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## Synthesis of Research on the Common Core State Standards and Dyscalculia

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# **Synthesis of Research on the Common Core State Standards and Dyscalculia**



Honors Thesis

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Department: Teacher Education

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April 2016

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## Abstract

This thesis analyzed the implications for instruction under the newly adopted Common Core State Standards (CCSS) and the effects they have on students with dyscalculia. The CCSS is an educational initiative created for students to succeed in their academic endeavors through college and their professional careers. Correlations were found in the research between the instructional implications under the CCSS and intervention strategies for students with dyscalculia. Parents, teachers and students were interviewed as evidence to verify this correlation.



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## Chapter 1: Introduction

### Section #1 Background of the Problem:

Dyscalculia is a mathematical learning disability that affects between 3-6% of the school aged population. It is not very well studied because teachers are often unsure if dyscalculia exists in their students or if the students are not trying hard in math. There are theories for the exact neurological cause of dyscalculia, but none have been proven. There is evidence of the right side of the brain attributing to the visual-spatial difficulties and the left side dealing more with the language processing difficulties that characterize dyscalculia. These difficulties cause students to have trouble with conceptualizing numbers, performing mathematical operations, memorization, understanding mathematical terminology, amongst others. There are signs that are displayed at different stages of life that, when noticed, lead to an eventual diagnoses of dyscalculia through testing and close observation. There are different instructional strategies for students with dyscalculia, such as multisensory instruction, support for organization, vocabulary review and other strategies. When these strategies are implemented with students with dyscalculia, academic success has been noticed. The study of this learning disability is a growing interest to educational researchers, but dyscalculia is still under-researched and not well known throughout the field.

The Common Core State Standards (CCSS) initiative was first being discussed and developed in 2009. The CCSS is a state-led initiative that started its implementation process in late 2012. The purpose of the new standards is to have students at the same ability level for math and language arts at certain grade levels across the country, and on an international scale. Although the new standards do not control how educators are to teach their students, the new standards have strong implications for instruction, in order for students to achieve the learning objectives. Specific to the CCSS for mathematics (CCSS-M), there is more emphasis on the concepts and applying those concepts to the

real world. Many questions have been asked concerning the new CCSS, such as, “What will be the modifications for students served under the Individuals with Disabilities Education Act (IDEA), with an Individualized Education Plan (IEP) plan, if any?, How would the CCSS impact Tier 2 or 3 of a Response to Intervention plan put in place by the district for a student? And finally, when will standards for other academic subjects be developed? These questions will be answered through the implementation process in the upcoming years.

Dyscalculia and the new CCSS for mathematics are interconnected indirectly. The CCSS-M has implications for instruction that correspond with instructional strategies that are suggested as modifications for students with dyscalculia. Real world applications can move the lesson from a lecture to an interactive learning experience for students. This usually involves the use of multi-sensory instruction, which has shown to help these students. The conceptual focus with the CCSS-M implies a teaching strategy that moves from teaching the procedure to teaching the mathematical concepts, and the reasoning for the procedure, rather than just simply the steps.

The possible connections between the implications of instructional strategies from the CCSS-M and the strategies used to support students with dyscalculia is the basis of this undergraduate research honors thesis. The results of this study will contribute to the current research by proposing a positive correlation between the implementation of the CCSS-M, and academic achievement by students with dyscalculia. Since both topics are relatively new in terms of educational practice, it is a very relevant topic in educational research because it has the potential to contribute to the literature in education and educational policy in the United States. The purpose of the study is to identify what instructional strategies using the Common Core State Standards support students with dyscalculia. This study could influence classroom application and practice, as well as increase awareness of dyscalculia.

## **Section #2 Definition of Terms:**

Common Core State Standards (CCSS)-” An educational initiative in the United States that details what K-12 students should know in English language arts and mathematics at the end of each grade.” -

Common Core State Standards website

Learning disability- An impairment that “affects the brain's ability to receive, process, store, respond to and communicate information. They are actually a group of disorders, not a single disorder.” (National Center for Learning Disabilities)

Dyscalculia- “ a wide range of lifelong learning disabilities involving math” (National Center for Learning Disabilities)

Dyslexia- a reading disability that occurs when the brain does not properly recognize and process certain symbols (National Center for Learning Disabilities)

Individuals with Disabilities Education Act (IDEA)- “the nation’s federal special education law that ensures public schools serve the educational needs of students with disabilities” (National Center for Learning Disabilities)

Individualized Education Plan (IEP) – An education plan tailored towards an individual students' needs that “creates an opportunity for teachers, parents, school administrators, related services personnel and students to work together to improve educational results for children with disabilities” (National Center for Learning Disabilities)

Response to Intervention (RTI) - “a multi-tier approach to the early identification and support of students with learning and behavior needs” (National Center for Learning Disabilities)

Arithmetic- “the branch of mathematics dealing with the properties and manipulation of numbers” -

Google

Mathematical Operations- “An action or procedure which produces a new value from one or more input values, called operands” -Wikipedia



Visual-Spatial- “pertaining to the perception of the spatial relationships between objects in one's field of vision” -Dictionary.com

Neurological- “the science of the nerves and the nervous system, especially of the diseases affecting them” -Dictionary.com

Ohio Achievement Assessment- Standardized assessments before the PARCC exams used in Ohio to test what students know and are able to do. -Ohio Department of Education

### **Section #3 Limitations**

There are a few limitations to this study. The first is a lack of research on the topic of dyscalculia. As a result, there are not many students who have been diagnosed with dyscalculia. Since there have not been many students identified with the learning disability, it is hard to study and analyze the topic. It is challenging to find students who have been formally diagnosed. Once they are found, analyzing the instruction by their teacher is problematic. Since the CCSS are new, it is arduous to make the connection between the CCSS-M and those instructional strategies. This limitation makes the study challenging because the knowledge and awareness of dyscalculia is limited.

Another limitation is the controversy surrounding the effectiveness of the new Common Core State Standards. Since it is still in the beginning stages of implementation, it is not well known if it is going to stay or get repealed. In addition, assessments for this exam have only taken place for one year (2014-2015 academic year). This system is fairly new and the analysis of the results varies from state to state, which can hinder precise analysis of test comparisons. The CCSS have only been created for mathematics and language arts, which hinder the analysis of the standards because they have not been created for each subject yet.

Co-morbidity is another limitation in this study. Co-morbidity is the presence of more than one learning disability in a student at once. Since co-morbidity is so prominent in those with dyscalculia, it

is hard to decipher which symptoms are relevant to dyscalculia and which are characteristics of another learning disability. Co-morbidity can make analysis of a learning disability difficult because characteristics of learning disabilities overlap so the identification of a characteristic is hard to place under one disability because many of the characteristics are similar. Also, when using intervention strategy, it is difficult to identify which learning disability is being addressed because of the similarities between them. Finally, due to public test records accessible by the Ohio Department of Education website, I was only able to gather data for students from grades five through eight (age of participants) to analyze test data.

#### **Section #4 Summary**

This research study is investigating the instructional strategies for children with dyscalculia under the context of the Common Core State Standards. Many of these instructional strategies are implied by the standards without a direct instructional requirement, but the standards also address learning disabilities separate in a way where all of the strategies are used. The research question of this thesis is what strategies under the Common Core State Standards will support students with dyscalculia? Methodology is not yet determined. This research will influence classroom application and practice as well as increase awareness of dyscalculia.

#### **Section #5 Research Question**

The research question of this thesis is “What instructional strategies used in implementing the Common Core State Standards for math could be identified as supporting students with dyscalculia?”. Since both topics are relatively new in terms of educational practice, it is a very relevant topic in educational research because it has the potential to contribute to the literature in education and

educational policy in the United States. This research could influence classroom application and practice, as well as increase awareness of dyscalculia.

