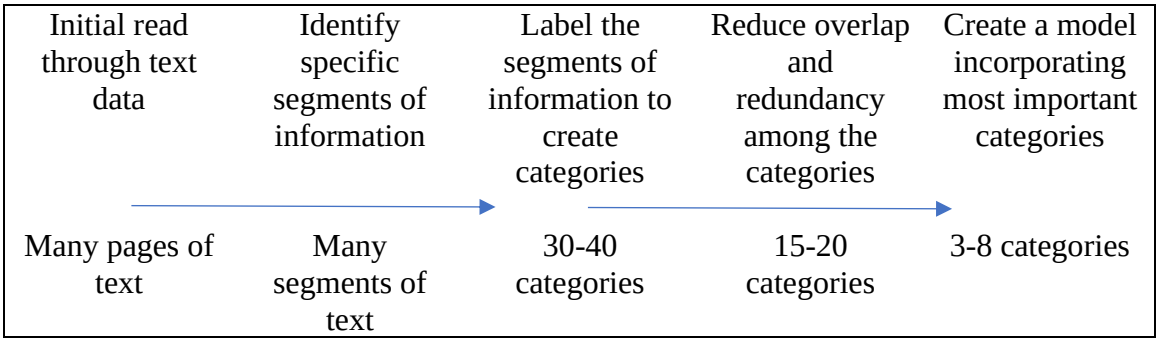
participant present, again to maximize the comfort level of the participants (Cassady, 2021). The interviews with teachers who agreed to participate in the study were recorded, with participant consent, so that I had the opportunity to review and code the qualitative data collected. I interviewed all teacher participants who agreed to take part in the study, including those who utilized instructional modifications for students diagnosed with ADHD and those who did not. I also transcribed and coded the responses from participants to identify common themes. I then used the coded qualitative data to determine if there was a relationship between participant responses and their implementation of instructional modifications.

Qualitative Data Analysis

Data analysis for the individual interviews took place after each interview. Data collected from interviews were coded using an inductive lens in which I let the data speak for me. Inductive coding means creating original codes from the collected data itself, rather than trying to make the data fit into predetermined themes or categories. This form of coding is popular among researchers because it shows the reader that the researcher is willing to listen to what each participant has to say rather than trying to manipulate their words to fit inside a predetermined box (Saldaña, 2021). Figure 3 shows a general outline of the inductive coding process.

Figure 3

Coding Process in Inductive Analysis



Note. From J. Creswell (2002), *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*, p. 266, (1st edition), Pearson Education.

Table 5 gives a more detailed outline of how I completed the inductive coding process for each interview.

Table 5

Detailed Inductive Coding Process

Research question	Instrument	Analysis method	Why
1. What are high school mathematics teachers' perceptions of their abilities to work effectively to meet the needs of students diagnosed with ADHD?	Interviews	1. First cycle: inductive coding 2. Second cycle: created categories 3. Third cycle: narrowed categories 4. Fourth cycle: created final categories or themes based on most important categories	I highlighted and coded dialogue to give insight into participants' overall perceptions of working with students diagnosed with ADHD.

Interview Analysis

The first step in the data analysis process for each interview was to transcribe the recordings into written dialogue. By transcribing each interview recording, I was able to ensure that participants were not misquoted and data collected were accurate (Jacobs, 2022). Coding each participant's data after each individual interview also helped prevent data sets from influencing one another and providing contrasting data (Saldaña, 2021). After each recording was transcribed, I followed the inductive coding process described previously. This initial analysis of each interview transcript allowed me to get the essence of each participant's responses and quickly identify key phrases or terms that required closer analysis (Crosley & Jansen, 2022).

In the first round of coding, I utilized inductive coding to code and analyze data from interview transcripts. Inductive coding approaches raw qualitative data from scratch rather than approaching data with a preset codebook. In other words, inductive coding lets the data speak for itself and allows the researcher to develop categories and themes as they go (Medelyan, 2022). The overall goal of the inductive coding process was to condense raw qualitative data into a presentation and/or description of categories most relevant to my research questions. The first reading of data in the inductive process included consideration of the multiple meanings inherent in the text and identified portions of the text that carried meaningful data points to me (Thomas, 2006).

In the second round of coding, I created categories based on the meaningful data points identified in the initial reading of the interview transcripts. The following categories emerged once the interviews were completed:

- personal experiences with students diagnosed with ADHD

- knowledge of academic struggles faced by students diagnosed with ADHD
- knowledge of ADHD as a disorder
- overall attitude towards teaching

Since perceptions are influenced by personal experience, prior knowledge, and bias, it was important to develop categories around those data points.

In the third round of coding, I narrowed down the identified categories looking for pieces of text that could be placed in multiple categories and reduced those categories into more specific themes (Saldaña, 2021). For example, responses specific to the formal training and education participants have received in working with ADHD, as well as their previous experiences in the classroom, provided relevant data on how well-equipped participants were in helping students diagnosed with ADHDs' academic success and were combined into more inclusive themes. The following themes resulted from identified categories in the previous round of coding:

- personal experiences
- training
- education

Finally, in the last reading of the text, I created a model that incorporated a few of the most important categories based on the overachieving themes that were identified in the previous round (Thomas, 2006). The goal of the final round was to create categories that were as specific as possible while still encompassing all of the overarching themes. For example, focusing on responses specific to how participants perceived challenges faced by students diagnosed with ADHD and their thought process when lesson planning gave insight into how they applied the knowledge they had to their instructional design

and could be combined into its own category.

Quantitative Data Analysis

Quantitative data were collected from the diagnostic tests as well as using the BERI protocol during classroom observations. The data collected on engagement and modifications during the observations were also compared to the perceptions of each participant derived from the interview data.

Classroom Observations

Data analysis of each classroom observation involved inductive coding and quantifying and scoring the data collected using the BERI observation protocol. The scoring protocol is described next.

During each observation, I assigned observation points based on the guidelines outlined by the BERI. The BERI scoring protocol, found in Appendix C, defines an observation interval as a 2-minute chunk of instructional time. During each observation interval, I identified the number of students displaying engaged behaviors and the number of students displaying disengaged behaviors. At the end of each observational interval, I assigned an overall score based on the number of students displaying engaged behaviors during that observation interval, i.e., if 17 students were engaged and eight were disengaged, that observation interval received an overall score of 17/25. At the end of each observation, the average student engagement score was calculated based on the score from each observation interval. Each overall score from each observation interval was also plotted to help identify which pieces of the lesson students were most engaged in and which parts of the lesson students were most disengaged in (Lane & Harris, 2016). Following the scoring process outlined in the BERI allowed me to identify how specific

modifications implemented by teachers throughout the lesson impacted student engagement and to quantify how often students were engaged and what types of activities or actions were taking place during that time. I also knew both the number of students diagnosed with ADHD in each class and the specific students with IEP or 504 accommodations as a result of an ADHD diagnosis; however, I observed the behaviors of all students in the class.

During the observations, I focused on body language, posture, physical interactions with objects, and other nonverbal forms of communication. Focusing on nonverbal elements helped me develop a complete picture of student engagement and pinpoint specific behaviors, gestures, or movements that correlated with engagement (Saldaña, 2021). Another point of emphasis during the observations was student-teacher interactions, allowing me to see the immediate impact identified instructional modifications had on the level of engagement and participation in identified students. By translating the student-teacher interaction observational data into textual descriptions, I was also easily able to compare the observational data collected from teachers who used the instructional modifications to those who did not. The textual descriptions of the observational data also allowed me to directly compare the number of engaged and disengaged students between the two observation groups.

Pre and Posttests

Quantitative data were collected from the diagnostic tests given to each student at the beginning of each course and from the final exam given in each course. A sample of a diagnostic test can be found in Appendix B. The diagnostic tests had a similar structure to that of the final exam, with the only difference being the number of questions and scope

of content covered. The diagnostic exam for each participating course including Algebra 1, Geometry, Algebra 2, Algebra 3, Pre-Calculus, and probability and statistics, included 20 questions: 10 multiple choice and 10 free response. Each multiple choice and free response question had varying levels of difficulty and required varying depths of knowledge ranging from basic recall questions to application. Scores from each participant were collected and inputted into spreadsheets, separated by those who received modifications or accommodations and those who did not. I then calculated the measures of central tendency including mean, median, and mode for each. At the conclusion of the study, I followed the same data collection process used for the diagnostic exams for the final exam. The final exams were structured the same way as the diagnostic exams with half multiple choice questions and half free response questions. The final exam questions also ranged in difficulty from basic recall to questions that required the application of prior knowledge. Both the diagnostic test and final exams contained similar structures, types of questions, and varying depths of knowledge to help limit variables that could have impacted the data collected. Giving similar assessments also greatly reduced the possibility of skewed or inaccurate data and helped improve the validity of the study (Urdan, 2017).

Once all assessment data were collected, I used a one-way analysis of variance (ANOVA) to generate an F-ratio that was used to determine a *p* value that helped determine if there was a statistically significant difference between the means of the samples. A probability or *p* value of less than .05 will allow me to reject the null hypothesis and state that there was a statistically significant difference between the mean scores of students diagnosed with ADHD who received modifications or

accommodations and those who did not (Urdan, 2017).

A one-way ANOVA was chosen to compare the means of the assessment data to try and limit the possibility for a Type 1 error, or rejecting the null hypothesis, when it is actually true (Bhandari, 2021). Using an ANOVA as opposed to multiple independent *t* tests allowed me to compare the means of multiple groups at once, rather than having to compare each group individually. In other words, using an ANOVA allowed me to compare the mean scores of students diagnosed with ADHD to multiple other groups without having to perform a *t* test for each one (Mishra et al., 2019). While performing *t* tests for each comparison would work, each test would produce a different *p* value, increasing the chance of committing a Type 1 error, because I would have had to make multiple decisions on statistical significance as opposed to just one with an ANOVA (Urdan, 2017).

One issue with using the ANOVA as opposed to an independent *t* test was that the F-score resulting from the ANOVA only stated that somewhere along the line there was statistical significance; it did not state which groups' differences in means were statistically significant. To determine which differences in means were statistically significant, I had to use a post-hoc test. The post-hoc test allowed me to compare individual groups to determine which ones were statistically significant. Post-hoc tests were similar to independent *t* tests, with the one difference being that post-hoc tests kept the Type 1 error rate constant by accounting for the number of groups being compared, limiting the probability of making a Type 1 error (Urdan, 2017).

I subtracted the score on the diagnostic assessment from the score on the final exam to produce a growth score for each student. The means of the growth scores

produced in each of the four identified groups were what was compared using the ANOVA. The four categories in which data were separated included students diagnosed with ADHD who received modifications, students diagnosed with ADHD who did not receive modifications, non- students diagnosed with ADHD who received modifications, and non- who did not receive modifications. Data were considered based on the overall growth score rather than the overall score because of the varying academic levels of the participants used, i.e., remedial, CP, and honors. For example, a participant who moved from a score of 50% on the diagnostic to a score of 76% on the final exam was considered to have better overall growth than a participant who moved from 80% to 91%, even though that participant received a higher overall score. The score on the diagnostic test given at the being of the study was compared to the score on the final exam for each of the four groups representing a paired sample (Urdan, 2017). The results of both the ANOVA and independent *t* tests determined if there was a statistically significant difference between the overall growth of the four groups considered.

Conclusion

This study focused on the academic impact of instructional modifications for students diagnosed with ADHD within the context of a high school mathematics classroom. This study also looked at the extent to which high school mathematics teachers are knowledgeable of the struggles students diagnosed with ADHD face and how teachers could adjust their instructional methods to aid in these students' successes. This study utilized a mixed-methods approach that collected data from multiple qualitative instruments as well as quantitative data from assessment scores. Interviews and classroom observations were utilized to gather relevant data from participants and

answer the posed research questions.

Chapter 4: Results

The theoretical framework for the research in this study was designed to examine the achievement of students with ADHD. Specifically, the research focused on the role teachers play in helping students diagnosed with ADHD address the social, emotional, and learning challenges they face in the context of a high school mathematics classroom. The study was also designed to determine teacher perceptions of ADHD and to examine to what extent teachers have prior knowledge or formal training in working with students diagnosed with ADHD. Additionally, the study determined if prior knowledge or formal training impacts a teacher's willingness and/or ability to implement methods and strategies designed to help students diagnosed with ADHD. Finally, this study considered what effect instructional modifications have on both the academic achievement and engagement of students diagnosed with ADHD. Classroom observations, one-on-one interviews, and assessment data were used to answer the following research questions:

1. What are mathematics teachers' perceptions of their abilities to work effectively to meet the needs of students diagnosed with ADHD?
2. What relationship exists between the utilization of instructional modifications not mandated by an IEP or 504 plan and the average engagement of students in a high school mathematics classroom?
3. What impact does the utilization of instructional modifications not mandated by an IEP or 504 plan have on the mathematics achievement of high school students who have been diagnosed with ADHD as measured by growth on pre and posttest scores?

