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Attention Deficit Hyperactivity Disorder (ADHD)-Specific Learning Disorder (SLD) in Mathematics Learner's Response towards Synchronous Online Class

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Abstract Developing basic mathematics skills for all children especially those who are diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and math disability is not easy. And the sudden shift from face-to-face classes to online instructional delivery due to the unprecedented COVID-19 pandemic has been a challenge to them. Hence, this qualitative descriptive-exploratory case study was undertaken to explore the response of a learner with Attention Deficit Hyperactivity Disorder (ADHD) and Specific Learning Disorder (SLD) with impairment in mathematics towards a synchronous online Orton-Gillingham Math intervention in terms of working behavior. The participant was chosen purposively based on the diagnosis, arithmetic calculation level, and unfamiliarity with the OG-Math intervention. The participant was taught using the OG-Math approach via an online platform for twice-a-week for 4 weeks. The online classes were recorded then transcribed with consent from the participant's parent and school. The data were analyzed using trustworthy thematic analysis to ensure validity and reliability. The analysis revealed five (5) emerging themes namely symptoms of inattention, symptoms of hyperactivity and impulsivity, lowered vigilance, emotional understanding and reactivity, and active class participation. Despite the existence of these responses, the participant was still able to participate actively in synchronous online class and showed emotional competence. It can be concluded that learner-participant with ADHD-SLD with impairment in math can thrive in synchronous online class given her short attention span.

Keywords: *attention deficit hyperactivity disorder, specific learning disorder, math disability, multisensory approach, concrete-representational-abstract progression, working behavior, Orton-Gillingham Math, intervention*

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1. Introduction

The COVID-19 pandemic resulted in an unexpected challenge for schools across the world. It made the educational system take implementation adjustments. Governments have allowed the continuation of education with strict adherence to safety and health protocols. In other Asian countries, for example in Indonesia, they implemented the non-conventional delivery modes through online classes [1]. In the Philippines, the Department of Education (DepED) allowed schools to choose from the different learning delivery modalities either through distance learning using printed modules or blended learning modality utilizing accessible media, such as TV, radio, and online synchronous or asynchronous classes [2].

However, the sudden shift of the learning delivery modes has been a challenge for both typically developing learners and those with special needs. According to a recent study conducted, students with special learning needs are struggling with the distance learning setting. It was also observed that most of them have a shorter attention span [1]. With this, teaching mathematics online to learners with Attention Deficit Hyperactivity Disorder (ADHD) would be a challenge. Teachers should bring mathematics lessons to learners diagnosed with ADHD considering the learners' short attention span.

Teachers should have strategies to teach mathematics for a student with ADHD that are different from strategies for other mainstream learners [3]. Developing basic mathematics skills for all children especially those who are diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and math disability is not easy [4].

Children with ADHD are considered to have a neurological disorder that may manifest itself with hyperkinetic activity and/or a difficult time concentrating. They tend to have inattentive and hyperactive or impulsive behaviors that often require support from caregivers and

treatments such as medication or behavioral interventions [5]. Moreover, they have very poor sleep patterns, and although they appear not to need much sleep, daytime behavior is often worse when sleep is badly affected [6]. Further, children with Specific Learning Disorder (SLD) with impairment in mathematics are observed to have patterns of difficulties in problems processing numerical information, learning arithmetic facts, and performing accurate or fluent calculations [7].

On one hand, Brandon [8] conducted a study on the effectiveness of the Hill Model of instruction on children with learning disabilities and attention deficit disorders' mathematics fluency. Hill Model is a methodology utilized by the Hill Center, an educational program for children with learning disabilities and attention deficit disorders in Durham, North Carolina. She incorporated the components from the Orton-Gillingham (OG) model of instruction in her model, such as multisensory instruction, mastery learning, and formative feed backing. It was found that there is a positive modest growth in a learners' mathematics fluency.

With these aforementioned points and as attested by Sheffield [9] stating that all Orton-Gillingham programs can be effective, as one of the implementers of the Orton-Gillingham approach, the researcher explored how an ADHD with Specific Learning Disorder (SLD) with an impairment in math diagnosed learner responds in her terms of working behavior towards online OG-Math intervention.