## Chapter 2: Review of The Literature

### Section #1: Knowns and Unknowns

Although not heavily researched, there is knowledge about both The Common Core State Standards in math (CCSS-M) and dyscalculia. Dyscalculia is understood as a learning disability that impacts an individual's ability to conceptualize numbers, arithmetic, counting, amongst others. It affects between 3-7% of the school-aged population, but is usually co-morbid with another disability. The exact causes of dyscalculia are not well known. Some strategies for supporting students with this learning disability have been studied and shown to be successful. These strategies are recommended to be implemented into the general education classroom because they can be useful to all students and intervention can be intensified and individualized for students who need extra help.

The CCSS are a state-led initiative that was designed to have students obtain the same content knowledge during the same time of their academic career in the subjects of math and language arts. The CCSS emphasize a stronger conceptual understanding in order for mastery of a standard to be considered. Some case studies that the implications for instruction to fulfill the requirements under the new standards are the same instructional strategies suggested for students with dyscalculia to succeed academically. These case studies involve students of different ages and genders and severity of dyscalculia. The strategies used in their intervention have led to an increase in academic achievement for the student. These strategies are also implied for instruction using the CCSS-M. This overlap and positive correlation link the CCSS-M implications for instructional strategies and the instructional strategies for students with dyscalculia.

In reviewing the literature about the CCSS and the instructional strategies used for students with dyscalculia. Several connections have been made and the researcher will use these connections to show how they imply a positive correlation between the implementation of the instructional strategies using

the CCSS-M and academic achievement in students with dyscalculia. The researcher has learned considerably more about dyscalculia and the CCSS by making connections between the two and understanding the implication in which they have for each other. There is not an overwhelming strong selection of research, however, because they are both relatively current topics that have not been around long enough to be fully understood by educational researchers. There has been recent development on the topic concerning the connection between learning disabilities and the CCSS. There is a growing concern over whether or not students with learning disabilities will be expected to fulfill the same requirements as students without learning disabilities and if so, how will the teachers make that possible?

## **Section #2: Dyscalculia**

Dyscalculia is defined as “the inability to conceptualize numbers, number relationships (arithmetic facts) and the outcomes of numerical operations (estimating the answers to numerical problems before actually calculating)” (MacDougall, 2009). It is one of the types of mathematical learning disabilities that affects people at all stages of their life at varying levels (Williams, 2012). There are two main areas that contribute to dyscalculia. One is visual-spatial difficulties, which refers to processing what the eye sees, and the other is language processing difficulties referring to processing what is heard (NCLD, 2012). Each area of contribution will affect those diagnosed with dyscalculia differently. Those with a more prominent visual-spatial difficulty will have problems with mathematical patterns, procedures and sequencing, while those with language processing difficulty will have trouble understanding the mathematical vocabulary that is necessary for understanding the concepts (NCLD, 2012). Dyscalculia leads to a difficulty to understand many everyday concepts such as time, measuring, etc. (Osisanya, 2013). Dyscalculia is not a widely known or understood learning

disability, but it does affect between 3-7% of the school aged population and is a consideration for education.

Number comprehension and production problems arise as one of the earliest signs of dyscalculia. This refers to the translation of verbal numbers into Arabic representations (Geary 2001). An example would be a dyscalculic student writing 608 when the teacher said 68 because the value system in accordance with base 10 is not understood (Geary 2001). Numeration values in accordance with number lines is evidence of number comprehension at an early age and a difficult concept for those diagnosed with dyscalculia (Geary, 2001). For example, students with dyscalculia may not understand that  $3 > 2$  because it is further away from zero on the positive side of the number line (Geary, 2001). The negative side of the number line is even more confusing for those students because after they have mastered the value system on the positive end, it is opposite on the negative end (i.e.  $-2 > -3$ ) (Geary, 2001).

Another one of the difficulties of dyscalculia lies in number syntax (Geary, 2001). This refers to the base-10 nature of the numerical system that we use (Geary, 2001). Base 10 can be explained by the different place values in a given number holding a different quantity in powers of ten (Geary 2001). For example, the concept of base 10 leads to the knowledge that 506 can be rewritten as  $5*100+6*1$ . This particular concept is difficult for those with dyscalculia because they do not understand complex relations involving numbers. Lexical access is another sub-category of number syntax, which refers to stating a number when given that number in written form (Geary, 2001). For example, when given the number 6 a student may say that is “nine” or “seven”. Although those numbers are close to 7 in value and shape of the number itself, neither are correct.

Difficulty in counting is another characteristic of dyscalculia. Those with dyscalculia may have trouble pointing to objects in succession as they are being counted as well as a habit of double counting (Geary, 2001). However, sometimes the students followed the objects correctly, but could not recite the

correct number names while counting (Geary, 2001). On other tasks that heavily involved “adjacency and order-irrelevance”, the students often made consistent errors (Geary, 2001).

Many arithmetic concepts are not understood by dyscalculic children. Once students have a better understanding of counting, they use that to complete arithmetic problems (Geary, 2001). Relying on fingers to add two single digit numbers is fairly common as well as using the max procedure (Geary, 2001). The max procedure is when students are given 2 digits and asked to add them they take the smaller number and add the bigger number to it from 1 (Geary, 2001). An example of this would be  $4+2$  and starting at 2 counting 3,4,5,6 to get to the answer. The reverse is called the min procedure and it is used more frequently when students develop thinking that leads them to the answer faster (Geary, 2001). Min procedure would be exemplified with the same problem ( $4+2$ ) as 4 and then adding the 2 as 5,6 to get to the correct answer. Addition and multiplicative reciprocity rules are often misunderstood (Vaidya, 2004). If given an expression,  $8+7 = 15$ , they will be able to understand how that conclusion is made, but not the reciprocity that  $7+8$  also equals 15. These students have trouble retrieving basic math facts from their long term memory for recitation and/or usage (Geary, 2001).

Word problems are also difficult for dyscalculic students. When they are given a word problem, they have trouble indicating what operation the question is calling for them to use (Vaidya, 2004). Many of these problems begin with difficulty retaining academic language in relation to math. Vaidya (2004), explains “mathematics is a second language and should be taught as such”. The language is important because the language is connected to the symbolic representations, which leads to conceptual understanding (Vaidya, 2004). Students may not be able to follow along with a lesson if they do not understand the terminology and syntax (Vaidya, 2004). In another sense, if students are not learning from the lessons, the inability to understand mathematical language can inhibit them from learning from alternative resources like the text book (Vaidya, 2004).

Memory retrieval is difficult for students with dyscalculia. In almost all cases concerning dyscalculia, there is evidence of the inability to retrieve basic mathematical facts from memory (Geary, 1993). Usually it is not with all kinds of math facts, but with certain operations, such as multiplication (Geary, 2001). Interestingly, the inability to retrieve those facts usually “lead way” to retrieval of facts concerning another operation, such as addition (Geary, 2001). One of the theories as to why this is true is a difficulty for dyscalculic students to differentiate between relevant and irrelevant associations in their working memory (Geary, 2001).

Dyscalculia is first identified when students are not reaching the milestones aligned with their peers (Vaidya, 2004). Formal diagnoses is based on results from formal testing, which is the most common way after teacher observation and consultation with special educators and school psychologists (NCLD, 2012). Usually initial attention is brought when the general education teacher notices the student struggling with math (NCLD, 2012). Then, the general education teacher observes the student while they are given math problems to try and understand how the student thinks about math (NCLD, 2012). If the teacher suspects that the student has dyscalculia after the observation, they consult a school psychologist to observe and finally, formal testing with a pencil and paper test is administered (NCLD, 2012). At an early age, warning signs for dyscalculia include “difficulty with learning how to count, trouble recognizing printed numbers, difficulty tying together a number and its existence in the real world (i.e. the number 6 indicates a quantity of 6), poor memory with numbers and trouble organizing things in a logical way” (NCLD, 2012). For school-aged children signs include trouble learning and understanding mathematical operations (addition, subtraction, multiplication, division), developing math problem-solving skills, poor long term memory of math facts and operations, unfamiliarity with math vocabulary, difficulty with measuring and reluctance to playing games involving strategy (NCLD, 2012). In adults and teenagers warning signs include difficulties



estimating costs and amount, learning passed basic math facts, mental math, budgeting, concepts of time and thinking of different strategies to solve a problem (NCLD, 2012).