Participants

A total of 15 teachers participated in this study. Two observations and an interview were conducted with each participant. The first observation focused on student engagement and calculating average engagement scores, while the second observation focused on student-teacher interactions and specific instructional modifications used. Table 6 shows a summary of the average of the participants' years in education and the highest level of education achieved. All subjects taught at the sight were represented, including Algebra 1, Algebra 2, Geometry, Pre-Calculus, Calculus, and Statistics, as well as all levels including CP, honors, and AP.

Table 6

Study Participants

Total participants	Average years of experience	Participants with bachelors	Participants with masters	Participants with doctorate
15	15.4	3	11	1

Each of the 15 participants in Table 6 participated in the entire study, including both observations, interviews, and assessment analysis.

Research Question 1: What Are Mathematics Teachers' Perceptions of Their Abilities to Work Effectively to Meet the Needs of Students Diagnosed With ADHD?

The purpose of this study was to provide insight into high school mathematics teachers' perceptions of ADHD and determine if the teachers' prior knowledge and/or formal training had an impact on their abilities to successfully implement strategies and modifications designed to help level the playing field for students diagnosed with ADHD. This study was also designed to determine if there was an association between the

number of modifications and strategies used during instruction and student engagement. This first research question was developed to determine teachers' attitudes towards ADHD and whether or not they consider ADHD a barrier to a student learning math. This question also helped determine what formal training and prior knowledge high school mathematics teachers had in regard to ADHD as a disorder as well as strategies for working with students diagnosed with ADHD specifically.

Interview Data

In order to answer the first research question in the study, each of the 15 participants completed a nine-question interview. Each of the participants was asked the same nine questions, and each interview was recorded for the purpose of transcribing responses. After each interview was transcribed, inductive coding was used to highlight meaningful parts of the qualitative data collected. A second reading of each transcript created specific codes for the data, while a third narrowed the codes into categories. The fourth and final reading of each transcript turned specific categories into overarching themes that emerged from the data. Table 7 provides a summary of the coding process, the categories that were used, and the overarching themes that emerged.

Table 7

Summary of Qualitative Coding

Broad codes	Narrowed categories	Specific categories	Overarching themes
1. Personal experiences 2. Prior knowledge 3. Attitude 4. Perceptions 5. Training 6. Education 7. Methods 8. Pedagogy 9. Modifications	1. Personal experiences with students diagnosed with ADHD 2. Knowledge of ADHD 3. Formal training and education in ADHD 4. Instructional modifications and strategies 5. Overall attitude towards teaching	1. Understanding of challenges faced by students diagnosed with ADHD 2. Instructional modifications used to help students diagnosed with ADHD 3. Perception of abilities to work with students diagnosed with ADHD	1. Little understanding of definition of ADHD 2. Lack of confidence in working with students diagnosed with ADHD early in their careers 3. Increased level of confidence with experience 4. Rudimentary understanding of instructional modifications designed to aid students diagnosed with ADHD 5. Lack of formal training and education in working with students diagnosed with ADHD. 6. Limited knowledge of academic and social challenges faced by students diagnosed with ADHD.

The interview questions were intentionally designed to be open-ended in order to allow each participant to present their own definition of ADHD as well as draw from their own prior knowledge and experiences working with students diagnosed with ADHD. These six overarching themes emerged after analyzing the qualitative data collected from each of the 15 interviews: Participants consistently had

- little understanding of the definition of ADHD,10

- a lack of confidence in working with students diagnosed with ADHD early in their careers,
- increased levels of confidence with experience,
- a rudimentary understanding of instructional modifications designed to aid students diagnosed with ADHD,
- a lack of formal training and education in working with students diagnosed with ADHD, and
- limited knowledge of academic and social challenges faced by students diagnosed with ADHD.

Little Understanding of the Definition of ADHD. Of the 15 participants interviewed, only one mentioned anything about ADHD being connected to the chemistry of the brain. While the majority of participants mentioned the inability to focus as a symptom of ADHD, their knowledge of the disorder itself did not go much beyond that. Most participants had a rudimentary understanding of ADHD and described it as a symptom, thing, or personality trait all centered on the idea of not being able to focus or pay attention for extended periods of time. For example, one participant described their understanding of ADHD as "a person who has difficulty concentrating on tasks or gets distracted easily." Another participant's response was similar: "Something causes kids to not be able to focus, and they get distracted very easily." Similarly, another participant stated that ADHD causes students to "struggle to focus, and most of the time are hyperactive." Only one participant had any knowledge of what causes ADHD or how it is diagnosed; and all but one response indicated a very limited understanding of the symptoms, signs, behaviors, and emotional signs associated with ADHD.

Even participants who were diagnosed with ADHD themselves or had a family member who was diagnosed with ADHD could only provide an elementary definition or understanding at best. One participant who was diagnosed with ADHD as an adult described their understanding in a similar way as the other participants, stating that ADHD is a "symptom that young children or even adults may have where they have difficulty focusing." Another participant, who had a family member diagnosed with ADHD, also described their understanding in a similar manner, stating that "a student that has ADHD is going to be unfocused in class." The responses received from participants made it clear that it is not uncommon for teachers to have limited knowledge or understanding of the most common disorder faced by their students.

There was one participant, however, who demonstrated a more thorough understanding of the definition of ADHD:

> ADHD, from what I understand, is a kind of neuron-related thing, where your brain can change based on your environment. ADHD has to do with the working memory. So, the analogy I use is that if your brain is a bookshelf, people with ADHD have less space to store stuff at one time so it is harder for them to keep up with what they are doing at any one point in time.

A Lack of Confidence Working with Students Diagnosed with ADHD Early in Their Careers. All 15 of the participants believed they were ill-prepared to meet the needs of their students diagnosed with ADHD in their first few years of teaching. The consensus among all participants was that the first few years of teaching were overwhelming. One participant stated,

> I felt like I was thrown to the wolves in my first few years teaching. I spent four

> years studying theories, different lesson planning techniques, and tips for classroom management, but nothing could prepare me for actually being in front of a class. To say it was overwhelming would be an understatement. I felt like I had no idea what I was doing and my students knew it. It was all I could do to keep my head above water and deliver the content, I didn't have the mental capacity to consider anything else.

Another participant shared a similar view of their first few years, stating,

> My first few years of teaching were rough. I feel like every first-year teacher goes through it, but at that point in my academic career, I hadn't had any formal training in education. I just majored in math in college, so I knew the content backwards and forwards, but actually teaching it was another story. I was overwhelmed, to say the least, and I knew that I was not doing a very good job differentiating instruction for my ADHD and other special ed students, but it was all I could do to just get by.

Other participants mentioned less about being overwhelmed and more about being ill-prepared to differentiate their instruction for all the various learning styles. One participant focused more on their teaching techniques during their interview:

> My first couple years of teaching I pretty much just used direct instruction. I stood up at the board and worked through example problems and then gave the students problems to work on their own. I didn't really utilize any other teaching methods until I had been teaching awhile. I knew that I was not really teaching the best way for my students, especially my students diagnosed with ADHD, but it was the way that made me feel most comfortable, and that was most important to me

> in the first few years.

Another participant mentioned,

> Direct instruction was really the best method for me to start. That was how I was taught in school, and that's how we were taught in all our college coursework as well. I tried to utilize some other methods to help out my students diagnosed with ADHD, but I was not as familiar with them, so it was difficult for me to implement. I really feel as though if I had more experience using those methods, I would have been more effective working with those students in my first couple years.

While there were several reasons given for why the participants lacked confidence in their abilities to work with students diagnosed with ADHD in their first few years of teaching, all the participants had a perceived sense that they were not prepared for the challenge of meeting the needs of all their students.

The consensus from all participants was that they were not prepared to meet the needs of any of their students during their first few years of teaching, including students diagnosed with ADHD. In fact, all participants admitted that they were in pure survival mode during their first few years of teaching, focusing completely on content and classroom management and figuring out how to teach before considering all of the other stuff that comes with teaching. One participant stated, "To be honest, my first few years I didn't think about much, I was not prepared, I was just trying to get through." Another participant shared a similar viewpoint, stating,

> I really don't remember ADHD standing out as a thing because I was so overwhelmed with what I was teaching, how I was teaching, and how I was going

> to manage a class. The big picture things are what I focused on the first few years. I would not have been able to tell you which kids had ADHD or be able to point them out, I just knew that I had some that were wild.

All the participants shared feelings of being overwhelmed, lost, or in over their heads in their first few years of teaching. None of the participants felt prepared to teach in general, much less modify their teaching to meet the needs of their diverse student populations. All the participants adopted a learn-as-you-go mentality in their first few years, and all believed experience was the best way to learn how to meet the needs of their students. A participant stated, “I didn’t think about anything but surviving my first few years teaching, I had to learn on the fly.” Another participant shared, “Unless a student had specific accommodations, I had no idea how to help them, I was winging it.” Some participants also shared how they were not prepared to meet the needs of their students in their first few years of teaching because they thought direct instruction was the only way to teach. One participant said,

> When I first started teaching, I thought that all of my favorite and most effective teachers growing up used more of a direct or lecture style of instruction. I kind of thought in my first few years that was the way to teach. It was my job as the teacher to stand up in front of the class and lecture and my students were just supposed to listen and learn.

Twelve of the participants shared that they changed a lot both personally and professionally in their first few years of teaching. The trial-and-error method they had adopted applied not only to their pedagogy but to how they interacted with their colleagues, administration, and students as well.

Increased Level of Confidence With Experience. All the participants shared that their confidence levels in working with their students diagnosed with ADHD have changed for the better throughout their teaching careers. While all the participants referenced an increased level of confidence working with students diagnosed with ADHD, there were several reasons given for why they felt more confident. Some participants credited the boost in confidence to their ever-changing teaching styles and experience working with students diagnosed with ADHD. One participant stated,

> Having an ADHD diagnosis, myself, I know how those students learn best, and I believe that I do a lot better teaching those students now. When I first started teaching, I used mostly direct instruction, but through the years I have transitioned into a more student-centered approach. It was quickly evident to me that what I was doing was not working and something had to change. I have noticed that I have a lot more engagement now that I have moved away from direct instruction as much as possible.

Another participant said,

> I feel like anything else; we learn a lot by trial and error. Once I got some experience under my belt, I slowly started trying new teaching methods and found things that worked and things that didn't. Learning on the fly is really a pretty common approach for me in the classroom.

One participant also shared that experience built their confidence, stating,

> I definitely feel like I am more confident now than when I first started teaching simply because I am more comfortable in the classroom. Now that I have been teaching the same content for so long, I am able to experiment with new

> approaches and techniques. I feel like I have been able to reflect on my practice a lot more now that I have gotten in the swing of things, which has allowed me to shift my thinking when something does not quite go as planned.

Another participant stated,

> I don't think of ADHD as much of a barrier anymore, because of my current teaching style. I feel as though the way I teach now is much more conducive to learning. I think about all of my students while I am lesson planning, and am able to differentiate when I need to, now that I am comfortable with my content and have been teaching for several years.

Another participant said,

> I have gained confidence over the years working with students diagnosed with ADHD, simply because I have had experience doing it. I know which students have ADHD and which ones have accommodations, and I have enough teaching experience now, that I can adjust how I teach a topic or try an activity that might not have in the past.

Eleven of the participants also credited their increase in confidence to additional trainings and professional developments they have attended. One participant stated that they were more confident now because they have an "increased level of understanding of the academic struggles students diagnosed with ADHD face." Another participant shared a similar view stating that they attended multiple professional developments on learning and cognitive disabilities, one of which focused on ADHD. Yet another participant said that those professional developments "broke down the complexities of working with students diagnosed with ADHD and made it exponentially easier for me to work with that

student population." Two participants also attended the same professional development and had similar things to say about how it impacted their confidence in working with students diagnosed with ADHD. One participant said that the training gave them "tangible and simple to implement resources" that made working with students diagnosed with ADHD easier, while the other participant stated that the professional development gave them a lot of "insight into what causes ADHD and what it is which made it easier for me to think about how I could adjust my instruction."

Four of the participants who shared that they believed their confidence came from professional development and formal trainings they attended all mentioned the same training. These participants all mentioned a training mandated by the district where a psychologist and special education teacher provided professional development on working with students diagnosed with ADHD specifically. One of the four participants called the training "eye-opening," while another participant stated, "I got a lot out of that training, and it really gave me some tangible resources to immediately implement into the classroom." Another of the four participants also mentioned the training, saying, "I learned a lot about how to approach my students diagnosed with ADHD, which was helpful." Similarly, another of the four participants stated, "I liked that the whole thing was scenarios rather than a PowerPoint of theories; it was nice to actually have something I could implement immediately."

Another reason participants gave for their increased confidence in working with students diagnosed with ADHD was their increased confidence in their teaching abilities in general. One participant stated, "I am just a better teacher now, that's why I feel more confident." Another participant gave a similar explanation, saying, "I don't have to think

about as much now with teaching, so now I have the mental capacity to think about things like that."