2. Theoretical Framework and Related Literature

This study is anchored on the behaviorism of Pavlov and Watson [10] learning theory. It focuses on how the learner as a participant of the study responded and behaved when subjected to stimuli. The study evolved around how the teacher's actions through instruction during an online class produced working behavior response through the learner's immediate reactions. More specifically, how the learner behaved during the online OG Math class as the stimulus and when this was repeatedly introduced throughout the observation period. Since the learner-participant is diagnosed with ADHD with Specific Learning Disorder (SLD) with impairment in mathematics, and the class was conducted online where the learner was not accustomed and familiar with, behaviorism was most appropriate and applicable to observe how the subject responded to the introduced stimuli.

This study is also grounded on Witzel's [11], Concrete, Representational, Abstract (CRA) instructional framework, which is one of the main features of OG Math. OG Math process for teaching and learning mathematical concepts started with the manipulation of concrete materials such as the OG colored bars, chips, and toys and gradually progresses to the representational level. This second stage of the learning process is where the conversion of concrete concepts to representations through drawing of bars and lines. Then, it peaks at the abstract level, at which numbers and symbols are used to demonstrate understandings. The CRA instructional framework uses explicit instruction, which is recommended for an effective mathematics pedagogical approach for students with disabilities [12]. The use of manipulatives in instruction is one strategy commonly used to encourage learners to become more actively involved in mathematics. Henceforth, the active engagement of the learner on the manipulation and construction of representations will give enough opportunity to observe responses and physiological and social reactions from the learner diagnosed with ADHD with SLD in mathematics.

Moreover, this study is also founded on a multisensory approach as the other main feature of OG-Math. According to Chacko, Underman, Feirsen, Bedard, and Marks [13], CRA model is categorized as a multisensory approach because it integrates visual, auditory, kinesthetic, and tactile interactions with content through the direct handling of objects and matching of graphic designs. These two main features of OG Math were found to be of help to children with disabilities in learning math.

On the other hand, the growing presence of K–12 online education programs is a trend that promises to increase flexibility, improve efficiency, and foster engagement in learning. Students with disabilities can benefit from dynamic online educational environments, but only to the extent that they can access and participate in the learning process [14].

However, at the start of the COVID-19 pandemic where schools around the world were forced to rapidly transition from face-to-face learning environments to online learning, students with special learning needs are struggling with the distance learning setting. Most of these learners with special needs have a shorter attention span. Though teachers and learning support teams periodically checked in with the learners, parents would mostly have to spend time assisting or monitoring these students' learning at home [1].

According to Grover and his research team [15] online classes have a negative impact on the behavior and physical health of the children in which suggests that the level of learning with regular classes, cannot be matched by the online classes. Teachers, students, and parents need time to adapt to the new learning system [1].

3. The Method

The researcher employed a qualitative descriptive-exploratory case study. One learner-participant was chosen based on the criteria - diagnosis, arithmetic calculation level, and unfamiliarity with OG-Math intervention. The learner-participant was taught basic operation addition skills for twice-a-week for four weeks using the Orton-Gillingham Math approach. The primary source of data for this research study included: (a) the evaluation from the Developmental and Behavioral Pediatrician of the participant, (b) the teacher-researcher assessment, and (c) the recorded observations during the implementation of the OG-Math intervention. The intervention was implemented through an online platform due to restraints in movement brought about by the unprecedented COVID-19 pandemic. The learner-participant was provided with OG manipulative-colored bars, flashcards, whiteboards, and markers. The online classes were recorded with consent from the participant's

parent and school. The data gathered from the recorded online classes were transcribed then coded together with the data gathered from the evaluation of the Developmental and Behavioral Pediatrician.

The recorded videos from eight online class sessions were transcribed. The videos provided data that could reveal how the learner-participant responded to a class delivered through an online platform.

The researcher used the 6-phase trustworthy thematic analysis outlined by Nowell et al. [16] which is a practical and effective procedure for conducting thematic analysis that aims to meet the trustworthiness criteria by Lincoln and Guba [17]. A trustworthy thematic analysis was employed to ensure the validity and reliability of the research findings. Following the 6-phase trustworthy thematic analysis, the researcher first read and re-read the data several times to gain familiarity with the data. Also, the researcher stored raw data in well-organized archives. Furthermore, the researcher documented thoughts about potential codes/themes. Second, after the researcher gained ideas of what was in the data and interesting about them, the production of initial codes was made. During coding, the researcher identify important sections of text and attached labels to index them as they related to a theme or issue in the data [18]. The transcribed data were coded using working behavior, addition skills, and mathematics concepts. The researcher extracted the significant statements and observation which were coded under working behavior and re-coded them into the codes under the formulated meanings and organized in a table. The significant observation and statements which occurred repeatedly were only noted once when presented in the table.