When in the process of the actual diagnoses, the teacher or specialist interview the student about math-related concepts and ideas to understand how the student uses and understands math, ranging from every day problems to advanced math problems (NCLD, 2012). After this observation or series of observations, usually a pencil-paper evaluation is given to compare the students' expected level of mathematical ability with their actual ability (NCLD, 2012). For the best intervention, the students' strengths and weaknesses are noted to see if they need more help on the visual-spatial aspect or language process aspect (NCLD, 2012).

Co-morbidity with other learning disabilities is highly present in students with dyscalculia meaning that multiple disabilities are present at once (Williams, 2012). For example, dyslexia, which is a difficulty relating to literacy is co-morbid with dyscalculia at a rate of about 50% (Williams, 2012). Other learning disabilities such as attention deficit/hyperactivity disorder (ADHD) and central auditory processing difficulty (CAPD) have a co-morbidity of roughly 40% (Williams, 2012). This can be particularly difficult because signs of one disorder or disability may not be recognized because it is also a sign of another that may be the main focus of the child's difficulties. This may also be difficult for intervention strategies because students with a deficit in math and literacy (dyscalculia and dyslexia) will not respond to intervention as significantly as those with only the mathematical difficulties. (Williams, 2012).

Although no conclusions have been made for the exact neurological explanation for dyscalculia, many of the difficulties are characterized by deficits in different areas of the brain that are responsible for different intellectual tasks. Researchers Geary and Hoard are exploring the question of the areas of the brain that cause the deficits in dyscalculia. This is supported by Faramarzi's study showing that those with mathematical disabilities show a lower score on neuropsychological tests (Faramarzi, 2014).

In relation to counting, some students with dyscalculia have trouble pointing to objects in succession as they are being counted, which is seen with damage to the right hemisphere of the brain (Geary, 2001). Another difficulty is reciting number names, memory of basic math facts and general number syntax, which is seen with damage to the left hemisphere of the brain (Geary, 2001). A 17-year-old with severe right frontal and parietal cortices showed similar difficulties to those described above with sequencing the order of operations and misalignment of numbers, which suggests a relationship between these problems and the right-frontal cortex (Geary, 2001).

The relation to dyscalculia and retrieval of facts and skills from long-term memory is believed to be associated with left-hemisphere of the brain specifically the left basal ganglia, thalamus and left parieto-occipito-temporal areas (Geary, 2001). Not only is long term memory affected, but so is the working memory. When these students learn, irrelevant associations to concepts are made that conflict with correct associations, which make it difficult for students to go about problem solving (Geary, 2011). This is associated with “delayed development of the prefrontal cortex or from neurodevelopmental abnormalities in these regions” (Geary, 2001). In general, the right hemisphere is linked with non-verbal and procedural processing, while the left mostly deals with verbal processing and memory (Osisanya, 2013).

Depending on the severity and specificity of the disability, different intervention strategies are utilized. In some cases, tier 2 level of RTI (Response to Intervention) strategies will be used to help those who do not respond to the general classroom curriculum in mathematics right away. Tier 2 is for about 10-15% of students who do not respond to general classroom instruction and thus need supplementary instruction either inside or outside of the classroom (Guiliani, 2014). Tier 2 instruction usually requires one on one attention between a student and an aid to review and use different strategies for information retention and understanding.

One method of intervention involves the mathematical language. Syntax and terminology are the biggest difficulty for those with the language processing impairment (Vaidya, 2004). A way to accommodate is by having an online glossary available to students as well as explaining ideas and problems as clear as possible and encouraging questions from students (NCLD, 2012). Another important strategy is linking concepts together in order to build on them. One example of this is explaining how multiplication is just repetitive addition (MacDougall, 2009). If the students understand addition, than thinking of multiplication in terms of addition may help them grasp that concept and use an older concept to strengthen memory (MacDougall, 2009). Using simple and concrete examples can establish a solid base before moving into more abstract and advanced concepts (NCLD, 2012). Visualizations is a useful method for these students, especially with sequencing (Vaidya, 2004). One way of accomplishing this could be as simple as colored text boxes to help the students improve retention on what they saw (MacDougall, 2009). For those who have problems with where to place partial answers, graph paper is a good way to have the numbers more organized (NCLD, 2012). There are many intervention methods that benefit students with dyscalculia and should be implemented in all classrooms where this learning disability is present.

### **Section #3: The Common Core State Standards**

The Common Core State Standards(CCSS) is a state collaborated initiative that was released in June of 2010 (Wu, 2011). It was created by the National Governor's Association Center for Best Practices (NGA Center) and The Council of Chief State School Officers (CCSSO) (Wu, 2011). It was developed in collaboration with teachers, school administration, and experts and supports a consistent framework that prepares children for the future (Hunt, 2014). The CCSS math curriculum drives away from the textbook school mathematics (TSM) that has dictated K-12 math education for a long time (Wu, 2011). In TSM there is a significant amount of academic language that is not addressed and logical reasoning is rarely provided (Wu, 2011). TSM requires that students learn certain content by the

time they leave a particular grade-level, which is similar to the CCSS, but instead of teaching all of algebra 1 in 8<sup>th</sup> grade, the CCSS requires some of algebra one and the geometry that corresponds with it that may enhance algebra understanding (Wu, 2011). Wu, 2011 states “TSM gives students (and teachers) a gimmick; the CCSS require that students actually learn mathematics”.

Academic language is a large part of the differences in the new standards. For example, defining equality as “the same value as” opposed to the “same as” is beneficial to avoid misconceptions (Faulkner, 2013). The same as implies that the two things are the same in all ways, but clearly  $3+4$  is not the same as  $1+6$ , but they give the same quantitative value (Faulkner, 2013). Another example of different use in academic language is in operations as simple as addition or subtraction. Instead of saying “addition makes things bigger” and “subtraction makes things smaller” the emphasis should be on noting that addition is about combining and subtraction is about difference (Faulkner, 2013). Using the latter eliminates confusion. Subtraction does not necessarily makes things smaller, for example,  $5-(-4)$  would make the value bigger (Faulkner, 2013). Instead of using the phrase a number “doesn't go into” another number, we can emphasize that a larger number does go into a smaller one, but the result will be a decimal/fraction that is less than one or a number goes into another number, just not evenly (Faulkner, 2013).

For example, we can divide 3 by 8, but we will not get a whole number. Another example is 48 divided by 7 does give us an answer, but it is not a natural number. The term “cancels out” is very dangerous as well. Using this term eliminates reasoning for why you are crossing out the two numbers and simply makes it procedural. Instead one might say, “I have an 8 divided by an 8 and we know anything divided by itself equals 1. So If I have 1 times something, what property can I use?” (Faulkner, 2013). Using this techniques eliminates confusion on when to cancel, for instance, when a student sees the same number on the top and the bottom of a fraction, and thus leads to an understanding of why the two numbers give us 1 (Faulkner, 2013). For example  $3/3 = 1$  or

$$4(6x+1) / 4 = (6x+1)(1).$$

An example of the difference between TSM and CCSS lies in adding fractions. In TSM, the meaning of combining fractions is ignored and it becomes a simple process of finding the least common multiple (Wu, 2011). In CCSS, the process of adding fractions as “combining things” is the main proponent that needs to be understood (Wu, 2011). Visual means are a CCSS concept as well, which can be very helpful for students with dyscalculia as are other multisensory techniques. Students will draw the number line and divide it into equal parts of the indicated fractions, find the equivalent fractions with a common denominator or “part” and combine (Wu, 2011). Another example is multiplying negative numbers, CCSS ensures that students are confident in their knowledge of what a negative number is as a specific object rather than a “fable philosophical idea” (Wu, 2011). The emphasis on understanding the nature of a negative number goes back to the number line in CCSS (Wu, 2011).