Similarly, while all participants discussed their limited knowledge of ADHD entering their first few years of teaching, several of the participants reported experience turning into positive experiences working with their students diagnosed with ADHD. One participant said,

> My personal experience is that a lot of the students I have are diagnosed with ADHD. I enjoy working with students diagnosed with ADHD because it's kind of how my brain works as well. I am not a sit-and-direct instruction kind of person; I enjoy doing a bunch of activities. I feel as though my teaching personality matches the needs of an ADHD student.

Another participant stated that they tend to gravitate towards students diagnosed with ADHD because "it forces me to be a better teacher, working with students diagnosed with ADHD requires me to utilize all my tools and I love to be challenged." Five participants shared this view that working with students diagnosed with ADHD challenged them, which is why the majority of their personal experiences working with students diagnosed with ADHD were positive. One participant said that students diagnosed with ADHD "keep me on my toes and challenge me to change things up in my lesson." Another of the five participants stated that "the challenge of working with students diagnosed with ADHD keeps my class interesting." Enjoying the challenge presented by students diagnosed with ADHD was a common theme among participants but was not the only viewpoint expressed.

One participant shared a different viewpoint describing working with students

diagnosed with ADHD as “exhausting” and that the constant redirection required becomes “tedious and frustrating, I just want to be able to stand at the board and teach.” Some participants also described their personal experiences working with students diagnosed with ADHD as limited, because they had difficulty distinguishing students diagnosed with ADHD from other students unless they had a 504 or IEP that explicitly stated a diagnosis. For example, one participant stated that “unless I have talked to the parent directly or they have an IEP or 504, I really have no idea if a student has ADHD.” Another participant also described their personal experiences working with students diagnosed with ADHD as “difficult and exhausting,” stating that “it is hard to not let my frustration with a student not paying attention show on my face.” Personal experiences were split pretty evenly between positive and negative among the participants; however, it was interesting to see how the reasons why a teacher found working with students diagnosed with ADHD enjoyable or not often overlapped. For example, two participants both described their experiences working with students diagnosed with ADHD as “frustrating and difficult,” but one participant stated that “I love and enjoy the challenge associated with teaching students with ADHD,” and in contrast, the other participant stated, “There are already enough challenges in teaching, working with students diagnosed with ADHD just adds to the pile.”

Rudimentary Understanding of Instructional Modifications Designed to Aid Students Diagnosed with ADHD. While all participants stated that they had increased confidence working with students diagnosed with ADHD, many of them struggled to name specific instructional methods they have used to work with that student population specifically. All participants could name some strategies that have been shown to be good

practice with all students, but only three were able to produce modifications or strategies for ADHD specifically. The most common strategy mentioned was proximity, meaning standing close to a student to ensure that they remain on task. While this is a strategy taught in teacher preparation programs, it is designed to be used with all students and not a specific subset. One of the three participants who was able to present specific strategies and modifications provided some insight into why they used those specific modifications or strategies. This participant stated,

> I teach all my students as if they have ADHD, just because I have found it to be effective for most students. I always make sure that I am constantly walking around the room ensuring that students are on task, asking them probing questions as I walk by to check for understanding. I also make sure that students are actively engaged in every activity making a point to call on every student, assign each student a unique task, or have them teach the concept to their peers. I also make sure that I change activities every fifteen minutes throughout a lesson to ensure they don't have the chance to get distracted or off task.

Some other strategies that were mentioned by the other two participants included "utilizing competition within a classroom activity," "chunking assignments into more manageable pieces, making a point to check-in with students frequently," and "giving students a choice of how to complete an assignment, and sitting students diagnosed with ADHD near the core of instruction." One participant also gave several of the methods listed previously with the addition of "setting short goals so that they don't get overwhelmed."

All but four of the participants also stated that they do not think about specific

modifications or strategies when lesson planning, reinforcing the idea that they have a limited understanding of instructional modifications that are designed to aid students diagnosed with ADHD. All but one participant stated that they do not think about specific students when lesson planning but rather design their lessons as general outlines of the content to be covered and differentiate when necessary. All but four of the participants also stated that they did not spend a ton of time lesson planning but have found an outline of what they are going to do when and for how long to be the best way to lesson plan. For example, one participant stated, “I think about every student when lesson planning; that’s why I just plan a very general outline.” Another participant shared a similar view, stating, “I think about what would be best for the class as a whole when lesson planning.”

Three participants also shared that they do not really lesson plan at all but have found that they have taught the same thing for so long that they can just wing it. One of the three participants stated, “I don’t really lesson plan, it is not really helpful for me.” Another of the three participants also shared the view of lesson planning not being particularly helpful for them, saying, “Lesson planning is difficult for me because I want to stick to the plan, but often end up having to adjust, so it’s just extremely frustrating for me.” One of the participants who shared that they do think about specific students when lesson planning provided some rationale and context to their thinking:

> I am probably in the minority with my view on lesson planning, but I have to write a unique lesson plan for every class even if it is the same content. Every class is different, and I have found through my 24 years of teaching that planning the same activity for every class doesn’t work well for me. Some students do really well with group work, others do not. For me to generalize instruction for all

students is doing a disservice to them and not giving them the best chance to be successful. I think about each student individually when planning activities, students diagnosed with ADHD included, and I always strive to differentiate my lessons so that every student has the best opportunity to be successful.

While the majority of participants discussed a limited understanding of instructional modifications and strategies to aid students diagnosed with ADHD, eight of the participants did discuss limited strategies and modifications they have had success with in the past. The most common answer for the strategies found to be effective was some variation of ensuring that students diagnosed with ADHD are seated in the core of instruction. Proximity was another similar strategy mentioned several times as well as switching up activities multiple times throughout a lesson. For example, one participant shared, “The most effective thing for me is to make sure I keep on them and am constantly right there around them.” Another participant said, “The easiest and most effective thing for me has been ensuring those students are in a place in the classroom where they cannot get distracted easily.” One participant also shared similar views, saying, “It has also been effective for me to just ensure that I check in regularly with my students diagnosed with ADHD and try my best to remove distractions.”

One of the eight participants described their experience as always seeing activities where students are “actively doing something” as being the most effective. Another participant shared an interesting explanation for why they provided modifications for students diagnosed with ADHD: “I believe chunking assignments was the most effective for students diagnosed with ADHD; they just don’t have as much room in their brains to process information at once.” Another participant had a similar response, stating,

"students diagnosed with ADHD have trouble processing multiple pieces of information at once, which is why I have found chunking to be the most effective strategy."

One participant shared a different view than many of their colleagues, stating that they have not found a strategy that works for all students diagnosed with ADHD:

> While I have found the 1 on 1 attention to be effective with most students diagnosed with ADHD, there really has not been one strategy that has been a one-size-fits-all approach for those students. I always make sure to give students diagnosed with ADHD the attention that they need, but that level of attention varies from student to student. Some students do really well with me staying on them all the time, while others prefer for things to be more on their terms. Strategies like chunking, proximity, or games are ones that I have had success with in the past, but again don't work with all students.

A Lack of Formal Training and Education in Working with Students Diagnosed with ADHD. All but one of the participants stated that they had limited or no formal training or course work in ADHD specifically during the completion of their professional degrees. Some participants gave very direct answers. One participant stated, "I had zero education on working with students diagnosed with ADHD." Another participant remembered, "I think I took one course on learning disabilities and ADHD was never mentioned." Similarly, another participant stated, "I had never even heard of ADHD until I had a student with a 504 and an ADHD diagnosis in my first year in the classroom."

All but two of the participants discussed how they received one or two courses on learning disabilities or disorders that could affect their students in general but never

discussed ADHD on its own. Most stated that the courses they did take in undergrad or grad school contained very little practical applications of how to help or adjust your teaching style to work with special education students, but rather were comprised of superficial descriptions of some disorders and disabilities, many of which impacted less than 1% of the population. For example, one participant stated, “I had to take one course on special education-related topics, everything else that I know about ADHD is from personal experience.” Similarly, a participant said that they had no formal education except for “1 class I took where we went through different diagnoses but didn’t talk anything about how to teach those students.”

The one participant who discussed having formal education specifically in ADHD was the one with the most formal education and the one who had been teaching the longest of all the participants. Coincidently, this participant was also the one with an ADHD diagnosis:

> I took multiple classes that focused on dealing with all kinds of special needs that students may have. I remember we discussed all kinds of learning disabilities and different disorders, and even spent a good chunk of time discussing ADHD. I also took an entire course in my graduate program on ADD and ADHD.

It was obvious in the majority of participants’ responses as well as from their body language that their perceived knowledge of ADHD was limited. Most of the participants rolled their eyes or gave an audible gasp when asked about their formal education in working with students diagnosed with ADHD, again suggesting that their formal knowledge was limited. Several of the participants stated that they had never even heard of ADHD until they had students diagnosed with it in their classrooms.

Three participants gave some insight into how a lack of training and education impacted their ability to implement modifications designed to aid students diagnosed with ADHD in their classrooms. The first participant stated,

> I had zero formal education in working with students diagnosed with ADHD in both my undergraduate and graduate programs. The special education training I did receive revolved around general academic challenges faced by special education students and did not include training on any specific diagnosis. I feel as though the lack of training has made it difficult for me to help my students diagnosed with ADHD. I do the best I can with them, but I do not feel like I do as much for them as I should.

The second participant said,

> I had very little formal training or classes on working with students diagnosed with ADHD. All of the classes I can remember talked about special education students in general and things like, how to read an IEP, the importance of implementing accommodations found on the IEP, and strategies for implementing those accommodations. We never really discussed practical applications or a specific diagnosis. I feel as though I could do a better job helping my special education students, but the only training or education I have had has been hands-on experience and trial and error.

The third participant stated,

> I had general special education courses where we talked about working with students with IEPs or 504s, but never really got any more specific than that. I can remember spending maybe a day on ADHD in one of my classes, but it was more

> about the origins of it and how it is diagnosed rather than practical applications or specific modifications. I feel as though having training where we discuss specific modifications or strategies for working with special education students in general, but especially ADHD would be beneficial to me. I feel like I don't have the knowledge or experience to work with those students effectively.

Nine participants discussed how they had no formal training or education in working with students diagnosed with ADHD but felt that their personal experiences in the classroom gave them a solid foundation. For example, one participant said, "I feel as though I work well with students diagnosed with ADHD just from the adjustment I have made to my instruction from personal experience." Similarly, another participant stated, "I had no formal training or education, but I feel like I do a pretty good job with students diagnosed with ADHD, just from having taught so long."

A Limited Knowledge of Academic and Social Challenges Faced by Students Diagnosed with ADHD. All but two of the participants' responses were limited to the context of their own classrooms. Their only frame of reference for the challenges faced by students diagnosed with ADHD was a high school mathematics classroom. For this reason, participants displayed little understanding of the academic, social, and emotional challenges faced by students diagnosed with ADHD. While all participants agreed that ADHD is a barrier to a student learning math, their reasons for why ADHD should be perceived as a barrier varied. One participant stated,

> I would see ADHD as a barrier to learning math just because of the traditional model of most high school math classrooms. The direct instruction model where the teacher teaches for 60 minutes out of the 90 and then completes independent

> practice the remaining 30 minutes does not work for students diagnosed with ADHD. Students diagnosed with ADHD struggle to maintain focus and tune out halfway through the lesson, meaning that they miss a good chunk of the content for that day, which is especially bad in a math class since our curriculum builds on previous topics.

All the participants shared this view that the mode of instruction used in the traditional high school math classroom hinders progress for students diagnosed with ADHD. One participant said that the biggest hurdle for students diagnosed with ADHD is the "sit and get" culture of the traditional math classroom, and "it is a massive struggle for students diagnosed with ADHD to maintain focus on a topic for more than a few minutes." Another participant shared a similar view stating that students diagnosed with ADHD "have difficulty concentrating or staying on task, which is going to make it even more difficult for those students to get work done." Another participant added that students diagnosed with ADHD "can't sit still for an hour and a half class and struggle because they have to sit and listen for an extended period of time."

One participant agreed that the direct instruction model does not work for students diagnosed with ADHD but took it a step further to state that the direct instruction model really does not work for any students:

> ADHD can be a barrier depending upon the instructional method used by the teacher. students diagnosed with ADHD, and all students really, have a difficult time paying attention in classes where there is a lot of sit-and-get culture. Classes where you are continuously taking note after note and doing example after example are difficult for all students, but especially those with ADHD. I believe

> students diagnosed with ADHD can actually thrive in a class where things are changed up quite a bit.

Some participants agreed that the traditional classroom model is not conducive to learning for any student, especially students with ADHD. Many participants had very strong opinions about not only the state of math education but the state of public education in general. Participants expanded on the barriers they saw for students diagnosed with ADHD in the traditional high school math classroom and expanded their opinions to cover all students served. For example, one participant stated,

> The whole entire educational system is not conducive for a lot of learning. Students in this cookie-cutter factory model of education are asked to sit still and pay attention to a teacher for hours at a time in class sizes of 30 or more. Students in a desk all day, especially when they are really young, like elementary age is not conducive to a lot of learning or really any learning except for those that strive to achieve and have a high level of academic standards. So yes, the whole entire system is broken and is doing a disservice to all kids, but especially ADHD kids.

