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Orton-Gillingham Approach as an Online Intervention for Learners Diagnosed with Attention Deficit Hyperactivity Disorder (ADHD)-Specific Learning Disorder (SLD) in Mathematics: A Descriptive Case Study

Laila S. Lomibao and Heidemae R. Tabor

Abstract

The purpose of this qualitative descriptive case study was to investigate whether the use of Orton-Gillingham Math as an intervention in teaching a child diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and Specific Learning Disorder (SLD) with impairment in mathematics lead to an improvement in addition skills. This study had a single participant chosen purposively based on the criteria namely diagnosis, arithmetic calculation level, and unfamiliarity with OG-Math intervention. The learner-participant was taught using the OG-Math approach which two main features are multisensory approach and concrete-representational-abstract progression via an online platform for twice-a-week over a period of four weeks. The pre and post evaluation of the learner-participant's Developmental and Behavioral Pediatrician and the pre and post paper and pencil test which was composed of 75-item addition problems conducted by the teacher were used to determine the learner-participant's basic operation addition fact knowledge prior and subsequent to the implementation of OG-Math online intervention. The data were analyzed using trustworthy thematic analysis and pattern matching. The analysis revealed that the learner-participant can already solve addition problems involving 3-digit addends with and without regrouping after the math intervention from only being able to solve single-digit addition problems. Hence, it is recommended to mathematics teachers to use OG-Math approach as an online intervention to children with ADHD and SLD with impairment in math to improve their addition skills.

Keywords: multisensory approach, concrete-representational-abstract (CRA) progression, addition skills, attention deficit hyperactivity disorder (ADHD), Specific Learning Disorder (SLD), mathematics

Laila S. Lomibao is a Full Professor and currently the Dean of the College of Science and Technology Education of the University of Science and Technology of Southern Philippines, Cagayan de Oro City. Dr Lomibao graduated with her PhD in Mathematical Sciences major in Mathematics Education at USTP. Also, before she joined the USTP System, she has also served as a secondary school teacher of the Department of Education (DepEd), division of Cagayan de Oro City. Dr. Lomibao was also recently awarded Research Productivity Awardee of the USTP System. Her recent publications include: Cajandig, A. J. S., & Lomibao, L. S. (2020). 5I's Learning Path with Cultural Approach Embedded to CAI on Student's Conceptual Understanding. American Journal of Educational Research, 8(10), 772-778; Bacabac, M. A. A., & Lomibao, L. S. (2020). 4S Learning Cycle on Students' Mathematics Comprehension. American Journal of Educational Research, 8(3), 182-186; Maandig, R. B., Lomibao, L. S., & Luna, C. A. (2017). Structured Content Reading Instruction vs. Direct Instruction: Their Implication on Students' Achievement, Reading Comprehension and Critical Thinking in Mathematics. American Journal of Educational Research, 5(5), 574-578; Lomibao, L. S., Luna, C. A., & Namoco, R. A. (2016). The influence of mathematical communication on students' mathematics performance and anxiety. American Journal of Educational Research, 4(5), 378-382; Lomibao, L. S. (2016). Enhancing mathematics teachers' quality through Lesson Study. SpringerPlus, 5(1), 1-13.

Heidemae R. Tabor is an Instructor of the College of Science and Technology Education of the University of Science and Technology of Southern Philippines, Cagayan de Oro City. Ms. Tabor graduated with her Master of Science in Teaching Mathematics at USTP. Also, before she joined the USTP System, she has also served for 7 years as an Orton-Gillingham Math teacher of iLearn Educational Intervention and Therapy Center which is a subsidiary of Bright Light Learning Academy in Cagayan de Oro City. Her recent publication includes: Heidemae R. Remata and Laila S. Lomibao. Attention Deficit Hyperactivity Disorder (ADHD)-Specific Learning Disorder (SLD) in Mathematics Learner's Response towards Synchronous Online Class. American Journal of Educational Research. 2021; 9(7):426-430. doi: 10.12691/education-9-7-5.