The “Guess-and-Check” strategy is also something that should be abandoned with TSM. An example of this strategy would be checking different values of  $x$  (1,2,3) that satisfy the equation  $9=2X+1$  until you find that 4. is the answer that satisfies this. Although it is a good number sense indicator, it should not be used as a mathematical strategy because it is not using the mathematical concepts asked for, and instead an unmotivated way to find an answer (Faulkner, 2013). In this situation, the student must have algebraic knowledge to know to subtract 1 from both sides of the equation and then divide both sides by 2 to find  $X$ , however, with the “guess and check” method, students simply plug in different numbers until the equation is solved and avoid using the procedure. Students' number sense can naturally develop as a result of making the connections in mathematics, which should be the emphasis of practice (Faulkner, 2013).

Since there is a population of students who have learning disabilities, techniques and interventions corresponding with the Common Core need to be addressed. Individualized interventions

may be used for students who do not show any progress or response to intervention (Powell, 2014). Since the CCSS alter the standards that need to be met from what states are used to, a big question lies in the accommodations for students with learning disabilities. Specifically, what intervention strategies correspond with the requirements under the new standards and what instructional strategies for conceptual understanding will be emphasized to ensure students are successful? This question can be answered with positive results by studying the variety of techniques that are both directly and indirectly implied to meet the new requirements from the CCSS. Since the new standards do not dictate how material is taught, only implications for instructions and suggestions are made to fulfill the standards' requirements.

Even though there are not assessments that directly link to the CCSS to date, Data-Based Intervention (DBI) may be a technique that creates them while addressing the needs of those with learning disabilities. DBI is a process that includes “adapting instruction using principles of intensive intervention and evidence-based practices and implementing these adaptations consistently and regularly” (Powell, 2014). The principles and processes for intensive intervention as addressed by Fuchs, 2008; Vaughn, Wanzek, Murray & Roberts, 2012; are as follows; smaller steps, precise language, repeat language, student explanations, modeling, manipulatives, worked examples, repeated practice, error correction, fading support and fluency” (Powell, 2014). Many of these ideas are implemented or encouraged by the new CCSS, showing that the needs of those with mathematical learning disabilities are being met indirectly through the standards themselves. In this case study, specifically, the needs of a 6<sup>th</sup> grader are being addressed by her teacher, Mr. Drummond. He uses the CCSS to work through interventions (Powell, 2014). For example, implementing the use of smaller steps, “Mr. Drummond plans to use task analysis to break specific fraction problems into smaller steps” (Powell, 2014).

Another case study addresses an elementary school teacher, Mr. Powers, who wants to “support understanding and use of content and practice standards embodied in the CCSS-M (Common Core State Standards- Mathematics) while attending to students' unique strengths and weaknesses” (Hunt, 2014). McLaughlin 2012, stated that the CCSS-M “provide a historic opportunity to improve access to rigorous content standards to students with disabilities” (Hunt, 2014). So, the students are still able to achieve the high demanding content standards, even while they are facing the challenges of a learning disability.

During intervention, a hybrid of strategies should be used, but the focus should be on problem-solving analysis of contextual and instructional variables (Hunt 2014). When the student is immersed into Tier 2 and Tier 3 levels of RTI (Response To Intervention), incorporation of task sequencing and student verbalization of mathematical reasoning is necessary and can be scaffolded by visuals, purposeful prompting and frequent feedback. (Hunt, 2014). The main target of these interventions is conceptual knowledge of the mathematics (Hunt, 2014).

The first step in the intervention process is to identify the difficulties that the student is having and reflect on what one as the educator already knows about the situation at hand. The first place a teacher may go to identify gaps in understanding is the CCSS-M, thus using them as a basis to understand where the concepts are starting to be misunderstood for the student, and using the standards as a stepping stone in the process of creating intervention (Hunt, 2014). The second step is to analyze the problem; the RTI team can design the intervention to meet students' current understanding of the material and build on understanding from current ability (Hunt, 2014). It is also the responsibility of the teacher to identify the students' skills and misconceptions of prior knowledge and conceptual understanding in order to correctly plan for their intervention (Hunt, 2014). Teachers should also use questions and probes to learn about the students' conceptual understanding by the answers that they provide (Hunt, 2014). One way of doing this is diagnostic interviews. Through this method, teachers

are able to gain insight into their students' conceptual understanding and procedures, identify any misconceptions students have, observe how their students think mathematically before, during and after the process (Hunt, 2014). Another point to consider as a teacher would be, what the students need to know to be able to meet the standard (Hunt 2014). Step three is implementing the solution (Hunt 2014). At this stage, teachers are expected to see where the student level is, and compare that to the understanding and performance of the standard, and be able to identify what the student may be having trouble with through assessment (Hunt 2014). Using the RTI as a framework will serve as a support for students to meet the grade-level expectations as defined by CCSS-M by means including “diagnosing and developing conceptual understanding” of each student (Hunt, 2014).

A final case study was analyzed involving a fifth-grader, Joseph, who has had problems in mathematics since he was in preschool (Saunders, 2013). Joseph was able to quickly grasp concepts such as perimeter and coordinate planes as a result of the teacher using real-world mathematics stories, interactive whiteboard materials and hands-on manipulatives (Saunders, 2013). The importance for teachers is an understanding of the standards and adapting instructions to fulfill the standards' requirements because of the demands of mathematical competence in today's world and the importance for students to have a strong mathematical understanding in society (Saunders, 2013). Another story involves Michael, a fourth-grade student having trouble with numbers, counting with one-to-one correspondence and matching/sorting (Saunders, 2013). With the use of reading real-life problems, systematic prompting strategies and incorporating basic mathematical skills, Michael showed progress in basic skills (identifying numbers and one-to-one correspondence to 10) and grade-aligned skills (finding area of a rectangle given an equation template, calculator usage, etc.) (Saunders, 2013). Students are able to learn grade-level content aligned with the CCSS while simultaneously improving on basic numeracy (Saunders, 2013). Saunders (2013) identifies 6 major steps when working with students with mathematical learning disabilities in relation to the CCSS. The first is to select a topic and create



objectives (Saunders, 2013). Depending on the severity of the disability and rate of progress, one may not be able to teach all of the standards, which is why it is very important to prioritize standards in consideration with the importance to the next grade-level and world context (Saunders, 2013). For example, a teacher may rank the top 5 priorities for students to learn in this unit and rank them one to 5 (Saunders, 2013). The second step includes identifying a real-life activity using the skill to give the concept real-world context and applicability (Saunders, 2013). The third step is to incorporate evidence-based practices while working with the students, such as time delay and least intrusive prompts (Saunders, 2013). The fourth step is including instructional support such as graphic organizers, hands-on manipulatives and technology (interactive whiteboards, calculators, etc) (Saunders, 2013). Steps five and six includes monitoring progress and planning for generalization to prevent memorization (Saunders, 2013).

#### **Section #4: Related Factors**

There are a few factors that impact the study. The first is the politics surrounding the new Common Core State Standards. In the beginning stages of implementation, there are 43 states that have chosen to adopt the standards as of 2014. There is a lot of controversy surrounding the effectiveness of the standards and college and career readiness it really gives students. In Ohio, assessments will begin in Spring 2015 and it will be easier to analyze the effectiveness of the CCSS-M. The CCSS have only been created for mathematics and language arts, which hinder the analysis of the standards because they have not been developed for each subject yet.