4. Results and Discussion

Depicted in Table 1 are the initial codes describing the working behavior of the participant based on the extracted significant statements and observations from the transcribed recording of online classes and the participants' Developmental and Behavioral Pediatrician. On the same table, generated clustered themes derived through a deductive analysis were also presented.

Table 1. The Generated Theme Clusters Using Deductive Analysis

Significant Observation and Statements	Formulated Meanings	Theme Cluster
S1: (looking at something on her table)	Has difficulty sustaining attention in tasks	Attention span is low
S1:(looks to her left and still no response)		
S1:(looks to her left and right)		
S1:(not looking at the screen)		
S1:(looks away and giggles)	Is distracted by extraneous stimuli	Gets distracted
S1:(looks to her right and giggles)		
S1:(does something on her table)		
T: "Read the next S1 please."	Does not seem to listen when spoken to directly	Has auditory inattention
T: "Do not write anymore on the board. Just look at the screen."	Does not follow through on instructions	
T: "Listen to the question."	Fails to give close attention to details or makes careless mistakes	
S1: "I still don't know, ma'am."	Avoids dislikes or is reluctant to engage in tasks that require sustained mental effort	Has task avoidance
S1: (agrees hesitantly)		
S1: (puts one hand on her chin)		
S1: (looks at the screen and gently scratches her hair)		
S1: (flips her hair using both hands and put hands on her chin)		
T: "Do not say the answer, yet. Listen first to the teacher."	Blurts out an answer before a question has been completed	Less Self-Control
T: "Yes, but you have to listen first."		
S1: "16" (already gives the final answer)		
S1: (shows her notebook with the answer she wrote)	Has difficulty waiting her turn	Has impatience
T: "Do not write it yet."		
T: "Wow. You did it already."		
S1: (shows her whiteboard with her answer)		
T: "Okay, just wait."	Interrupts or intrudes on the teacher	Rushing through tasks
S1: "Me, ma'am."		
S1: (writes something on her notebook)		
S1: (yawns and stretches her arms)	Feeling sleepy	Sleepiness
S1: "I'm sorry."	Feeling sorry	Feelings toward Getting mistakes
S1: (shows sad face)	Feeling sad	
S1: "I'm happy."	Feeling happy	Feelings toward Getting correct answers
S1: (smiling and dancing on her chair)		
S1: (answers the questions)	Answers questions verbally	Verbal participation
S1: (reads the addition sentences)	Takes part in the discussion	
S1: (reads the definitions and meanings of addition terms and symbols)		
S1: (uses the manipulatives to answer practice problems)		
S1: "Me, ma'am." (raises her hand)	Raises hand to volunteer in answering problems	Non-verbal participation
S1: (nods her head)	Nods head to show understanding of the lesson	
S1: (gives her answers by showing the OG bars or her fingers)	Answers questions non-verbally	
Teacher: S1 looks at the shared presentation on screen most of the time.	Has eye contact	

Table 2. Emerging Themes on the Participant's Response Towards an Online OG-Math Intervention in Terms of Working Behavior

Theme Cluster	Emerging Theme
Attention span is low	Theme 1: Symptoms of inattention
Gets distracted	
Has auditory inattention	
Has task avoidance	
Less Self-Control	Theme 2: Symptoms of hyperactivity-impulsivity
Has impatience	
Rushing through tasks	
Sleepiness	Theme 3: Evidence of Lowered Vigilance
Feelings toward Getting mistakes	Theme 4: Emotional Understanding and Reactivity
Feelings toward Getting correct answers	
Verbal Participation	Theme 5: Active Class Participation
Non-Verbal Participation	

The researcher gave theme names that were impactful and would immediately give the reader a sense of what the theme was about and considered how each theme fitted into the overall story about the entire data set concerning the research question as suggested by Braun and Clarke [19]. There were five (5) emerging themes generated after the trustworthy thematic analysis was employed namely, symptoms of inattention, symptoms of hyperactivity-impulsivity, evidence of lowered vigilance, emotional understanding and reactivity, and active class participation as shown in Table 2.