Introduction

Arithmetic calculation is a basic academic skill, along with reading and writing skills, which forms the foundation for academic learning and practical skills of daily life (Heale, & Forbes, 2013). However, the development of arithmetic skills is not easy for all children especially those who are diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and math disability (Remata & Lomibao, 2021; Platt, 2016). These two neurodevelopmental disorders have high comorbidity in children. Mathematics disability rarely occurs in isolation. It is frequently diagnosed with ADHD (Waton, et al., 2013). The research of Mayes, Calhoun, and Crowell (2000) indicates that 26% of children with ADHD have a specific math disability. Given the negative consequences of ADHD, effective school based interventions are warranted to enhance their capacity for learning (Shillingford-Butler, et al., 2013). This also holds true for math disability. There is no medicine for it and it never get cured (Amimul, et al. 2020). However, on the basis of the few high-quality mathematics interventions for learning disabled students, the National Mathematics Advisory Panel determined that direct, teacher-guided explicit instruction on how to solve specific types of mathematics problems was the most effective intervention. Effective interventions always involved multiple sessions extending over several weeks to six months and resulted in large improvements in students' ability to solve mathematical word problems, computational arithmetic problems, and novel word and arithmetic problems (Geary, 2011).

Based on the Diagnostic and Statistical Manual for Mental Disorders (DSM-V; APA 2013), attention-deficit/hyperactivity disorder (ADHD) is a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development, as characterized by inattention and/or hyperactivity and impulsivity. The Specific Learning Disorder (SLD) with impairment in mathematics refers to a pattern of difficulties characterized by problems processing numerical information, learning arithmetic facts, and performing accurate or fluent calculations.

According to Parsons and Bynner (1997) these difficulties in arithmetic can have serious long-term consequences for later school achievement and limit one's societal and occupational opportunities in adult life, hence, these learners need special instruction in order to experience success. Children diagnosed with ADHD and Specific Learning Disorder with impairment in mathematics need intervention to cope up with the demands of the schools. Effective tools for support should be available at schools to provide adequate basic skills and to diminish later difficulties in basic mathematical skills, and thus, prevent long-lasting negative impacts. However, some of the schools in the Philippines cannot provide such interventions. And so parents choose to enroll their children to math programs offered by educational centers which they believed to be of help for the improvement of their children's math skills. Unfortunately, not all types of learners can benefit from these programs. Some programs are proven to have significant effect on the math performance of the children but not specifically to those diagnosed with ADHD and Specific Learning Disorder with impairment in Mathematics.

In recent times, a wide variety of educational interventions have been developed for helping children with difficulties of varying severity in mathematics (Dowker, 2017). One of the interventions used now is the Orton-Gillingham approach. It is used to treat Dyslexia. It is a style of instruction that focuses on certain features, namely: personalized, multisensory, diagnostic and prescriptive, direct instruction, systematic and structured, sequential, incremental and cumulative,

continuous feedback and positive reinforcement, cognitive approach and emotionally sound. Educators are using this with children who struggle in math. Orton-Gillingham Math generally refers to a multisensory approach effective to children with learning disability. It follows a progression of concrete-representational-abstract. It is also designed to be used with direct one-on-one or small group instruction. According to Sheffield (1991), all Orton-Gillingham programs can be effective. She also claimed that OG may be the only remedial programs that are valid for many struggling children and discouraged adults. As for its features, the use of multi-sensory learning had been studied as an effective approach in maximizing learning (Suryaratri, Prayitno, & Wuryani, 2019). And CRA was not just found effective in teaching mainstream learners but it also demonstrated effective for students with learning disabilities who struggled in mathematics is significant (Bouck, Satsangi, & Park, 2018). However, Orton-Gillingham Math has no broad support yet in the research community, because there are only a few studies that focus on the use of Orton-Gillingham approach as mathematics intervention to children with special needs.

A school in Cagayan de Oro City provides educational therapy services for children in mainstream and with special needs. One of the services is the Orton-Gillingham Math which generally refers to a multisensory approach for achieving mastery of primary and intermediate level math concepts. The children enrolled in this program are diagnosed with learning disabilities and disorders attend a one-on-one face-to-face instruction. They have an evaluation report from their Developmental and Behavioral Pediatrician and they will be re-evaluated after six months or one year.

With these, this study aimed to investigate the teaching of basic addition skills using OG-Math to the child diagnosed with ADHD-SLD with impairment in mathematics. This study was not intended to promote Orton-Gillingham Math as the only multisensory approach to improve basic operation skills to a child diagnosed with ADHD-SLD with impairment in mathematics. However, it was hypothesized that OG-Math approach would lead to an improvement in the child's mastery of basic operation addition skills and facts.