Another factor that could impact the study is the minimal amount of awareness about dyscalculia. Since there have not been as many children identified with the learning disability, it is hard to study and analyze the topic. It is difficult to find students who have been formally diagnosed and once they are found, analyzing the instruction by their teacher in relations to the standards is equally difficult at this time.

Co-morbidity is another impacting factor on this study. Since co-morbidity is so prominent in those with dyscalculia, it is hard to decipher which symptoms are relevant to dyscalculia and which are characteristics of another learning disability. This makes it difficult when analyzing the data from the study because some positive affects corresponding with different standards and instruction may be impacting another learning disability the child has and not the dyscalculia. Thus, no connection can be made about the success from the standard and instruction and dyscalculia directly.

### **Section #5: Summary**

Review of the literature began with an analysis of dyscalculia and the Common Core State Standards. The research consists of the connections between the strategies for students with dyscalculia within the context of the CCSS. Some of the different instructional strategies implied within the CCSS correspond with those suggested for dyscalculia, which may indicate that the new standards have implications for instruction to help those with dyscalculia succeed academically. The work done by the new standards have led to this exploration. Factors that may affect this study in relation to legislation of the CCSS and awareness of dyscalculia were raised as considerations for this research study.

## **Chapter 3: Methodology**

### **Section #1: Research Question**

My research question concerns what instructional strategies in correspondence with the Common Core State Standards will support students with dyscalculia. This question centers around the new standards and their implications for instruction. There is more of a conceptual and real-world application emphasis with the new Common Core State Standards as well as utilization of technology that influences the instruction teachers must convey in their teaching. To answer my question, I will examine how the standards have changed instruction for teachers and how this changed instruction has impacted achievement for students with dyscalculia. By looking at the intervention strategies for students diagnosed with dyscalculia as well as the instruction implied under the new standards, I will analyze their similarities that will lead me to expect a positive correlation between the achievement for students with dyscalculia and the implementation of the new Common Core State Standards. This question has significance to the teacher education population because of the relevance to new policy. In addition, answering this question will help future educators better understand what strategies under the new standards are most successful for these students as well as raise awareness about dyscalculia.

### **Chapter #2: Setting**

This study takes place at multiple locations. Some interviews were conducted at a medium-sized (approximately 8,000 undergraduate students), comprehensive university. Two interviews were conducted in an office in the Teacher Education department. Five

interviews (2 teachers, 3 students) were conducted at a small Catholic elementary school that had adopted standards in alignment with the Common Core State Standards. Email interviews with two of the parents were also conducted in this setting. The adaptation of the new standards in the school is important because of the impact of the standards on recent instructional practices. The interviews were conducted shortly after the first Partnership for Assessment of Readiness for Colleges and Career (PARCC) exams were conducted. The interviewees were able to reflect on the exams when answering interview questions and the changes in the standardized tests as a result of the standards and how that might impact success for the students. This question has significance to the teacher education population because of the relevance to new policy and answering this question will help future educators better understand what strategies under the new standards are most successful for these students as well as raise awareness about dyscalculia.

### **Section #3: Research Design**

In my study I used both quantitative and qualitative methods. In my review of the literature, I examined statistical values that showed scores of math assessments from students of the Common Core State Standards who took the PARCC exam and compared them to scores from the old achievement tests, namely the Ohio Achievement Assessment that was used when the CCSS was not part of the curriculum to find an achievement gap. I took a qualitative approach by conducting interviews with open-ended questions and used a coding methods to analyze the transcripts for themes and patterns.

I interviewed four female students who showed signs of dyscalculia and who were students in classrooms implementing the Common Core State Standards. One of the

students was in 5<sup>th</sup> grade, one in 6<sup>th</sup> grade and the other two in 8<sup>th</sup> grade at a small catholic school that is implementing the Common Core State Standards. I interviewed their parents and teachers as well. There was a total of nine participants who were interviewed. The purpose of these interviews was to find common themes in the responses of the students, teachers and parents. This is an effective way of designing the research because between the different students, teachers and parents I can find similarities that were not influenced by one another. These similarities will further validate their contributions and address the research questions.

I used quantitative methods by comparing the standardized tests results from the previous achievement tests and the PARCC exams to compare achievement in the students' grade levels as a whole. The PARCC exam score data is examined in chapter 4 of this thesis and the analysis will be discussed in that chapter as well. The score data will indicate if students scored higher using the PARCC exams with the alignment with the CCSS or the previous curriculum with the old achievement tests. Although the test scores of the students were not able to be given, these results will show the effect of the Common Core on the class achievement as a whole, which will contribute to this study by addressing effects of the standards on students with and without dyscalculia.

There are a few limitations to this study. The first is a lack of research on the topic of dyscalculia. As a result, there are not many students who have been diagnosed as having dyscalculia. Since there have not been many students identified with the learning disability, it is hard to study and analyze the topic. It is challenging to find students who have been formally diagnosed. Once they are found, analyzing the instruction by their teacher is problematic. Since the CCSS are new, it is arduous to make the connection

between the CCSS-M and those instructional strategies. This limitation makes the study challenging because the knowledge and awareness of dyscalculia is limited.

Co-morbidity is another limitation in this study. Co-morbidity is the presence of more than one learning disability in a student at once. Since co-morbidity is so prominent in those with dyscalculia, it is hard to decipher which symptoms are relevant to dyscalculia and which are characteristics of another learning disability. Co-morbidity can make analysis of a learning disability difficult because characteristics of learning disabilities overlap so the identification of a characteristic is hard to place under one disability because many of the characteristics are similar. Also, when using intervention strategies, it is difficult to identify which learning disability is being addressed because of the similarities between them.

Finally, a limitation of the study design was the gender, school and ages of the students interviewed. The students interviewed were all female. This is a limitation because we are only able to examine one gender. There is no known variation of dyscalculia or intervention strategies amongst different genders, however, only examining one gender eliminates those possibilities being discovered or accounted for. They all attended the same school, which was a small, Catholic and private elementary school who was implementing the Common Core State Standards. This is a limitation because although they are using the standards, they are not required to use every aspect of the standards and can slightly alter their curriculum. Finally, the students were only between the ages of 10 and 14 years old. This is a limitation because this limits the age range that we are examining. The Common Core State Standards are being implemented for students grades K-12, and only a small portion of that is accounted for in this study

due to time conflicts and availability.

#### **Section #4: Subject Selection**

I interviewed four female students between 5<sup>th</sup> and 8<sup>th</sup> grade who showed signs of dyscalculia and who were students in classrooms with standards in alignment with the Common Core State Standards. I chose students who were in different grade levels and who had varied signs of dyscalculia to observe the correlation for different ages and severities. There was one student who was in 5<sup>th</sup> grade at the time of the study; a student who was in 6<sup>th</sup> grade and two students who were in 8<sup>th</sup> grade. The two students in 8<sup>th</sup> grade had the same teacher, but had different signs and severity of dyscalculia. I chose this group of participants to gain a better understanding of the different signs of dyscalculia as well as the impact of instruction for those varying levels. I interviewed their parents and teachers as well. There was a total of nine participants who were interviewed. The purpose of these interviews was to find common themes in the responses of the students, teachers and parents. The students were chosen based on their mathematical abilities and struggles. Their teachers must be implementing the new Common Core State Standards in their instruction as well. The students had a few similarities and differences in terms of what exactly they struggled with in math, but they each showed evident signs of dyscalculia as identified by their teachers and parents. All of the students struggle with word problems and the language processing side of dyscalculia, while their algebraic and visual-spatial difficulties varied. I protected their anonymity by being the only individual with access to their interviews via voice recordings on my phone as well as access to the emailed interviews. In the analysis of the

interviews, the researcher used pseudonyms to protect their identity and keep data confidential. These strategies were used to keep confidentiality for the participants in this study as noted in their agreement to participate.