Overall, the majority of participants agreed that it was the instructional methods used in the traditional high school math classroom that caused issues for students diagnosed with ADHD. Direct instruction requires a lot of focus, attention to detail, and the ability to process information quickly and efficiently. They noted that all those requirements are difficult for many students, but next to impossible for students diagnosed with ADHD.

Research Question 1 Summary

The qualitative data collected for this research question was intended to describe high school mathematics teachers' perceptions of their abilities to effectively work with

students diagnosed with ADHD. Overall, the data collected showed that the participants interviewed had very limited background knowledge of what ADHD was and the academic struggles that come with a diagnosis. The participants interviewed lacked confidence in working with students diagnosed with ADHD due to very limited formal training in working with students diagnosed with ADHD. The participants of this study had a superficial understanding of the academic difficulties faced by students diagnosed with ADHD. Their understanding of ADHD was limited to students who have difficulty maintaining focus or paying attention. While this is a main symptom of ADHD, it is far from the only thing that makes learning difficult for these students.

While most of the participants expressed being more confident working with students diagnosed with ADHD now than at the beginning of their careers, their knowledge of how to best meet these students' needs is still limited. Many of the strategies mentioned in the interviews for working with students diagnosed with ADHD were strategies taught in general special education classes. These strategies are designed to help a wide array of students and are not specifically designed for students with ADHD. All the participants interviewed started with a perceived inability to work effectively with students diagnosed with ADHD. Their knowledge and confidence have grown throughout their teaching careers through experience and professional development, but the majority of the participants still perceived working with students diagnosed with ADHD as a challenge for which they were not prepared.

Research Question 2: What Relationship Exists Between the Utilization of Instructional Modifications Not Mandated by an IEP or 504 Plan and the Average Engagement of Students in a High School Mathematics Classroom?

The purpose of this research question was to determine the impact instructional modifications had on student engagement during instruction and if there was a relationship between the number or type of modifications or strategies used and average student engagement. To answer this research question, I observed each participant's instruction twice throughout the course of the semester. The first observation focused entirely on calculating the average student engagement scores utilizing the BERI observational protocol and the type of activity occurring during each interval. Each observation was completed over the time frame of an hour, and the number of students engaged and disengaged was tallied every 2 minutes for a total of 30 intervals. Detailed explanations of what were considered engaged and disengaged behaviors were presented in Chapter 3. At the end of each observation, the 30 intervals were averaged together and an overall engagement score was calculated showing the average number of students engaged throughout each observation.

Observation Data

Table 8 shows the average engagement scores for each participant's classes during the first observational period. Table 8 also shows which type of activity showed the lowest and highest levels of student engagement as well as the level of each observed class. The levels observed included CP Inclusion, CP, honors, and AP.

Table 8

First Observation Engagement Scores

Participant	Class Level	Average number of students engaged (percent)	Average number of students disengaged (percent)	Activity with lowest engagement	Activity with highest level of engagement
1	CP	9.63/17 (57%)	7.27/17 (43%)	Notes	Independent practice
2	CP Inclusion	9.13/17 (54%)	7.82/17 (46%)	Examples	Group work
3	CP	11.4/18 (63%)	6.6/18 (37%)	Review	Independent practice
4	Honors	16.5/22 (75%)	5.5/22 (25%)	Examples	Independent practice
5	CP	13.2/20 (66%)	6.8/20 (34%)	Project directions	Group work
6	CP	19.4/24 (81%)	4.56/24 (19%)	Independent practice	SEL activity
7	CP Inclusion	15.2/23 (66%)	7.82/23 (34%)	Going over homework	Independent practice
8	CP	13.7/25 (55%)	11.3/25 (45%)	Notes	Mini project
9	CP	15.1/28 (54%)	12.9/28 (46%)	Guided practice	Group work
10	Honors	21.3/30 (71%)	8.7/30 (29%)	Notes	Independent practice
11	Honors	19.7/27 (73%)	7.3/27 (27%)	Going over homework	Jigsaw activity
12	Honors	19.6/30 (65%)	10.5/30 (35%)	Notes	Mini project
13	AP	27.3/35 (78%)	7.7/35 (22%)	Examples	Practice AP exam questions in groups
14	AP	28.8/33 (87%)	4.29/33 (13%)	Going over homework	Group activity
15	CP Inclusion	12.8/22 (58%)	9.24/22 (42%)	Notes	Group activity

Table 8 shows that components of a lesson that were teacher-led such as notes, going over homework, or working through examples received the lowest levels of student

engagement regardless of subject or course level. Activities that allowed students to work independently or with their peers such as independent practice, group work, or a project received the highest level of student engagement, again regardless of course content or level. The level of each course observed was considered to determine if there were variables other than the type of activities used that impacted or related to average student engagement scores. Data from the first observations showed that there was a direct association between the level of course observed and average student engagement scores. Overall, students in the AP and honors courses had higher average engagement scores than those courses taught at the CP level. In other words, students taking math courses with more rigorous workloads showed a higher level of engagement on average.

In contrast, each of the original observations showed similar results for types of activities that resulted in the lowest and highest levels of student engagement. All observations showed that students are least engaged during some form of direct instruction, regardless of the level of the class. Students in CP, honors, and AP classes all showed the lowest levels of engagement while the teacher was going over notes, examples, or homework, or giving directions for an activity. In other words, students showed relatively low levels of engagement during portions of the class that required the traditional “sit and get” style of instruction. Similarly, students showed the highest level of engagement during parts of instruction that allowed them to work with their peers or focus on an independent task. All class levels showed high levels of engagement during activities that allowed students to take ownership of the content and apply their knowledge of the material. Activities where students were given the opportunity to interact with their classmates, bounce ideas off each other, and work collaboratively also

showed high levels of engagement.

To give a more complete picture of the changes in student engagement throughout the course of a lesson, I also chose to plot each of the 30 engagement scores for each of the original observations. In the majority of classes observed, the number of students engaged was highest towards the middle of each observation and lowest at the beginning and end. While there are several variables that could have impacted the number of students engaged during each interval, the common trend of student engagement increasing from the beginning of the lesson and peaking somewhere in the middle supports the types of instructional methods observed as most and least engaging. This is the case because all observations started and ended with periods of direct instruction, while the independent practice and more hands-on collaborative methods occurred in between the direct instruction.

During the second observation, while I still collected student engagement scores over the 30 two-minute intervals, the main focus of the observation was identifying the number and types of instructional modifications and strategies used. While research on what strategies have been shown to be effective in improving academic outcomes for students diagnosed with ADHD was presented in Chapter 2, there were specific strategies and instructional methods I looked for during the second observation. Some specific strategies and methods I looked for included sitting students diagnosed with ADHD near the core of instruction, utilizing student choice for independent practice, chunking instructions and practice into more manageable pieces, allowing students to work in groups, allowing students to get up and move during transitions, providing guided notes, and giving students the opportunity to lead instruction. Table 9 shows the average

engagement scores for each of the second observations as well as the number of instructional modifications or strategies utilized by the participants.

Table 9

Data From Second Observation

Number of modifications or strategies used	Average number of students engaged (percent)	Average number of students disengaged (percent)	Class
4	19.1/22 (87%)	2.9/22 (13%)	CP
3	23.4/32 (73%)	8.6/32 (27%)	H
3	14.2/22 (65%)	7.8/22 (35%)	CP Inclusion
2	30.3/34 (89%)	3.7/34 (11%)	AP
2	28.7/35 (82%)	6.3/35 (18%)	AP
2	18.3/30 (61%)	11.7/30 (39%)	CP
2	14.1/23 (61%)	8.9/23 (39%)	CP
1	16.8/24 (70%)	7.2/24 (30%)	H
1	20.2/31 (65%)	10.8/31 (35%)	H
1	11.1/19 (58%)	7.9/19 (42%)	CP
1	11.1/20 (56%)	8.9/20 (44%)	CP Inclusion
0	17.7/25 (71%)	7.3/21 (29%)	H
0	13.4/21 (64%)	7.6/21 (36%)	CP
0	10.7/18 (58%)	7.3/18 (42%)	CP Inclusion
0	13.7/24 (57%)	10.3/24 (43%)	CP

To help eliminate as many variables as possible, the second observations were performed on an instructional day similar to the first observation whenever logistically possible. In other words, if new material was introduced during the first observation combined with group work or independent practice, I tried to complete the second observation on a day with similar instructional methods. While the engagement scores were slightly skewed from the first observation because there were more or fewer students present during the second observation, overall, the average engagement scores changed between the two observations. The trend of the AP and honors classes having higher average engagement scores than their CP counterparts continued, but the number

of modifications or strategies used did have an impact on student engagement.

While it was difficult to say from the observational data alone how much of an influence the number of strategies and modifications used by each participant had on student engagement, there were some definite relationships that emerged. The participants who used more than one modification saw a higher increase in student engagement than the participants who used one or no strategies or modifications. For example, Participant 15 used a total of three modifications and strategies and saw a 7% increase in average student engagement during the second observation, whereas Participant 10 only used one and actually saw a 6% decrease in student engagement between the two observations. Similarly, Participant 6 used four modifications and strategies and saw a 6% increase in student engagement after already having achieved one of the highest average student engagement scores during the first observation. Overall, any participants who utilized two or more modifications and strategies saw at least a 2% increase in their average student engagement scores, with participants who used three or four seeing an even larger increase of at least 5%. On the other hand, participants who utilized one or no strategies or modifications either had no change in engagement from the first observation or had a decrease of as much as 6%.

The data collected from both observations showed that there are many factors that can have an impact on student engagement. The level of the course observed, the types of activities utilized, and the number of identified strategies or modifications used all impacted the average student engagement scores. The data from both observations also showed that there was a direct positive relationship between the number of modifications and strategies not mandated by an IEP or 504 and the average student engagement scores.

This association applied to not only students diagnosed with ADHD but all students, showing that utilizing specific modifications and/or strategies designed to improve academic outcomes for students diagnosed with ADHD had a positive impact on engagement for all students.

Research Question 3: What Impact Does the Utilization of Instructional Modifications Not Mandated by an IEP or 504 Plan Have on the Mathematics Achievement of High School Students Who Have Been Diagnosed With ADHD as Measured by Growth on Pre and Posttest Scores?

The purpose of this research question was to collect and analyze quantitative data to support the qualitative findings of the study. Assessment data were collected from the students of each of the participants at the beginning and end of the period of the study. Scores were collected from the same classes that participated in both observations and no assessment data were collected from participants' classes that were not observed. Data collected at the beginning of the study consisted of scores on the pretest given in every participant's class to determine what foundational knowledge students have and what remediation might be required. While the content of each course's pretest was different, the format for each assessment was identical. Specific details about the number and type of questions were discussed in Chapter 3.

Assessment data were also collected from the same classes at the end of the study period. Scores from the final exams were collected from each participant. The final exam was chosen because it was the assessment given by each participant most similar to the pretest, which eliminated several variables that could have impacted student growth. Table 10 shows the average score in each participating class on both the pretest and final

exam. Growth scores are also included along with the number of students diagnosed with ADHD in each participating class and the number of modifications or strategies used during the observations.

Table 10

Assessment Data

Number of modifications or strategies used	Overall growth (percent out of 100)	Average score on pretest (percent out of 100)	Average score on final exam (percent out of 100)	Number of students diagnosed with ADHD
4	36	56	80	2
3	34	58	78	4
3	23	60	74	2
2	42	55	78	3
2	34	53	71	1
2	27	60	76	2
2	19	58	69	2
1	36	56	76	1
1	34	53	71	2
1	32	56	74	2
1	17	53	62	5
0	13	55	62	2
0	13	56	63	4
0	12	57	64	3
0	7	56	60	3

While the number of modifications or strategies used did not seem to have an impact on the growth in scores between the pretest and final exam, there was a difference in growth between those participants who used modifications and those who did not. All participants who utilized modifications or strategies in their instruction had a higher growth percentage than the participants who did not.

To gain a better understanding of the significance of the differences between groups who received modifications and those who did not, a one-way ANOVA was used. To run the ANOVA, I split the assessment data into four groups: students diagnosed with

ADHD who received modifications, students diagnosed with ADHD who did not receive modifications, students not diagnosed with ADHD who received modifications, and students not diagnosed with ADHD who did not receive modifications. The gain scores or numerical differences between the pre and postassessment scores were then calculated for each of the four groups. The ANOVA allowed me to compare the means of the gain scores from each group to determine if there was a statistically significant difference. The significance level or alpha used for the ANOVA was 0.05, meaning any *p* value less than 0.05 would be considered significant. Figure 4 shows the results of the ANOVA with the *p* value highlighted.

Figure 4

Results of ANOVA

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
ADHD With Modifications	26	427	16.42	92.41
ADHD Without Modifications	12	40	3.33	6.97
Non-ADHD With Modifications	258	4797	18.59	140.98
Non-ADHD Without Modifications	82	804	9.8	77.39

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6810.78	3	2270.26	18.9154	1.92354E-11	2.628774
Within Groups	44888.16	374	2270.26			
Total	51698.94	377				

With a *p* value of 1.92 x 10^{-11}, well below the determined significance level of 0.05, the ANOVA told me that there was a significant difference between two of the groups; however, the ANOVA did not tell me which groups' differences were significant.