Methodology

The research employed a qualitative descriptive case study. A non-probability purposive sampling was adapted in this study. Out of twelve, one participant was chosen based on the criteria - diagnosis, arithmetic calculation level and unfamiliarity with OG-Math intervention. The chosen participant in this study was a 13-year old diagnosed with ADHD and SLD with impairment in mathematics by a Developmental and Behavioural Pediatrician. This study was conducted in iLearn Educational Intervention and Therapy Center which is a subsidiary of Bright Light Learning Academy in Cagayan de Oro City. iLearn provides educational therapy services for children in mainstream and with special needs since 2013.

The learner-participant was taught basic operation addition skills for twice-a-week over a period of four weeks using Orton-Gillingham Math approach. The evaluation of the learner-participant's Developmental and Behavioral Pediatrician which could show the math-numerical level and basic operation skills and the performance of the learner-participant on the teacher's paper and pencil test composed of 75-item addition problems were conducted and recorded before

and after the implementation of the OG-Math intervention. The intervention was implemented via synchronous online class through an online platform due to restrains in movement brought about by the unprecedented pandemic COVID 19. The learner-participant was provided with OG manipulative - colored bars, flash cards, white board and marker. The online classes were recorded with consent from the learner-participant's parent and school.

The data gathered from the recorded online classes were transcribed then coded using Microsoft Word and Excel together with the data gathered from the evaluation of the Developmental and Behavioural Pediatrician and performance on the paper-and-pencil test before and after the implementation of OG-Math intervention.

The data were analyzed using trustworthy thematic analysis and pattern matching to ensure the validity and reliability of the research findings.

Results and Discussion

Depicted in Table 1 below is the theme generated on the addition skill of the learner-participant prior to OG-Math online intervention.

Table 1: Theme Generated on the Addition Skill of the Participant prior to OG-Math Online Intervention

Significant Observation and Statements	Formulated Meanings	Emerging Theme
Doctor: "Math-Numerical: Grade IV A-mid"	Math Level	Can only answer single-digit addition problems and is still prone to errors
Doctor: "Her examiner administered an academic achievement test which showed severe delay in reading, spelling, comprehension and Math."		
Doctor: "In Math, she can already solve problems involving addition…"	Addition Problems	
Teacher: "The child committed errors in adding single-digit addition problems."		
Teacher: "In adding 2-digit and 1-digit addends without regrouping, she was not able to answer all the 5 problems."		
Teacher: "In adding 2-digit and 1-digit addends with regrouping, she still was not able to answer the problems."		
Teacher: "She would not be able to answer the problems with 2 to 3-digit addends with and without regrouping correctly."		
Teacher: "Over-all, she got 56% accuracy in this pre-assessment."		
Teacher: "She used her fingers most of the time in finding the sum."	Addition Concepts	
Teacher: "She added all the digits in the problem without the application of place value concept and regrouping."		

Results revealed that the learner-participant's mathematical ability is severely delayed according to the doctor's observation and evaluation. She was enrolled as Grade VII but her Math-Numerical Level was Grade IV A-mid. In terms of her addition skills, the doctor noted that she can already solve problems involving addition. However, it was not specified as to what kind of addition problems she could already perform. This prompted the teacher-researcher to conduct pre-test. During the teacher's assessment, it was observed that the learner-participant can only answer single-digit addition problems but prone to errors and could not solve addition problems involving 2 to 3 digits with and without regrouping of numbers. The teacher-researcher also observed that the learner-participant could not answer the rest of the addition problems in the 75-item addition worksheet because she did not have grasp of the concepts of place value and regrouping with only 56% accuracy.

To investigate whether OG-Math intervention lead to an improvement of the addition skills of the learner-participant, further analysis was done which is depicted in Table 2 below.