### **Section #5: Design of the Study**

I conducted the research for this study in a few different ways. I began by studying dyscalculia and The Common Core State Standards separately. Then, I compared the standards to the intervention strategies for dyscalculia to see if there were any similarities. Once I had a strong understanding of both dyscalculia and the standards, I found students who matched the description for students with dyscalculia and interviewed those particular students, their teachers and parents about their understanding and difficulty with mathematics. I used the students' struggles with math and their understanding of math as it has changed with the implementation of the standards as focal points of the interviews. Once scores for the PARCC exam were released, the researcher compared the scores in the mathematics section for these exams and Ohio Achievement Assessment exams to see if there was any significant increase in scores or student understanding of the material exemplified by their exam. The data was examined through averages in the state opposed to averages in schools or specific classrooms. The data was analyzed and the interviews were transposed and analyzed to come to a conclusion about the implementation of the standards and dyscalculic student success.

### **Section #6: Data Collection**

I used a few different methods while collecting data for this study. I collected the quantitative data and scores from the internet and public accessed websites. For the qualitative data, I interviewed using a few different materials. I used a voice recording



app on my phone to record the interviews used for two of the teachers, a parent and all four of the students interviewed. For the remaining two parents, I asked the interview questions over email. I transcribed the interviews on a Word document on my computer and printed them out to search for common themes in interviewee responses. I designed my research questions for the students to better understand how they think about math and the areas in which they struggle. I also framed my questions to examine how their thinking has changed in the past couple of years since the new standards have been put in place. I took a very similar approach when interviewing the students' parents about their child and how they understand their child/children's thinking. When interviewing the teachers, I examined their instructional strategies and how they've changed with the implementation of the Common Core State Standards. I also investigated the teacher's analysis on student achievement and/or improvement with the new standards in place. These questions were grounded in my literature review, which linked the instructional strategies implied using the Common Core State Standards and the intervention strategies for students with dyscalculia with commonalities. The interview questions were reviewed by a University of Dayton faculty member for validation and editing before they were used in this study. The data will be interpreted through the identification of common themes in the interviews. Numerical data will be compared through standardized test score averages to see a potential correlation. The data collected is only accessible to me for confidentiality purposes. Pseudonyms will be used throughout the analysis to guarantee anonymity. The researcher gained permission from the participants involved in this study. In addition, there was an "exemption" granted by the University of Dayton's Institutional Review Board (IRB). Students had a parental consent form signed and each

participant was given a form consisting of the purpose of the study and contact information if questions arose.

## **INTERVIEW QUESTIONS USED**

Honors Thesis Interview Questions:

### **Student:**

1. Tell me about your experiences learning mathematics.
2. What do you do when you don't know the meaning of the words your teacher uses in math class? How often does this occur?
3. When your teacher demonstrates the steps in solving a math problem for you, do you feel you are able to follow along? Why or why not
4. Do you know where to put all of the partial answers (numbers) when multiplying, adding, dividing and subtracting?
5. Do you understand math better when there is a real-world example/application used? (CC)
6. Do you understand why you are doing what you are doing when solving math problems?
7. Can you usually estimate your answer before finishing the problem?
8. How quickly can you do mathematical operations?
9. Do you understand why certain numbers are bigger than others?
10. Do you understand things better when you know all of the vocabulary your teacher is using? (CC)
11. Do you understand math processes better when you understand why you are doing it? (CC)
12. Do you learn math best by hearing it, seeing it or doing it? (CC) (Multisensory)

### **Parent:**

1. When did you first notice your child having trouble with math?
2. Have you seen any progress in their achievement since 2012? (CC)
3. Do you help your child with math homework at home, if so, what strategies do you use?
4. Is there a specific area of math that your child has problems with?
5. Does your child's confidence in math shift? What increases their confidence? What decreases their confidence?
6. Does your child have any other learning disabilities, if so, what specifically?
7. Is there anything you are noticing that is different in your child's learning that is making it easier or harder for them to succeed in math?

8. Does your child seem to understand math more when it is used with a real world application? (CC)
9. Does your child seem to understand why they are doing what they are doing in terms of solving math problems? (CC)
10. Multisensory strategies consist of incorporating all learning styles (auditory, visual and kinesthetic) while teaching. Do multisensory strategies seem to promote more achievement? (CC)

**Math Teacher:**

1. What does this student struggle with mathematically?
2. Are you implementing the CCSS in your curriculum?
3. What ways do the new standards impact your instructional strategies? What have you had to change?
4. Do you see more student achievement when multisensory approaches are being used?
5. Do you use real world applications? Does this student respond to that positively?
6. Do you ever see a change in the students confidence with math? What increases their confidence? What decreases it?
7. What instructional strategies have you had to use with this student to promote success?
8. Do you think that understanding why you are doing a math problem is equally as important as understanding the process you need to do ?
9. What has this student shown the most achievement in since switching to CCSS?
10. Is there any strategies implied through the CCSS that seems to have no affect on this students achievement?

**Section #7: Ethical Issues**

There were no ethical issues to be considered in this research. All participants and their parents signed a form allowing the students to be interviewed about their struggle in math to assist with this research study.

## INVITATION TO PARTICIPATE IN RESEARCH

Research Project Title: The Common Core State Standards in Mathematics and  
Dyscalculia\_\_\_\_\_

You have been asked to participate in a research project conducted by \_\_Melissa Siegel\_\_\_\_\_  
(researcher name) from the University of Dayton, in the Department of \_Teacher  
Education\_\_\_\_\_.

The purpose of the project is Propose the impact the new Common Core standards will have on students  
with dyscalculia\_\_\_\_\_ .

**You should read the information below, and ask questions about anything you do not understand,  
before deciding whether or not to participate.**

- Your participation in this research is voluntary. You have the right not to answer any question and to stop participating at any time for any reason. Answering the questions will take about \_\_30-40\_\_ minutes.
- You will not be compensated for your participation.
- All of the information you tell us will be confidential.
- If this is a recorded interview, only the researcher and faculty advisor will have access to the recording and it will kept in a secure place. If this is a written or online survey, only the researcher and faculty advisor will have access to your responses.
- I understand that I am ONLY eligible to participate if I am over the age of 18.
- **DISCLAIMER (online research only):** All internet research carries the risk of breach of confidentiality. It is not possible for us to guarantee anonymity, although we will treat your responses confidentially and keep the data as secure as possible. No one on the research team will collect identifying information, however we cannot guarantee the security of the computer you use to respond, nor can we guarantee the security of data transfer between that computer and our data collection point or while it is stored online. We urge you to consider this carefully when responding to these questions.

**Please contact the following investigators with any questions or concerns:**

*Name of Student, University of Dayton E-mail Address, Phone Number:*

*Name of Faculty Supervisor, University of Dayton E-mail Address, Phone Number:*

**If you feel you have been treated unfairly, or you have questions regarding your rights as a research participant, you may contact Mary Connolly, Ph.D., IRB Chair, at [IRB@udayton.edu](mailto:IRB@udayton.edu); Phone: (937) 229-3493.**

### **Section #8: Summary**

The research question focused on the Common Core State Standards and their implications for instruction in correlation for intervention strategies for students with dyscalculia. No ethical issues were present to consider in this study. The researcher protected confidentiality and anonymity with the data collected through interviews over email and recorded on a voice recording app. The purpose of the interviews was to find common themes in the responses that suggests a correlation in the research question. The scores were compared to investigate any improvement in scores while using the PARCC exam with the CCSS. These two pieces of data will contribute to the conclusion of the thesis and a proposed answer to the research question. The subjects were selected based on their mathematical understanding and difficulties. The Common Core State Standards must be implemented into their curriculum for this study. In conclusion, nine participants were interviewed and numerical data was compared to suggest a proposed answer to the research question

## **Chapter 4: Analysis and Discussion of Data**

### **Section #1: Introduction**

This study examined the Common Core State Standards, the instructional implications under those standards and the effect that those implications will have on students with dyscalculia. The research suggests that these implications should positively affect the students' achievement due to the conceptual and multiple approach nature of the standards. Four students, their parents and their teachers were interviewed with a series of questions that will better inform me about the severity of the difficulties with mathematics that the students have and improvement or lack of improvement with the new standards. The participants ranged from grades four to eight with varying mathematical abilities, learning styles and extra help access. The teachers are both implementing the standards in their classroom and have witnessed changes in their instruction as well as in the way that their students think about and do mathematics. The research supports positive correlation between student achievement and implementation of the new standards.