4.1. Symptoms of Inattention

The observations from online classes revealed that the participant with ADHD and SLD with impairment in mathematics showed symptoms of inattention. Several observable behaviors often happened during the OG-Math online intervention. She could be observed looking at her left and right instead of looking at the screen. She would often not respond to the teacher when asked questions or when talked to. Moreover, she often could not follow the instructions which were already simplified for easy understanding and even when she was reminded about it. She would tend to perform a task that was correct but was not asked for her to perform. Furthermore, she had a tendency to avoid tasks which she found difficult. These observations were similar to the symptoms of inattention observed by Grover, Goyal, Mehra, Sahoo, & Goyal [15] in their explorative study on the impact of the COVID-19 pandemic on online home learning in primary schools in Indonesia. They found out that most of the students with special learning needs have a shorter attention span in an online class.

4.2. Symptoms of Hyperactivity-Impulsivity

The observations from online classes also showed that the participant with ADHD and SLD with impairment in mathematics showed symptoms of hyperactivity-impulsivity. The participant was observed interrupting the teacher's discussion by doing irrelevant things and blurting out answers before the questions were completed. These observations confirmed Youn's [5] findings that children with ADHD tend to have inattentive and hyperactive or impulsive behaviors that often require support from caregivers and treatments such as medication or behavioral interventions. These hyperactive and impulsive behaviors came out during OG-Math online intervention.

4.3. Evidence of Lowered Vigilance

The teacher observed that the participant would always rub her eyes, yawn and stretch her arms whenever she was sleepy. This is an example of motor restlessness which is the most obvious evidence of lowered vigilance. It could be observed that the participant became sleepy after an average of 39 minutes. During the first day of online class, she showed gestures of being sleepy after 50 minutes and 54 seconds. On the second, third, fourth, fifth, and eighth day, she showed sleepiness at 52:39, 35:28, 38:23, and 39:05 respectively. Problem such as difficulty staying awake (drowsiness or sleepiness) can be the result of disturbed vigilance. When vigilance is lost, the individual has difficulty sustaining attention. The words sleepy and drowsy are used synonymously to denote decreased (negative) levels of attention [20].

4.4. Emotional Understanding and Reactivity

The participant expressed three dominant feelings during her online classes - feeling happy, sad, and apologetic. The participant displayed sad gestures when not being able to get the correct answer or when making a mistake. She was also apologetic.

S1: "Sorry"

She constantly said "sorry" every time the teacher told her to try again after committing mistakes.

S1: "Yes, I'm happy".

Meanwhile, whenever she got the correct answers, she would always display her happiness by swinging, waving, and raising her hands happily. She would also dance on her chair and tell the teacher that she is happy. The participant displayed matched expressions and situations which is a sign of emotional understanding and reactivity. She was also able to label her emotions.

4.5. Active Class Participation

The learner-participant's participation in the online classes was through two communication behaviors namely verbal and non-verbal. She would answer questions verbally and non-verbally. She also volunteered in answering some of the problems by raising her hand. She

would often nod her head to show that she understood the lesson. Despite the existence of inattention, hyperactivity, impulsivity and lowered vigilance, she was observed to have eye contact most of the time by looking at the presentation shared on the screen.

5. Conclusions

This study examined a learner's responses towards online OG-Math intervention to be; inattention, hyperactivity, impulsivity, lowered vigilance, emotional understanding and reactivity, and active class participation. Despite the existence of inattention, hyperactivity, impulsivity and lowered vigilance, the participant was still able to participate actively in online class and showed emotional competence. Based on the findings, this current study concluded that learners with ADHD-SLD with impairment in math can thrive in online class given their short attention span.

6. Limitation of the Current Study and Implication for Future Study

In the current study, only one participant was involved as suggested by Boddy [21]. The impact of online classes on the working behavior of the participant could be better investigated if there were more participants to identify commonalities among them. Given this limitation, it can be implicated for future study to consider three to four participants diagnosed with ADHD and SLD with impairment in Math as suggested by Creswell [22].

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