The data from the ANOVA showed that there was at least one significant difference between groups, considered to be the groups with the largest difference in their

means, which were students diagnosed with ADHD with modifications and students diagnosed with ADHD without modifications. In other words, the ANOVA determined that there was a statistically significant difference in the mean gain scores between students diagnosed with ADHD who received modifications and those who did not. To determine which groups also had a significant difference, another statistical test had to be used. Independent *t* tests were used to calculate the *p* value between each group to determine which groups had a significant difference between their means. Table 11 shows the comparison between each group along with the calculated *p* value.

Table 11

Comparison of Group Means Using Independent t Tests

Groups (mean)	Difference in means	*p* value
Non-ADHD with modifications (18.59) versus ADHD without modifications (3.33)	15.26	0.00002009
ADHD with modifications (16.42) versus ADHD without modifications (3.33)	13.09	0.003817
Non-ADHD with modifications (18.59) versus Non-ADHD without modifications (9.80)	8.79	0.000000004397
ADHD with modifications (16.42) versus Non-ADHD without modifications (9.8)	6.62	0.03793
Non-ADHD without modifications (9.8) versus ADHD without modifications (3.33)	6.47	0.225
Non-ADHD with modifications (18.59) versus ADHD with modifications (16.42)	2.17	0.7708

The data presented in Table 11 show that there was a statistically significant difference between the means of gain scores between four of the six pairs of groups. The independent *t* tests showed that there was no significant difference between students

diagnosed with ADHD and students not diagnosed with ADHD who received modifications as well as no significant difference between students diagnosed with ADHD and students not diagnosed with ADHD who did not receive modifications. The test also showed that the most significant difference was actually between the students not diagnosed with ADHD who received modifications and the students not diagnosed with ADHD who did not.

Research Question 3 Summary

To answer the research question, "What impact does the utilization of instructional modifications not mandated by an IEP or 504 plan have on the mathematics achievement of high school students who have been diagnosed with ADHD as measured by growth on pre and posttest scores," a one-way ANOVA combined with independent *t* test was used to determine statistical significance. The quantitative data analyzed showed that there is a statistically significant difference in gain scores for students diagnosed with ADHD who received instructional modifications and students diagnosed with ADHD who did not. In other words, students diagnosed with ADHD who received modifications during instruction obtained significantly more growth between their pre and postassessment scores than their ADHD peers who did not receive modifications. The data also showed similar results for students not diagnosed with ADHD, meaning there was more significant growth between pre and posttest scores in both students diagnosed with ADHD and students not diagnosed with ADHD student populations who received modifications.

Overall Summary

The qualitative and quantitative data collected gave insight into what factors have

an impact on the achievement of students diagnosed with ADHD. The qualitative data gained from both interviews and observations showed that teachers have very little understanding of what ADHD is, as well as the academic, social, and emotional challenges these students face. The qualitative data also showed that teachers have limited formal training in best instructional practices for working with students diagnosed with ADHD but have significant knowledge of general instructional strategies that have also been shown to work well with students diagnosed with ADHD. The quantitative data collected showed that there is a statistically significant difference in assessment scores between students diagnosed with ADHD who received some sort of instructional modification and those who did not. Students diagnosed with ADHD who received modifications performed significantly better than their ADHD peers whose teachers did not use any specific instructional strategies or modifications designed to aid students diagnosed with ADHD.

Chapter 5: Discussion

This study was designed around the theoretical framework of academic achievement of students diagnosed with ADHD, specifically, and what controllable external factors could influence the academic achievement of these students. The factors considered for this study included teachers' perceptions and prior knowledge of ADHD, teachers' formal training in working with students diagnosed with ADHD, and the implementation of specific instructional modifications or strategies designed to help level the playing field for these students. The context considered for this study was traditional high school mathematics classrooms; and the perceptions, formal training, prior knowledge, and use of instructional modifications were analyzed for 15 different high school mathematics teachers from different content areas.

Summary of the Study

A combination of quantitative and qualitative data was used during the course of the study. Qualitative data in the form of interviews and classroom observations were used to determine what impact teacher perceptions and prior knowledge of ADHD had on their willingness and ability to implement instructional modifications designed to aid the academic achievement of students diagnosed with ADHD. Interviews and observations were also utilized to determine what impact formal training in working with students diagnosed with ADHD had on the use of the same instructional modifications. Finally, quantitative data in the form of pre and postassessment scores were used to determine the impact identified modifications and strategies had on the academic achievement of students diagnosed with ADHD.

Implications of Research

The outcomes of this study provided implications for all relevant stakeholders. The stakeholders of this study included high school mathematics teachers, high school administrators, students diagnosed with ADHD, and their parents. Considering that 13% of all students aged 12 to 17 have an ADHD diagnosis, the data collected in this study could have a significant impact on the high school math instruction of students diagnosed with ADHD (CDC, 2022). The perspectives and prior knowledge of high school mathematics teachers depicted in this study could also have implications on future policy decisions at both the district and state levels. Another implication of the perspectives and prior knowledge presented in this study might be the implementation of professional development for high school math teachers specific to working with students diagnosed with ADHD.

Interpretation and Discussion of the Results

Both the qualitative and quantitative data collected during this study provided insight into how high school math teachers can best work with students diagnosed with ADHD. Six themes were identified through the analysis of the qualitative data collected from interviews, including

- little understanding of the definition of ADHD
- a lack of formal training and education in working with students diagnosed with ADHD
- a limited knowledge of academic and social challenges faced by students diagnosed with ADHD
- a lack of confidence in working with students diagnosed with ADHD early in

their careers

- increased level of confidence with experience
- a rudimentary understanding of instructional modifications designed to aid students diagnosed with ADHD

Implications for Practice: Qualitative Findings

The qualitative data collected through interviews and multiple classroom observations consistently showed that teachers were not confident in working with students diagnosed with ADHD at the beginning of their careers. While there were many factors that influenced the lack of confidence, such as little understanding of ADHD as a disorder, a lack of formal training, or just a lack of experience, all participants stated that they were initially unprepared to work with these students at the beginning of their teaching careers. Considering that ADHD is one of the top learning challenges faced by adolescents aged 12 to 17, it would be appropriate to require all teachers who have students within that age group to have some sort of training and continued professional development in at least the basics of ADHD as a disorder and how best to meet the needs of those students (CDC, 2022).

Little Understanding of the Definition of ADHD

In order to understand how to address a topic or challenge in any field, especially education, knowing and understanding the definition and context of the problem is essential. Only one of the 15 participants in the study had any understanding of the mental and physical components associated with ADHD. Fourteen of the participants had no knowledge of ADHD as a disorder beyond that students with an ADHD diagnosis have trouble staying focused. Having limited knowledge of how ADHD impacts a

student's brain puts participants at an immediate disadvantage in knowing how to work with students diagnosed with ADHD. Knowledge of the mental and physical issues associated with ADHD is an important piece of the puzzle in understanding how to best help students diagnosed with ADHD be successful. The one participant who had a more detailed understanding of the psychological issues associated with ADHD was also one of the only participants who was able to give detailed and specific instructional modifications they have used with students diagnosed with ADHD and how those impacted their academic performance.

A Lack of Formal Training and Education in Working with Students Diagnosed with ADHD

Balancing the needs of all students and expecting teachers to differentiate their instruction to meet their students' needs is one of the biggest challenges professional educators face. The training teachers receive in their degree programs often focuses on content knowledge and basic pedagogy, which are all worthwhile topics of study but leave teachers with a gap in knowledge necessary to fully support their students. Teachers need formal training and instruction on strategies and techniques for helping all their students be successful. Having no knowledge of ADHD immediately puts both teacher and student at a disadvantage. Even just a basic understanding of how ADHD affects a student's social, emotional, and physical health could have a big impact on the academic success of that student. The participants in the study who had a working knowledge of the challenges faced by students diagnosed with ADHD were the same participants who were able to describe specific modifications and strategies they had seen be effective. Similarly, the participants who demonstrated a limited understanding of the definition of

ADHD and the challenges associated with the disorder gave more general strategies and modifications that are designed to be used with all students as basic good pedagogy rather than strategies and modifications specific to those students with ADHD.

This study showed that teachers are not confident in working with students diagnosed with ADHD at the beginning of their careers, suggesting more training and resources in teacher preparation programs are necessary to give teachers and students diagnosed with ADHD a leg up. All but one participant stated that they had little to no training specific to students with ADHD in their undergraduate or graduate studies. The one participant who did have a course specific to students diagnosed with ADHD showed an increased level of confidence in their ability to help students diagnosed with ADHD be successful in their class. The participants who had no training or course specific to ADHD continually stated they were underprepared at the beginning of their careers to meet the needs of students diagnosed with ADHD but slowly had an increased level of confidence in their abilities with experience. If a course on ADHD was made mandatory in all teacher preparation programs, perhaps teacher confidence would increase in working with students diagnosed with ADHD at both the beginning and throughout their teaching careers. Multiple surveys have reinforced the results of this study, suggesting the need for more formal training in teaching students with disabilities. A 2019 national survey found that only 30% of classroom teachers felt prepared to teach students with disabilities like ADHD (Mitchell, 2019). The same survey stated that all participants reported not being required to take any courses in working with students with disabilities in their respective teacher education programs (Mitchell, 2019). While many teacher preparation programs do not require a special education course, the number of special

education students served in public schools has drastically increased (Will, 2020). According to the National Center for Education Statistics (2023), the number of special education students served by public schools has increased by roughly 900,000 students over the last decade. This number equates to a 13% to 15% increase over the same period (National Center for Education Statistics, 2023). While not all students diagnosed with ADHD receive special education services, a recent study found that roughly 70% of students diagnosed with ADHD receive one or more special education services, supporting the argument for including special education courses in regular teacher education programs as well as courses specific to ADHD modifications and strategies (DuPaul et al., 2018).

A Limited Knowledge of Academic and Social Challenges Faced by Students Diagnosed with ADHD

The majority of interview responses as well as data collected during observations showed that the participants in this study had little understanding of the academic and social challenges students diagnosed with ADHD face. Participants were unable to describe the symptoms of ADHD beyond difficulty focusing or paying attention. While this is one of the major symptoms of ADHD, there are so many more hurdles these students face in the classroom. It is difficult for students diagnosed with ADHD to filter out distractions around them and sit still for extended periods of time, and they often experience difficulty controlling their impulses. All these symptoms of ADHD have a significant number of strategies and resources that have been shown to be successful in helping students diagnosed with ADHD learn (Cox, 2022); however, these tools and strategies are of no use if teachers are not aware of them, which was the general

consensus reached during this study. This study showed that teachers lack the skills and knowledge necessary to help combat the academic challenges faced by students diagnosed with ADHD.

Students diagnosed with ADHD face a number of social challenges as well, which can also have a significant impact on their performance in the classroom. Students with ADHD often talk excessively, interrupt their peers, have difficulty listening to others, have difficulty picking up on social cues, and display goofy or silly behaviors at inappropriate times (Gill & Hosker, 2021). While there are also strategies for helping students diagnosed with ADHD cope with these social challenges, again, they do no good if teachers are not aware of how to properly implement them. Developing social skills also has a significant impact on academic success. Students who have the social skills and emotional awareness to interact positively with their peers perform better in school than those with social struggles, such as students diagnosed with ADHD (Sparks, 2021). It is important for teachers to have the tools and resources necessary to help their students build social and emotional skills as well, as they have been shown to have a significant impact on academic success (Brown, 2021).

The qualitative data collected during the interviews showed that all but two of the participants had knowledge or experience with ADHD outside the context of their individual classrooms. All 15 participants believed that ADHD was a barrier to learning math and gave similar reasons why. Thirteen of the participants discussed the use of direct instruction in a math classroom as a poor form of instruction for students with ADHD. One participant blamed the public education system in general for setting up students with ADHD for academic failure. While all participants could list at least one

academic challenge faced by students diagnosed with ADHD, all but three could not provide a very detailed list or explain in any detail why that challenge would make learning math difficult. Teachers need to have a working knowledge of both the academic and social challenges faced by their students diagnosed with ADHD in order to be able to help that particular subset of students be successful. Teachers need training and continued professional development on the best strategies and tools for helping their students diagnosed with ADHD be successful in order to feel confident in their abilities and equipped to help all of their students be the best version of themselves.

A Lack of Confidence in Working with Students Diagnosed with ADHD Early in Their Careers

A lack of confidence in working with students with ADHD was a concern voiced by all participants in the study. Teachers are not prepared to address the needs of students diagnosed with ADHD and have little knowledge of not only the disorder itself but also the best practices for managing it in the classroom (Poznanski et al., 2018). The data collected during this study supported the claim that teachers are not prepared to address the needs of students diagnosed with ADHD. All 15 participants described being in pure survival mode during their first few years of teaching, focusing only on basic pedagogy and content knowledge and not really having the time or energy to consider anything else. All 15 participants also stated in some form that they did not think about differentiation in their first few years of teaching. All participants stated that they taught all students the same and did not consider any other factors in the first few years of their careers.