### **Section #2: Research Question**

My research question is; “what are the effects of the instructional implications under the Common Core State Standards for students who have dyscalculia?”. This question centers around the teachers’ implementation of the standards and their instructional strategies and the impact it has on these students and their mathematical achievement. Although the research looks at this question at an angle that includes grades

K-12, only grades 4-8 were available for this study, however, research as well as these results help answer the question as it pertains to the age range not evaluated.

### **Section #3: Results**

#### Research Participant 1:

Abby's main difficulty in math centers around thinking critically about math and mathematical processes. Specifically, when it comes to real world situations, Abby has a difficult time applying mathematical concepts to situations that are not straight forward. This is prominent in both word problems as well as systematic mathematical problems. For example, when working on a problem that asked how many hours Bobby must work to buy a magazine that is \$4.88 if he makes one dollar an hour, Abby answered 4, only noting the amount of dollars the magazine costs and not accounting for needing another dollar to cover the 88 cents. Another instance comes with a different problem. When learning the order of operations, PEMDAS, Abby was able to learn the basic principles and knew it to the point where she could help other classmates. However, when it came time to make the problems more complicated, she was not able to apply the same basic principles to more complicated situations.

Since critical thinking is difficult for Abby, she also has a hard time with real world application problems according to her teacher. Her parent also commented on Abby's work with real world application by commenting that the real world application must make sense and relate to her in order for it to increase her understanding, which Abby also explained. Abby's difficulty with critical thinking is likely the reasoning for

difficulty with real-world applications because critical thinking is required to bring the mathematical concepts and systematic formulas to real-world use and application. Even on homework, her teacher comments “Once Abby has mastered it, she does pretty well on the first page of their homework; it's pretty much just doing the math and keeping it basic and the second part is applying it to the real world and that's where she tends to struggle”.

She struggles with algebraic thinking, thinking with expressions and following patterns as well. Her parents comment by saying that she has struggled in math dating back to Kindergarten. Her parent comments that conceptual understanding has been a problem for Abby as well. She adds, “One example I can think of is the number line. We always struggle with the number line especially with negative numbers and decimals and where they fall between other numbers. She just has a really hard time conceptualizing that”.

While evaluating her own learning, Abby mentions that sometimes math comes really easy and sometimes it doesn't really come to her at all. However, she does not comment on when or the types of problems that cause easy and hard understanding. When it comes to estimating her answers before finishing a problem, Abby can finish it quickly if it is easy, but if it is more difficult than it takes her a longer time to complete. Similarly, she can only do mathematical operations quickly in the event that the problem is an easier problem, such as long division. In addition, Abby has no other learning disabilities other than her difficulty with mathematics.

There have been a multitude of different intervention strategies that have assisted in Abby's learning. Abby's teacher says that Abby among the rest of the students have a



positive response to multisensory learning. Abby has a tutor that she sees twice a week for 30 minutes during the day that gives her one-on-one attention. Her teacher works with her at recess as well a few times a week. In addition, when group work is handed out to the students, her teacher pairs her with another student who is struggling in math so she can spend a lot of time with them and give them more individualized instruction.

In addition, doing things at a slower pace assists with Abby's learning as well. She also gives her different problems on occasion that is more on her individual level to help Abby make progress in her class. Abby is able to understand math a lot better and follow steps easier with her teacher because “she does it at a pace [she] can keep up with”. It also helps Abby to articulate the process she is going through by saying her steps and her thought processes out loud; a strategy that her parents say seems to help her. Abby uses other programs to help her with mathematics, including an app called dream box. Her parent comments, “whenever she uses dream box consistently, her confidence increases”. She is engaged and comfortable doing these activities that focus on her conceptual understanding so she responds very well since it significantly helps her understanding. The CCSS centers around different ways to solve the same problem. When different approaches are used, Abby responds very positively, according to her parent, teacher and herself.

### Research participant #2

Gwen has had trouble with math since the 6<sup>th</sup> grade. She really has to work hard in order to understand concepts because it does not come easily to her. She especially struggles with word problems as well as using a problem solving technique in different

applications. This stems from her lack of understanding that she can use a method in a variety of ways and therefore has a problem applying techniques to different contexts. She has been identified as a slow reader. Her words per minute is not at the expected level for a student in 8<sup>th</sup> grade. As a result, Gwen is on an IEP for reading.

She usually tends to not really look into the math problem very much to try and understand why she must use the procedure that is called for. She just wants to turn them in and be done without any other thought going into it. This became evident when I asked Gwen if she understands why certain numbers are bigger than others. While she responded yes, she said that it was “because the quantity is bigger”, neglecting the number line.

When it comes to following steps, Gwen is only able to do it if the material is not very hard, “but if it is really hard [she] probably won't be able to follow it”. Most of the time when she is following steps to solve a problem she does not understand why she is using the procedure she is using for that particular instance. In addition, she usually cannot estimate answer before completing the problem. However, she can quickly do mathematical operations and usually understands most of the vocabulary used. In the event that she doesn't, she usually uses Google to find the answer.

Most intervention strategies for Gwen centers around multisensory learning, however, others are used as well. When helping Gwen at home, her mother explains her that she always needs to explain things visually with paper and pencil. Her teacher also comments that visualization on paper is very helpful for Gwen. She responds well to real-world applications and it increases her understanding of mathematical concepts. Also, she does better in her math classes with repetitiveness of concepts and constant review. One

on one instruction helps as well. Like Abby, Gwen likes to talk out math problems. Her teacher comments that “she needs to be allowed to do that because [she feels] like that is the way she learns best”. She talks out the problems and figures out what she needs to do to solve it. She even responds better if you talk out a problem with her.

### Research Participant #3

Mackenzie has been struggling with math since about the 4<sup>th</sup> grade. The first indication of trouble began with the multiplication table and her difficulties with understanding it and finishing it in the time allotted. She is slower with understanding concepts and tends to work slow as well. She has not been tested or diagnosed with any learning disability. She does not really have much of an interest in mathematics and is more of a reader. Mackenzie sometimes rushes through her work and therefore makes errors as a result of that. She has the most problems with algebra, but like previous instances in math, it may be due to a lack of interest or understanding of its use.

Systematically, Mackenzie sometimes has problems with more technical mathematical details. For example, when placing partial answers, sometimes she knows where to put them while solving a problem, however, if the numbers are pretty big, she occasionally gets confused. This is also supported by her difficulty with the multiplication table as earlier explained as being the first indication of problems in math. She can estimate her answers before finishing a problem on a few of them. It usually takes longer because she has to think about it longer, but her ability to do this usually depends on the types of numbers she is working with. For example, whole numbers she is able to estimate well. Similarly, Mackenzie is able to do mathematical operations quickly

depending on what the numbers are. When using decimals, it is a little bit more difficult and requires more thinking for her. Similar to Grace, she claims she understands why certain number are bigger than others, but resorts to quantity while neglecting the number line.