Table 2: Themes Generated on whether the use of Orton-Gillingham Math as an Intervention in Teaching a Child Diagnosed with ADHD and Specific Learning Disorder with Impairment in Mathematics lead to an Improvement in Addition Skills

Significant Observation and Statements	Formulated Meanings	Emerging Theme
Teacher: "The child was able to shows the application of place value and regrouping concepts."	Acquisition of Place Value and Regrouping Concepts	OG-Math lead to an Improvement of Addition Skills
Teacher: "She still used her fingers but was also able to apply the counting on strategy in addition."		
Doctor: "She is able to solve problems involving addition with and without regrouping of numbers but commit errors due to inattention."		
Independent Practice: Solving single-digit addition without regrouping problems (78.6% accuracy)	93.9% Accuracy in Solving Addition Problems	
Independent Practice: Solving single-digit addition with regrouping problems (75% accuracy)		
Independent Practice: Solving 2-digit plus 1-2-digit addition with and without regrouping problems (100% accuracy)		
Independent Practice: Solving 2-digit plus 2-digit addition with regrouping problems (40% accuracy)		
Independent Practice: Solving 3-digit plus 1-digit addition with and without regrouping problems (100% accuracy)		
Independent Practice: Solving 3-digit plus 2-digit addition without regrouping problems (100% accuracy)		
Independent Practice: Solving 3-digit plus 2-digit addition with regrouping problems (75% accuracy)		

Independent Practice: Solving 3-digit plus 3-digit addition with and without regrouping problems (100% accuracy)		
Teacher: "Over-all, she got 98.7% accuracy in this assessment."		
Teacher: "The child only committed 1 error in answering the 75-item worksheet."		
Doctor: "S1 always perform better in Math but her profile is still delayed for her grade level."	Math Level	Delayed Math Profile
Doctor: "Math-Numerical: Grade IV A-mid"		
Doctor: "S1 is observed to have significant auditory inattention."	Working Behavior	Affected Solving Accuracy due to Inattention
Doctor: "S1 is able to participate in the academic achievement test but noted to be inattentive at the start."		
Doctor: "She is able to solve problems involving addition with and without regrouping of numbers but commit errors due to inattention."		

The themes that emerged that could answer the research question on whether the use of Orton-Gillingham Math as an intervention in teaching a child diagnosed with ADHD and Specific Learning Disorder with impairment in mathematics lead to an improvement in addition skills are reported below. However, not all these themes are relevant to the research question. The researchers included them as they could add more details to the case being investigated.

A) Orton-Gillingham Math Lead to an Improvement of Addition Skills

It can be recalled that prior the implementation of OG-Math intervention, a theme emerged from the observation, assessment and evaluation of the learner-participant's teacher and doctor. The learner-participant could only solve single-digit addition and had no grasp of the concepts of place value and regrouping with only 56% accuracy. After the 4-week online intervention, the hypothesis that OG-Math approach would lead to an improvement in the child's mastery of basic operation addition skills and facts was supported by the findings. The learner-participant was able to acquire understanding of regrouping and place value concepts and got a 93.9% accuracy in solving addition problems with and without regrouping using the multisensory approach and CRA progression of OG-Math online intervention. Based on the findings of this study, the OG-Math online intervention can lead to the improvement of Addition Skills of the child with ADHD and SLD with impairment in Math. Moreover, the existing literature supports the use of multisensory approach to children with math disabilities in the reviewed literature. This is also true for CRA instructional sequence. Specifically, they make acquisition of mathematical concepts possible which results to the learning of procedures in solving mathematical problems. This current study

extended the literature of the existing studies that investigated multisensory approach and CRA instructional sequence by providing findings that the use of OG-Math can lead to an improvement in addition skills to a learner-participant with specific diagnosis.

The teacher-researcher gave importance to the identification of the weaknesses of the learner-participant in terms of skills and concepts in math prior to implementation of instruction. This gave one an idea on what to emphasize and focus on during lesson proper. As for this study, the concepts of regrouping and place value were the weaknesses of the learner-participant. The researchers believed that this was the reason of the learner-participant not being able to answer the problems involving 2 to 3 digit addends with and without regrouping prior to intervention. The learner-participant only added all the digits of the addition problem (ex. 32 + 8 = 13). With this prior knowledge of the math ability of the learner-participant, the teacher was able to put greater emphasis on regrouping and place value. The two main features of Orton-Gillingham Math approach helped a lot in introducing these concepts.