The data collected also reinforced the idea that a lack of confidence from the

teacher also puts strain on the development of the student-teacher relationship. Many teachers, because of their lack of knowledge and confidence, have poor relationships with their students diagnosed with ADHD. Teachers are not equipped to deal with the physical, social, and emotional side effects that result from an ADHD diagnosis; as a result, teachers tend to shy away from interacting with students diagnosed with ADHD (Baker, 2021). The data collected showed that several of the participants did not enjoy interacting with their students diagnosed with ADHD because they believed it to be exhausting or frustrating. Eight of the 15 participants also ignored or chose not to interact with some of their students during their observations, again reinforcing the idea that lack of knowledge or understanding can impact the student-teacher relationship.

A negative or nonexistent student-teacher relationship has been shown to have a significant impact on not only a child's emotional health but also their academic success. Negative student-teacher relationships can lead to unnecessary stress, anxiety, and even aggression in students (Zhou, 2021). Student-teacher relationships have a significant impact on student achievement and learning outcomes as well; in other words, students will not learn from teachers they do not like or with whom they have a negative relationship (Agyekum, 2019). Developing a positive student-teacher relationship is essential for the overall success of students, which is why teachers need to have all the knowledge, skills, and resources necessary to interact and best meet the needs of all their students (Baker, 2021). The observation data collected during this study reinforced these claims of the negative impact student-teacher relationships can have on academic performance. While comparing the participants' perceptions and relationships with their students with ADHD and other students to their use of modifications was not part of the

study, there did seem to be a relationship between the two. Quantifying the perceptions of participants would have been difficult, as there are a lot of other variables that could have impacted their use of modifications and their relationships with their students; however, there did seem to be enough of a relationship in the data collected during the observations and interviews that it was worth mentioning. The trend that developed in the observational data was that participants with a negative or neutral perception of some of their students were less likely to use instructional modifications than those with positive perceptions. Participants with what was believed to be a positive perception of students with ADHD, based on their interview responses, consistently utilized more of the identified modifications in their instruction.

Providing teachers with training and continued professional development in the side effects and challenges students diagnosed with ADHD face and strategies to help them be successful could go a long way in improving student-teacher relationships. Providing the knowledge, skills, and strategies necessary to increase teacher confidence in meeting the needs of all their students could have a significant impact on their perceptions of not only students diagnosed with ADHD but also other students with disabilities as well as their overall effectiveness as a professional educator (Gonzalez, 2022).

Increased Level of Confidence With Experience

All the participants in the study stated that their confidence in working with students diagnosed with ADHD grew with experience. While there is no substitute for hands-on experience, an argument could be made that teachers would have more confidence at the beginning of their careers if training specific to students diagnosed with

ADHD was included as part of teacher preparation programs. Developing teacher efficacy early on in an educator's career could have a significant impact on a teacher's success in the classroom (Herbert-Smith, 2023). This claim was supported by participant responses given during the course of the study. All 15 participants discussed being unsure of their ability to be an effective teacher in their first few years but also stated that their overall confidence increased with experience. Nine of the 15 participants also stated that their increased confidence with experience applied to all aspects of teaching, including their ability to deliver content effectively, their ability to differentiate instruction, their ability to manage a classroom, and their ability to ensure the academic success of all their students.

A teacher's lack of confidence in their abilities to be an effective teacher puts not only the teacher at a disadvantage but their students as well (Guskey, 2023). Teacher preparation programs should not only give teachers the basic content and pedagogical skills necessary to be effective teachers but should also focus on building teacher efficacy. Confidence is a significant contributing factor in the overall effectiveness of educators, which is why we should be equipping beginning teachers with all the knowledge and resources we can, not just the basic foundation (Guskey, 2023). The data collected in this study showed that confidence and perception of ability also had an impact on the use of differentiation and modifications in participant instruction. Teachers with a positive perception of their abilities tended to implement more modifications and strategies than the participants with more negative perceptions of their abilities and limited confidence. In fact, participants with positive perceptions used twice as many modifications or strategies on average than their peers with more negative or neutral

perceptions.

Providing the foundational knowledge and strategies necessary to help students diagnosed with ADHD and other students with disabilities be successful as early as possible in a teacher's career could have a massive impact on their confidence level in the classroom. Having a foundational knowledge and understanding of strategies for working with all students entering a teaching career could have a huge impact on not only teacher efficacy but retention as well (Ronfeldt, 2021). The hands-on experience teachers gain throughout the beginning of their careers would be so much more valuable if they already had the foundational knowledge, skills, and confidence necessary to help all their students be successful (Shahzad & Naureen, 2017).

A Rudimentary Understanding of Instructional Modifications Designed to Aid Students Diagnosed with ADHD

All the participants of this study showed limited knowledge or understanding of how to help their students diagnosed with ADHD be successful. While many of the participants used instructional modifications that have been shown to improve ADHD student outcomes, they struggled to identify ones specific to that subset of students. Utilizing instructional modifications designed to reduce distractions, incorporate physical movement, encourage positive behavior, or prevent interruptions has been shown to have a significant impact on the academic performance of students diagnosed with ADHD (Jackson, 2022). Teachers need to have the knowledge and training necessary to help them implement these modifications and, in turn, improve the academic outcomes of their students diagnosed with ADHD. Teachers who have formal training in these modifications are far more likely to implement them and are also more likely to

implement them effectively (Ward et al., 2020). Instructional modifications designed to help counteract the symptoms of ADHD in the classroom are essential for teachers to ensure that they are meeting the needs of all their students and setting up each student to be successful and reach their full potential (Brooks, 2022).

Implications for Practice: Quantitative Findings

The quantitative data collected showed a significant impact on the academic achievement of students diagnosed with ADHD.

Impact on Academic Achievement

This study showed a statistically significant difference in the academic achievement of students diagnosed with ADHD who were taught by teachers who utilized modifications and those who were not. In fact, students diagnosed with ADHD who received modifications had an average of 12 points more growth between their pre and postassessment scores. Strategies and modifications such as allowing for student choice on assignments, chunking large assignments into more manageable pieces, providing written directions to students, checking student work often, using patterns and visual aids, and allowing students to work collaboratively with peers were all observed strategies that were shown to have a significant impact on the academic achievement of students diagnosed with ADHD.

Another interesting piece of data that emerged from the study was the fact that these modifications and strategies were not only shown to be impactful with students diagnosed with ADHD but with all high school math students who participated in the study. In fact, there was shown to be a statistically significant difference in the mean growth scores between students not diagnosed with ADHD who did and did not receive

modifications as well. This result suggested that all students can benefit from the use of modifications and strategies designed to help students diagnosed with ADHD be academically successful. Considering that ADHD is one of the most common disorders that can impact learning high school math teachers face, this study provides some relevant and compelling data on how to improve academic outcomes for all students in the high school mathematics classroom (Miller, 2019). The learning challenges students diagnosed with ADHD face are compounded by the traditional struggles faced by all students when transitioning to high school. Hurdles such as having to develop time-management skills, developing the ability to self-advocate, adjusting to a larger school, and trying to develop a school-life balance are all challenges high school students face beyond academics (Morin, 2023b). All these hurdles reinforce the need for teachers to utilize any and all strategies and modifications that have been shown to have a significant impact on achievement, such as those shown in this study.

Suggestions for Further Research

The first suggestion for further research is to design a study to see if the results can be duplicated in other subjects. While some of the modifications observed were specific to math, many could be applied to any topic of study. It would be interesting to see if the same modifications would have a significant impact on an ADHD student in an English, history, or science class as they did in a math class. It would also be interesting to investigate whether teachers in other content areas had more, less, or the same amount of formal training and education on working with students with ADHD in their perspective teacher education programs. Utilizing a similar study with participants from multiple content areas could give some more perspective on how effective the

modifications identified are as well as if the results of the study can be generalized to all topics of study in high school.

Another suggestion for future research would be to build on the results of this study and identify the instructional modifications that might be more effective than others. While the results of this study showed that participants who utilized modifications shown to be beneficial for students diagnosed with ADHD had better outcomes, there was no method used to compare the effectiveness of the individual modifications. Designing a study that utilizes the same statistical analysis, but with more categories to compare in the ANOVA, could give some perspective on which modifications have the greatest impact. While broadening the scope of the ANOVA would increase the chance for inaccurate data, it could also give some direction as to what should be the topic of focus for future studies or professional developments. Finally, designing a study to compare the effectiveness of the modifications in both traditional and virtual classrooms could provide a unique perspective as well. With the growing popularity of virtual education, determining whether the same modifications could be used in a virtual format could provide vital information on how to best educate students with ADHD, although there would be a lot of variables that could impact the results of a study focusing on virtual classrooms.

Delimitations

Delimitations are defined as the boundaries or limits the researcher sets to help ensure that the scope of the research is not too broad and is achievable. In other words, delimitations are the variables or components of the research that the researcher has chosen to control (Theofanidis & Fountouki, 2018). One of the delimitations of this study

was the population chosen for the study. I chose to sample only high school mathematics teachers at a single site out of confidence but also to ensure I had the best chance of active participation in the research. By limiting the research population to a single site, I was able to interview and observe participants I already had established a repour with, increasing the validity of the data collected (Cassady, 2021). Choosing my colleagues to participate in the study eliminated some of the variables that might have influenced the data had I chosen teachers from other schools who were unfamiliar with me.

Another delimitation of the study was the research method I chose for the study. I chose to utilize both quantitative and qualitative methods for this study in order to gather as many types of data as possible. Utilizing both methods of research provided complimentary data as well as increased validity (Wasti et al., 2022). Qualitative data such as the interviews and observations allowed me to include variables such as personal opinion, perception, and understanding of the defined content of the research, which would not be possible without qualitative methods. Similarly, the quantitative methods used allowed me to analyze raw numerical data and make an informed conclusion on the impact modified instructional methods had on the academic performance of students with and without ADHD.

Limitations

Limitations of a study are defined as variables that are out of the researcher's control or potential hurdles or weaknesses in the research design or analysis that could impact the validity of the results (Theofanidis & Fountouki, 2018). One major limitation of this study was the sample size. While the sample used was representative of math teachers at the chosen site, since all math teachers participated, it would be difficult to

generalize the results of the study to apply to all high school math teachers. There were other variables and factors that could have influenced the results as well. For example, being a high school math teacher myself, there could have been some personal bias that influenced how I interpreted the data collected during observations and interviews, which was why both qualitative and quantitative methods were used. The quantitative data could have also been influenced by some other variables. For example, a student could have been sick on the day of the assessments and their grade reflected a makeup, or a student could have missed a day of instruction which could have influenced their performance on the assessment.

The overall duration of the study could also be considered a limitation. The study took place over a single semester, limiting the amount of data that could be collected. If the study took place over the course of an entire school year or even multiple school years, more data could have been collected, increasing the validity of the results. A longer study would have also given the opportunity to reduce some of the variables around the assessments used for quantitative data collection. A study taking place over an entire school year would allow for multiple assessments to be used, allowing for multiple data points and a more accurate representation of the participants' academic performance.

Summary of the Results

This study showed that there are a significant number of regular education teachers who are ill-prepared to meet the needs of their students diagnosed with ADHD. Regular education teachers have limited knowledge of the disorder itself, as well as how the side effects and symptoms of the disorder can impact student academic performance. This study also showed that teachers have limited knowledge of the instructional

modifications that have been shown to level the playing field for students diagnosed with ADHD in their classrooms. Quantitative data collected over the duration of the study also showed that instructional modifications have a significant impact on overall academic achievement for students diagnosed with ADHD. The results of this study could also be expanded to all students, as the statistical analysis used showed a significant impact on academic performance for students not diagnosed with ADHD as well.

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Appendix A

Vanderbilt Assessment Scales for Diagnosing ADHD

NICHQ Vanderbilt Assessment Scale—TEACHER Informant

Teacher's Name: _____ Class Time: _____ Class Name/Period: _____

Today's Date: _____ Child's Name: _____ Grade Level: _____

Directions: Each rating should be considered in the context of what is appropriate for the age of the child you are rating and should reflect that child's behavior since the beginning of the school year. Please indicate the number of weeks or months you have been able to evaluate the behaviors: _____.

Is this evaluation based on a time when the child ☐ was on medication ☐ was not on medication ☐ not sure?