The findings showed that OG-Math can lead to the acquisition of regrouping and place value concepts which are of vital use to solving addition problems. The findings were in conformity with the studies and literature reviewed. For multisensory approach, Obaid (2012) found out that there was a significant difference between the pre-test and post-test scores of subjects who had participated in the multi-sensory approach to learn addition and other mathematical concepts than those who had not participated. And for concrete-representational-abstract approach, the study of Flores, et al (2014) and Stroizer, et al. (2015) found out that CRA instructional sequence made significant progress with regard to basic additional and subtraction and provided students with clear expectations and the scaffolding regarding the conceptual meaning of operations to support the procedural knowledge needed to complete the problems.

The following themes are not relevant to the research question but are considered essential to provide richness of data.

B) Delayed Math Profile

The learner-participant's math profile was still delayed after the intervention. Also, her level remained at Grade IV A-mid. This was expected to happen since the intervention was only in a period of 4 weeks and only addition was introduced. This could not be considered an evidence for the investigation whether the use of Orton-Gillingham Math as an intervention in teaching a child diagnosed with ADHD and Specific Learning Disorder with impairment in mathematics lead to an improvement in addition skills.

C) Affected Solving Accuracy due to Inattention

It can be said that the errors committed by the learner-participant in solving addition problems after implementing OG-Math online intervention were not due to lack of understanding of the lesson but of the existence of inattention which is one of the main symptoms of ADHD.

Data Integration of the Participant's Doctor and Teacher Pre and Post Evaluation

This section presents the data triangulation in this current qualitative research design. Studies that use triangulation may include two or more sets of data collection using the same methodology, such as from qualitative data sources (Heale & Forbes, 2013). Using triangulation to answer a specific research question may result in one of the following three outcomes: (1) the results may converge and lead to the same conclusions; (2) the results may relate to different objects or phenomena but may be complementary to each other and used to supplement the individual results; and (3) the results may be divergent or contradictory. However, the interpretations for these outcomes are different in this study. Converging findings would mean that there were no changes in the evaluation and observation of the participant's doctor and teacher. Complementary findings still highlight different aspects of the phenomenon and divergent findings would mean that there were changes in the evaluation and observation of the learner-participant's doctor and teacher.

Table 9: Data Integration of the Participant's Doctor and Teacher Pre and Post Evaluation

Pre evaluation of the Participant's Doctor and Teacher	**Post evaluation of the Participant's Doctor and Teacher**	**Nature of Integration**
Doctor: Her examiner administered an academic achievement test which showed severe delay in reading, spelling, comprehension and Math. Her Math-Numerical level is Grade-IV A-mid.	Doctor: S1 always perform better in Math but her profile is still delayed for her grade level. Her Math-Numerical level is still Grade IV A-mid.	Convergence
Doctor: She can already solve problems involving addition. Teacher: The child committed errors in adding single-digit addition problems in the 75-item addition paper and pencil test. She would not be able to solve 2-3 digit and 1-3 digit addends with and without regrouping due to lack of application of place value and regrouping concepts.	Doctor: She is able to solve problems involving addition with and without regrouping of numbers but commit errors due to inattention. Teacher: The child only committed 1 error in answering the 75-item addition paper and pencil test.	Divergence

Results revealed that the pre and post evaluation of the participant's doctor regarding her Math-Numerical level converged. This means that there was no change in her math-numerical level. It can be recalled that the OG-Math online intervention was only implemented in 4-week period and only addition was taught. It was not sufficient time for the child to complete all the topics of the program and for the teacher to address all her weaknesses in math.

Meanwhile, the pre and post evaluation of the learner-participant's doctor and teacher regarding her addition skills diverged. This means that there were changes in the addition skills of the learner-participant. It can be said that OG-Math online intervention lead to an improvement in the learner-participant's addition skills.

Conclusions and Recommendations

This study found out that OG-Math approach as an online intervention can lead to the improvement of addition skills of a child diagnosed with ADHD and SLD with impairment in Math. There were 3 (three) emerging themes generated when data were analyzed namely "Orton-Gillingham Math Lead to an Improvement of Addition Skills", "Delayed Math Profile", and "Affected Solving Accuracy due to Inattention".

Based on the findings, this current study supports the use of OG-Math approach as an online intervention to children with ADHD and SLD with impairment in math to improve their addition skills. The researchers also recommend in future investigations to have participants with different neurodevelopmental disorder and Math disabilities use OG-Math approach to teach other basic operation skills and extend the existing literature.

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