Symptoms	Never	Occasionally	Often	Very Often
1. Fails to give attention to details or makes careless mistakes in schoolwork	0	1	2	3
2. Has difficulty sustaining attention to tasks or activities	0	1	2	3
3. Does not seem to listen when spoken to directly	0	1	2	3
4. Does not follow through on instructions and fails to finish schoolwork (not due to oppositional behavior or failure to understand)	0	1	2	3
5. Has difficulty organizing tasks and activities	0	1	2	3
6. Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort	0	1	2	3
7. Loses things necessary for tasks or activities (school assignments, pencils, or books)	0	1	2	3
8. Is easily distracted by extraneous stimuli	0	1	2	3
9. Is forgetful in daily activities	0	1	2	3
10. Fidgets with hands or feet or squirms in seat	0	1	2	3
11. Leaves seat in classroom or in other situations in which remaining seated is expected	0	1	2	3
12. Runs about or climbs excessively in situations in which remaining seated is expected	0	1	2	3
13. Has difficulty playing or engaging in leisure activities quietly	0	1	2	3
14. Is "on the go" or often acts as if "driven by a motor"	0	1	2	3
15. Talks excessively	0	1	2	3
16. Blurts out answers before questions have been completed	0	1	2	3
17. Has difficulty waiting in line	0	1	2	3
18. Interrupts or intrudes on others (eg, butts into conversations/games)	0	1	2	3
19. Loses temper	0	1	2	3
20. Actively defies or refuses to comply with adult's requests or rules	0	1	2	3
21. Is angry or resentful	0	1	2	3
22. Is spiteful and vindictive	0	1	2	3
23. Bullies, threatens, or intimidates others	0	1	2	3
24. Initiates physical fights	0	1	2	3
25. Lies to obtain goods for favors or to avoid obligations (eg, "cons" others)	0	1	2	3
26. Is physically cruel to people	0	1	2	3
27. Has stolen items of nontrivial value	0	1	2	3
28. Deliberately destroys others' property	0	1	2	3
29. Is fearful, anxious, or worried	0	1	2	3
30. Is self-conscious or easily embarrassed	0	1	2	3
31. Is afraid to try new things for fear of making mistakes	0	1	2	3

The recommendations in this publication do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

Adapted from the Vanderbilt Rating Scales developed by Mark L. Wolraich, MD.

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Please return this form to: _____

Mailing address: _____

_____

Fax number: _____

For Office Use Only

Total number of questions scored 2 or 3 in questions 1–9: _____

Total number of questions scored 2 or 3 in questions 10–18: _____

Total Symptom Score for questions 1–18: _____

Total number of questions scored 2 or 3 in questions 19–28: _____

Total number of questions scored 2 or 3 in questions 29–35: _____

Total number of questions scored 4 or 5 in questions 36–43: _____

Average Performance Score: _____

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D3 **NICHQ Vanderbilt Assessment Scale—PARENT Informant**

Today's Date: _____ Child's Name: _____ Date of Birth: _____

Parent's Name: _____ Parent's Phone Number: _____

Directions: Each rating should be considered in the context of what is appropriate for the age of your child. When completing this form, please think about your child's behaviors in the past 6 months.

Is this evaluation based on a time when the child ☐ **was on medication** ☐ **was not on medication** ☐ **not sure?**

Symptoms	Never	Occasionally	Often	Very Often
1. Does not pay attention to details or makes careless mistakes with, for example, homework	0	1	2	3
2. Has difficulty keeping attention to what needs to be done	0	1	2	3
3. Does not seem to listen when spoken to directly	0	1	2	3
4. Does not follow through when given directions and fails to finish activities (not due to refusal or failure to understand)	0	1	2	3
5. Has difficulty organizing tasks and activities	0	1	2	3
6. Avoids, dislikes, or does not want to start tasks that require ongoing mental effort	0	1	2	3
7. Loses things necessary for tasks or activities (toys, assignments, pencils, or books)	0	1	2	3
8. Is easily distracted by noises or other stimuli	0	1	2	3
9. Is forgetful in daily activities	0	1	2	3
10. Fidgets with hands or feet or squirms in seat	0	1	2	3
11. Leaves seat when remaining seated is expected	0	1	2	3
12. Runs about or climbs too much when remaining seated is expected	0	1	2	3
13. Has difficulty playing or beginning quiet play activities	0	1	2	3
14. Is "on the go" or often acts as if "driven by a motor"	0	1	2	3
15. Talks too much	0	1	2	3
16. Blurts out answers before questions have been completed	0	1	2	3
17. Has difficulty waiting his or her turn	0	1	2	3
18. Interrupts or intrudes in on others' conversations and/or activities	0	1	2	3
19. Argues with adults	0	1	2	3
20. Loses temper	0	1	2	3
21. Actively defies or refuses to go along with adults' requests or rules	0	1	2	3
22. Deliberately annoys people	0	1	2	3
23. Blames others for his or her mistakes or misbehaviors	0	1	2	3
24. Is touchy or easily annoyed by others	0	1	2	3
25. Is angry or resentful	0	1	2	3
26. Is spiteful and wants to get even	0	1	2	3
27. Bullies, threatens, or intimidates others	0	1	2	3
28. Starts physical fights	0	1	2	3
29. Lies to get out of trouble or to avoid obligations (ie, "cons" others)	0	1	2	3
30. Is truant from school (skips school) without permission	0	1	2	3
31. Is physically cruel to people	0	1	2	3
32. Has stolen things that have value	0	1	2	3

Adapted from the Vanderbilt Rating Scales developed by Mark L. Wolraich, MD.

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D3 **NICHQ Vanderbilt Assessment Scale—PARENT Informant, continued**

Today's Date: _____ Child's Name: _____ Date of Birth: _____

Parent's Name: _____ Parent's Phone Number: _____

Symptoms (continued)	Never	Occasionally	Often	Very Often
33. Deliberately destroys others' property	0	1	2	3
34. Has used a weapon that can cause serious harm (bat, knife, brick, gun)	0	1	2	3
35. Is physically cruel to animals	0	1	2	3
36. Has deliberately set fires to cause damage	0	1	2	3
37. Has broken into someone else's home, business, or car	0	1	2	3
38. Has stayed out at night without permission	0	1	2	3
39. Has run away from home overnight	0	1	2	3
40. Has forced someone into sexual activity	0	1	2	3
41. Is fearful, anxious, or worried	0	1	2	3
42. Is afraid to try new things for fear of making mistakes	0	1	2	3
43. Feels worthless or inferior	0	1	2	3
44. Blames self for problems, feels guilty	0	1	2	3
45. Feels lonely, unwanted, or unloved; complains that "no one loves him or her"	0	1	2	3
46. Is sad, unhappy, or depressed	0	1	2	3
47. Is self-conscious or easily embarrassed	0	1	2	3

Performance	Excellent	Above Average	Average	Somewhat of a Problem	Problematic
48. Overall school performance	1	2	3	4	5
49. Reading	1	2	3	4	5
50. Writing	1	2	3	4	5
51. Mathematics	1	2	3	4	5
52. Relationship with parents	1	2	3	4	5
53. Relationship with siblings	1	2	3	4	5
54. Relationship with peers	1	2	3	4	5
55. Participation in organized activities (eg, teams)	1	2	3	4	5

Comments:

For Office Use Only

Total number of questions scored 2 or 3 in questions 1–9: _____

Total number of questions scored 2 or 3 in questions 10–18: _____

Total Symptom Score for questions 1–18: _____

Total number of questions scored 2 or 3 in questions 19–26: _____

Total number of questions scored 2 or 3 in questions 27–40: _____

Total number of questions scored 2 or 3 in questions 41–47: _____

Total number of questions scored 4 or 5 in questions 48–55: _____

Average Performance Score: _____

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NICHQ Vanderbilt Assessment Follow-up: Teacher Informant

Child's Name: _____

Child's Date of Birth: _____

Teacher's Name: _____

Today's Date: _____

Class Time: _____

Class Name/Period: _____

Grade Level: _____

Directions: Each rating should be considered in the context of what is appropriate for the age of the child you are rating and should reflect that child's behavior since the last assessment was filled out. Please indicate the number of weeks or months you have been able to evaluate the behaviors: _____.

Symptoms	Never	Occasionally	Often	Very Often	
1. Fails to give attention to details or makes careless mistakes in schoolwork	○	○	○	○	
2. Has difficulty sustaining attention to tasks or activities	○	○	○	○	
3. Does not seem to listen when spoken to directly	○	○	○	○	
4. Does not follow through on instructions and fails to finish schoolwork (not due to oppositional behavior or failure to understand)	○	○	○	○	
5. Has difficulty organizing tasks and activities	○	○	○	○	
6. Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort	○	○	○	○	
7. Loses things necessary for tasks or activities (school assignments, pencils, books)	○	○	○	○	
8. Is easily distracted by extraneous stimuli	○	○	○	○	
9. Is forgetful in daily activities	○	○	○	○	For Office Use Only _____/9
10. Fidgets with hands or feet or squirms in seat	○	○	○	○	
11. Leaves seat in classroom or in other situations in which remaining seated is expected	○	○	○	○	
12. Runs about or climbs excessively in situations in which remaining seated is expected	○	○	○	○	
13. Has difficulty playing or engaging in leisure activities quietly	○	○	○	○	
14. Is "on the go" or often acts as if "driven by a motor"	○	○	○	○	
15. Talks excessively	○	○	○	○	
16. Blurts out answers before questions have been completed	○	○	○	○	
17. Has difficulty waiting in line	○	○	○	○	
18. Interrupts or intrudes in on others (eg, butts into conversations/games)	○	○	○	○	For Office Use Only _____/9
19. Loses temper	○	○	○	○	
20. Activity defies or refuses to comply with adults' requests or rules	○	○	○	○	
21. Is angry or resentful	○	○	○	○	

NICHQ Vanderbilt Assessment Follow-up: Teacher Informant

Symptoms (continued)	Never	Occasionally	Often	Very Often	
22. Is spiteful and vindictive	○	○	○	○	
23. Bullies, threatens, or intimidates others	○	○	○	○	
24. Initiates physical fights	○	○	○	○	
25. Lies to obtain goods for favors or to avoid obligations (eg, "cons" others)	○	○	○	○	
26. Is physically cruel to people	○	○	○	○	
27. Has stolen items of nontrivial value	○	○	○	○	
28. Deliberately destroys others' property	○	○	○	○	For Office Use Only 2&3s: 0 /10

Academic Performance	Excellent	Above Average	Average	Somewhat of a Problem	Problematic	
29. Reading	○	○	○	○	○	
30. Mathematics	○	○	○	○	○	For Office Use Only 4s: 0 /3
31. Written expression	○	○	○	○	○	For Office Use Only 5s: 0 /3
Classroom Behavioral Performance						
32. Relationship with peers	○	○	○	○	○	
33. Following directions	○	○	○	○	○	
34. Disrupting class	○	○	○	○	○	
35. Assignment completion	○	○	○	○	○	For Office Use Only 4s: 0 /5
36. Organizational skills	○	○	○	○	○	For Office Use Only 5s: 0 /5

Adapted from the Vanderbilt Rating Scales developed by Mark L. Wolraich, MD.

Side Effects: Has the child experienced any of the following side effect or problems in the past week?	Are these side effects currently a problem? None	Mild	Moderate	Severe
Headache	○	○	○	○
Stomachache	○	○	○	○
Change of appetite—explain below	○	○	○	○
Trouble sleeping	○	○	○	○
Irritability in the late morning, late afternoon, or evening—explain below	○	○	○	○
Socially withdrawn—decreased interaction with others	○	○	○	○
Extreme sadness or unusual crying	○	○	○	○
Dull, tired, listless behavior	○	○	○	○
Tremors/feeling shaky	○	○	○	○
Repetitive movements, tics, jerking, twitching, eye blinking—explain below	○	○	○	○
Picking at skin or fingers, nail biting, lip or check chewing—explain below	○	○	○	○
Sees or hears things that aren't there	○	○	○	○

Explain/Comments:

Adapted from the Pittsburgh side effects scale, developed by William E. Pelham, Jr, PhD. Available for downloading at no cost in expanded format at http://ccf.FIU.edu.

Please return this form to: _____

Mailing address: _____ Fax number: _____

For Office Use Only

Total number of questions scored 2 or 3 in questions 1–9: 0

Total number of questions scored 2 or 3 in questions 10–18: 0

Total number of questions scored 2 or 3 in questions 19–28: 0

Total number of questions scored 4 in questions 29–31: 0

Total number of questions scored 5 in questions 29–31: 0

Total number of questions scored 4 in questions 32–36: 0

D5 NICHQ Vanderbilt Assessment Follow-up—PARENT Informant

Today's Date: _____ Child's Name: _____ Date of Birth: _____

Parent's Name: _____ Parent's Phone Number: _____

Directions: **Each rating should be considered in the context of what is appropriate for the age of your child. Please think about your child's behaviors since the last assessment scale was filled out when rating his/her behaviors.**

Is this evaluation based on a time when the child ☐ **was on medication** ☐ **was not on medication** ☐ **not sure?**

Symptoms	Never	Occasionally	Often	Very Often
1. Does not pay attention to details or makes careless mistakes with, for example, homework	0	1	2	3
2. Has difficulty keeping attention to what needs to be done	0	1	2	3
3. Does not seem to listen when spoken to directly	0	1	2	3
4. Does not follow through when given directions and fails to finish activities (not due to refusal or failure to understand)	0	1	2	3
5. Has difficulty organizing tasks and activities	0	1	2	3
6. Avoids, dislikes, or does not want to start tasks that require ongoing mental effort	0	1	2	3
7. Loses things necessary for tasks or activities (toys, assignments, pencils, or books)	0	1	2	3
8. Is easily distracted by noises or other stimuli	0	1	2	3
9. Is forgetful in daily activities	0	1	2	3
10. Fidgets with hands or feet or squirms in seat	0	1	2	3
11. Leaves seat when remaining seated is expected	0	1	2	3
12. Runs about or climbs too much when remaining seated is expected	0	1	2	3
13. Has difficulty playing or beginning quiet play activities	0	1	2	3
14. Is "on the go" or often acts as if "driven by a motor"	0	1	2	3
15. Talks too much	0	1	2	3
16. Blurts out answers before questions have been completed	0	1	2	3
17. Has difficulty waiting his or her turn	0	1	2	3
18. Interrupts or intrudes in on others' conversations and/or activities	0	1	2	3

Performance	Excellent	Above Average	Average	Somewhat of a Problem	Problematic
19. Overall school performance	1	2	3	4	5
20. Reading	1	2	3	4	5
21. Writing	1	2	3	4	5
22. Mathematics	1	2	3	4	5
23. Relationship with parents	1	2	3	4	5
24. Relationship with siblings	1	2	3	4	5
25. Relationship with peers	1	2	3	4	5
26. Participation in organized activities (eg, teams)	1	2	3	4	5

Adapted from the Vanderbilt Rating Scales developed by Mark L. Wolraich, MD.

Revised - 0303

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D5 **NICHQ Vanderbilt Assessment Follow-up—PARENT Informant, continued**

Today's Date: _____ Child's Name: _____ Date of Birth: _____

Parent's Name: _____ Parent's Phone Number: _____

Side Effects: Has your child experienced any of the following side effects or problems in the past week?	**Are these side effects currently a problem?**			
	None	**Mild**	**Moderate**	**Severe**
Headache				
Stomachache				
Change of appetite—explain below				
Trouble sleeping				
Irritability in the late morning, late afternoon, or evening—explain below				
Socially withdrawn—decreased interaction with others				
Extreme sadness or unusual crying				
Dull, tired, listless behavior				
Tremors/feeling shaky				
Repetitive movements, tics, jerking, twitching, eye blinking—explain below				
Picking at skin or fingers, nail biting, lip or cheek chewing—explain below				
Sees or hears things that aren't there				

Explain/Comments:

For Office Use Only

Total Symptom Score for questions 1–18: _____

Average Performance Score for questions 19–26: _____

Adapted from the Pittsburgh side effects scale, developed by William E. Pelham, Jr, PhD.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

NICHQ

National Initiative for Children's Healthcare Quality

McNeil Consumer & Specialty Pharmaceuticals

11-21/rev0303

Appendix B

Sample Assessment Used for Quantitative Data Collection

Geometry Diagnostic Test

Multiple Choice (4 pts. Each)

1) Solve: $x - (15x - 6) = 104$

A) $\frac{-55}{7}$ B) $\frac{-49}{8}$ C) $\frac{-55}{8}$ D) -7

2) Find the distance between P(-4, 6) and Q(-2,-8)

A) $2\sqrt{58}$ B) $2\sqrt{10}$ C) $10\sqrt{2}$ D) $4\sqrt{58}$

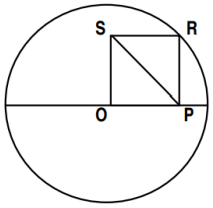
3) The value of $3^{-2} + 2^{-3}$ is:

A) -1 B) $\frac{1}{17}$ C) $\frac{17}{72}$ D) $\frac{1}{72}$

4) Solve the equations $2(m + 5) = -25$ and $4(2 - n) - 2 = 41$. What is the sum of the solutions for m and n?

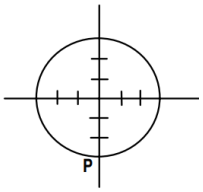
A) 17 B) -35 C) $-\frac{35}{2}$ D) $-\frac{35}{4}$ E) $-\frac{105}{4}$

5) In the figure to the right, O is both the center of the circle with radius 2 and a vertex of the square OPRS. What is the length of diagonal PS?



(A) 1/2 (B) 1 (C) 4 (D) 2 (E) 2/3

In the figure to the right, the circle is centered at the origin and passes through point P (0, -3). Which of the following points does it also pass through?



A) (3, 3) B) $\left(-2\sqrt{2}, -1\right)$ C) (2, 6)

D) (1.5, 1.3) E) (-3, 4)

6)

Factor completely: $18x^3 - 63x^2 + 9x =$

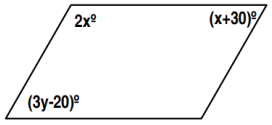
A) $9\,(2x^3 - 7x^2 + x)$ B) $9x\,(2x^2 - 7x)$

C) $9x\,(2x^2 - 7x + x)$ D) $9x\,(2x^2 - 7x + 1)$

E) $9x\,(2x - 1)(x - 3)$

7)

Find the value of x and y that will make this a parallelogram.



A) $x = 45,\ y = \frac{110}{3}$ B) $x = 50,\ y = \frac{100}{3}$

C) $x = 50,\ y = 20$ D) $x = 50,\ y = 60$

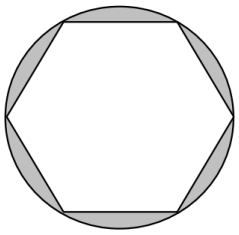
8)

Give the most <u>specific</u> name for the polygon with vertices (5,-2), (4,2), (0,3), and (1,-1)

A) parallelogram B) rectangle
C) square D) rhombus
E) quadrilateral

9)

Find the area of the shaded region (a regular hexagon inscribed in the circle with a radius of 6)



A) $54 - 36\pi$ B) $36\pi - 108$ C) 6π

D) $108\pi^2$ E) $36\pi - 54\sqrt{3}$

10)

<u>Free Response (6 Pts. Each)</u> 2 pts for picture, 2 pts for correct eqution, 2 pts for correct answer

Given the measure of angle A is 33°. Find the sum of the measures of the complementary angle, supplementary angle and vertical angle for angle A.

11)

A boy is mowing a rectangular lawn 40 ft. long and 30 ft. wide. He has cut all of it except for a rectangle that is 20 ft. long and 15 ft. wide. What fractional part of the lawn remains uncut?

12)

13)

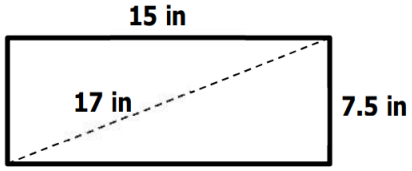
Devin paid $30 to be a member of the Fox Lake Gym. When he takes the boxing class, it costs him $2. Jared is not a member of the Gym, and it costs him $5 for the same class. How many classes would it take for Devin's total cost to equal Jared's total cost?

14)

David must install fencing around a lot that is shaped like a right triangle. The side of the lot that runs east-west is 200 ft long. The side of the lot that runs north-south is 125 ft long. Calculate how many feet of fencing he will need to surround the entire lot.

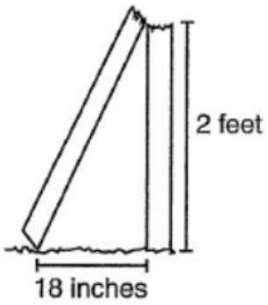
15)

Stephanie wants to check if the top of a side table she saw for sale is perfectly rectangular. She measured the dimensions of the table and found the following:
Length of table: 15 inches
Width of table: 7.5 inches
Diagonal length of table: 17 inches
Is the table perfectly rectangular?



16)

The diagram at the right shows how a post was broken. What was the original height of the post?



17)

The length of a rectangle exceeds 3 times its width by 1 inch. If the length of the rectangle is diminished by 3 inches and the width is doubled, a new rectangle is formed whose perimeter is 46 inches. Find the dimensions of the original rectangle.

18)

Mr. Price deposited $170 in his bank. The number of $5 bills was 3 times the number of $10 bills, and the number of $1 bills was 30 more than the number of $5 bills. How many bills of each type did he deposit?

19) The perimeter of a rectangle is 28 in. If its length is 9 in., find its area.

20) Find the equation of the line containing the point (–3, –12) and having slope: –4.

Appendix C

Behavioral Engagement Related to Instruction Observational Protocol

Behavioral Engagement Related to Instruction (BERI)
Version 1

PhysPort
Supporting physics teaching with research-based resources

Developed by: Erin S. Lane and Sara E. Harris
Format: Observation protocol
Duration: any minutes
Focus: Interactive teaching
Level: Graduate, Upper-level, Intermediate, Intro college, High school, Middle school

How to give the test

- Prior to conducting a classroom observation, obtain a printed copy of the instructor's notes or lesson plan.
- At the beginning of the class, the fills out a coversheet that contains general information and notes about the class.
- For a large lecture room, randomly choose a spot in the classroom where you are sitting in the row directly behind the students being observed and at an angle so that the students were still within your sight line. For alternative classroom settings, the number of students or observers' position may have to be adjusted so that all students in the observation group can be adequately see.
- Using the engaged and disengaged behaviors shown under Example Questions, cycle through each of the 10 students in sequence and for each student recorded "E" for engaged, "D" for disengaged, and "U" for uncertain. Uncertain is most often used when the view of the students is obstructed.
- It takes approximately 3 to 10 seconds to gauge the level of engagement of each student, with a 10-student cycle taking approximately one minute to complete. Don't record the specific behavior of each individual; rather, for each 10-student cycle record one observation point (e.g., "8/10 students engaged") with a time stamped at the start of the cycle.
- Once the class starts, record observation points directly onto the copy of the instructor's notes in the section corresponding to what is being covered. This ensures that the instructor will later be able to relate engagement with what was happening in their class at any specific time. An observation point is taken for every page of notes, for any major change in activity or content, or at 2-minute intervals depending on which time interval is shorter. Changes in the classroom activity (e.g., clicker question, in-class discussion, demonstration) or instructor behaviors (e.g., moving around the classroom, using humor or real-world examples) are recorded under each observation point.
- Instructor questions to the class and student questions to the instructor should also be documented with the following information: the section of the room in which the question/answer originated and how the interaction is followed up (e.g., entire class, subgroup of students, one student).

How to score the test

- Calculate the average student engagement score for the class including the standard error. You can also calculate the average student engagement score for specific instructional activities.
- Plot the student engagement score over time to get a sense of which classroom activities are more or less engaging.

Student Engaged and Disengaged Behaviors

During your classroom observation, use these engaged and disengaged behaviors and cycle through each of the 10 students you are observing in sequence and for each student recorded "E" for engaged, "D" for disengaged, and "U" for uncertain on the instructor notes or lesson plan provided to you by the instructor. Uncertain is most often used when the view of the students is obstructed

TABLE 1

Descriptions of student in-class behaviors that indicate they are engaged.

	Engaged
Listening	Student is listening to lecture. Eye contact is focused on the instructor or activity and the student makes appropriate facial expressions, gestures, and posture shifts (i.e., smiling, nodding in agreement, leaning forward).
Writing	Student is taking notes on in-class material, the timing of which relates to the instructor's presentation or statements.
Reading	Student is reading material related to class. Eye contact is focused on and following the material presented in lecture or preprinted notes. When a question is posed in class, the student flips through their notes or textbook.
Engaged computer use	Student is following along with lecture on computer or taking class notes in a word processor or on the presentation. Screen content matches lecture content.
Engaged student interaction	Student discussion relates to class material. Student verbal and nonverbal behavior indicates he or she is listening or explaining lecture content. Student is using hand gestures or pointing at notes or screen.
Engaged interaction with instructor	Student is asking or answering a question or participating in an in-class discussion.

TABLE 2

Descriptions of student in-class behaviors that indicate they are disengaged.

	Disengaged
Settling in/ packing up	Student is unpacking, downloading class material, organizing notes, finding a seat, or packing up and leaving classroom.
Unresponsive	Student is not responsive to lecture. Eyes are closed or not focused on instructor or lecture material. Student is slouched or sleeping, and student's facial expressions are unresponsive to instructor's cues.
Off-task	Student is working on homework or studying for another course, playing with phone, listening to music, or reading non-class-related material.
Disengaged computer use	Student is surfing web, playing game, chatting online, checking e-mail.
Disengaged student interaction	Student discussion does not relate to class material.
Distracted by another student	Student is observing other student(s) and is distracted by an off-task conversation or by another student's computer or phone.

Appendix D

BERI Observation Protocol Coversheet

BERI Observation Protocol Coversheet

Date of Observation: _____

Course Name, Number and Section: _____

Instructor(s): _____

Observer's Name: _____

Classroom Number: _____

Estimate of class attendance: _____

Position in Class: (drawing a diagram of the class may be useful)

Notes on classroom environment: (i.e. description of space and seating arrangement, abnormal temperature, use of technology).

Brief description of instructional method: (i.e. traditional lecture mixed with clicker questions).

Notes about group of students being observed: (i.e. 5/10 are using a computer).