She usually tends to have trouble at the very beginning of the unit, but after asking questions of her teacher and parents, she is usually able to understand it by the end. She says when her teacher is demonstrating steps to solving a problem she is able to follow along because “she tells [her] what to do, what [they] shouldn't do and it's really just listening to her, paying attention and not having your mind wander off”. She does comment that sometimes vocabulary doesn't stick with her and that could contribute to her lack of understanding.

Mackenzie stays for extra help after school on Mondays and responds very well to one on one help. Her parents comment that although Mackenzie is “sometimes slower with understanding the concepts, with one on one instruction, she can figure out where she was going wrong”. Along with extra help after school, constant review and repetitiveness has been essential to her learning. She has learned that she is able to ask questions when she does not understand a concept or process and that has helped her tremendously in her understanding of mathematics.

#### Research Participant #4:

Emily's main difficulty with math centers simply around being able to remain focused and dragging out her work, as noted by herself, her parent and her teacher. She comments that “[she has] always had trouble focusing, but especially in math”. She is not

interested in the material and thus can't focus on it as much, which makes it difficult for her. Even when her teacher is explaining all of the steps to solving a math problem, Emily is only able to follow along if she is paying attention and does not zone out. She says that she is most effective when the math problem is given a value to her in terms of how she will use it in her everyday life past the classroom. Her inability to keep attention most of the time affects her quickness when doing mathematical operations as well. She says it usually takes her a while to do mathematical operations because she often zones out and “[I] really do not want to do the problem so I drag it out to take longer than it needs to take”. Emily's parent also comments on this and says that she could take hours to do one assignment and is rarely in the zone doing math because she avoids it and drags it out. Even while taking a test or working in class, Emily's teacher comments that she often gets distracted and she has to tap on Emily's desk to remind her to get busy. This has changed with teachers as well. Emily's parent comments that she liked math a lot better and was more engaged when she had a different teacher in 7<sup>th</sup> grade, however, her grades did not reflect that greater interest with higher achievement.

Emily comments that she usually can't estimate the answer to a problem unless it is something easy like a “really simple algebra [or] geometry problem like trying to figure out the angles of a triangle”. When asked if she knows why certain numbers are bigger than others, she answers that she knows, but like the others, attributes it purely to quantity and neglects the number line. Her parent as well as herself acknowledge that she often makes computational errors, even if she does understand the concept. Algebra especially was difficult for Emily to grasp. She used to have a lot of trouble with understanding vocabulary and often would not know the meanings of the words her

teacher was using, thought that has greatly subsided. Like Mackenzie, she has been struggling with math since about the 4<sup>th</sup> grade and has not been tested or diagnosed with a learning disability.

Emily does feel confident when she does math when she has one-one instruction, which may be in part due to being forced to keep focus and not zone out. Along with her sister, she stays after school on Mondays for extra help and they respond very well to that one on one help. Emily will sit right next to her teacher's desk and stay with her teacher the entire time because the one on one attention helps her so greatly. Repetitiveness, constant review and extra help have served Emily very well in her mathematics. Emily says that she usually understands math processes better when she understands why she's doing what she is doing in the problem. Emily is “also someone who needs to see it on paper, not just hear it, but work it out” according to her teacher. The visualization on paper greatly assists her. She understands math better when she works with manipulatives and pictures as well

#### Research Participant #5 (Teacher 1)

This teacher is the teacher of Abby, our first research participant. She is implementing the Common Core State Standards (CCSS) in her curriculum, although since this is the first year that the staff are fully implementing it into their classrooms, “there is a learning curve that comes with it for the teachers and also for the students”. She says there are still gaps to be filled.

The biggest change in her instructional strategies as a result of the CCSS implementation is teaching the students a multitude of ways to do one task.

Multiplication, fractions and division are just a few examples. Conceptual understanding has been incorporated into her curriculum as well. For example, she says “with adding fractions you have to have a common denominator then there is actually understanding what does that common denominator actually look like and what does it mean and not just lets find it”. She uses real-world applications to reinforce this understanding as well. She thinks it is really important for the students to understand their process as well as its use later on in math and across other areas as well. Students have shown the most achievement in getting a deeper understanding and a faster understanding when multiple approaches are shown.

#### Research Participant #6 (Teacher 2)

This teacher is also implementing the CCSS and has Mackenzie, Emily and Gwen as students. She has transitioned into fully using the new CCSS because previously she was using the new standards as well as working out of old textbooks.

Similar to teacher #1, she has had to change her instructional strategies in that she has to present more ways to solve problems and introduce concepts. She explains that at first they give a more visual way with pictures and visuals and show the more computational ways and how to work through the problem after. Some of her students like that, others would prefer to just go straight to the computational problem solving. She notes that another “change is the way [the math] is presented in the textbooks and being able to help them understand how things are asked”. Questions are asked differently in the new books opposed to the older ones that she had used in her previous 25 years teaching. She does like the multiple step process, however, and even praises it

and attributes it to student understanding; “it's because of the multiple ways of doing things that it reaches more kids”. She also thinks it is important for students to understand the process they are undergoing and why they are doing the problems to give it a value.

Teacher 2 uses real-world applications while teaching as often as possible. Her teaching strategy usually follows teaching the concept, how to do it and why is it necessary to know. She praises the book for being efficient in giving real world application problems noting that the book will literally say “real world activity” for the concepts. Most of her students do well with the real world application problems, but some don't like to spend the time to try and figure them out or the length of the problem.

## **Themes**

### Presence of Mathematical Difficulty

Throughout my study, I wanted to analyze any other causes for the presence of math difficulty in the students who participated. Abby, Mackenzie and Emily have not been identified with any other learning disability. However, Gwen is on an IEP for reading as she has been identified as a slow reader. Her math teacher does not have to make accommodations for her though. Gwen's main area of difficulty is with word problems and using a concept in a multitude of ways, likely in part due to her difficulties in reading.

More so, systematic and visual-spatial reasoning are present in all four of the participants. All four students have problems with algebraic expressions and problems. They usually need an easy problem in order to follow steps on the board as their teacher explains how to solve these kinds of problems, but have difficulties otherwise. When



estimating answers to a particular problem, their ability to do so is dependent on the kind of problems and numbers that they are working with. If the problem is difficult or the numbers are not natural numbers, they have difficulty. In addition, many of them struggle with thinking critically. For example, Gwen and Abby cannot often apply a concept to different scenarios and applications. This could potentially explain why these students have a more difficult time with real-world applications as well. Instead of assisting with their understanding, real-world applications have confused these students even more and have not contributed to their understanding of the concepts.

The students admittedly do not spend a significant amount of time trying to understand why things are done the way they are. This limits their understanding of their processes and could be attributed to the difficulty that they have in that area. Many of them say that they “just do the problem and don't think much of it” or just don't understand the reasoning behind why it's done a certain way. During my study, I asked the participants, “do you know why certain numbers are bigger than others?” and although they all responded yes, none of the answers mentioned the number line, which shows a lack of conceptual understanding. Abby's parent attributes most of Abby's problems in math to a lack of conceptual understanding. The majority of the time, these students do not understand concepts or how to solve a problem the first time around.

### Intervention Strategies:

#### Multisensory

All four of the students said that multisensory learning techniques helps them greatly with their mathematical understanding. The one multisensory technique that they

all agreed on was kinesthetic, so doing the math. Mackenzie says that “[she] learned subtraction and addition from hearing it and then watching it and then doing it”. Emily says that it increases her understanding and even prevents her from forgetting it later if she is able to do it.

All four parents agreed that multisensory learning techniques have greatly helped with the students' understanding as well. Gwen's parent explains that she needs to explain mathematical concepts and problem solving visually to assist Gwen with homework. Abby's parent comments that “it helps Abby a lot when she can draw pictures to solve the math problem or think about it in a more visual and holistic way”. She says that Abby also enjoys working with objects. An example of this would be when she takes 20 M&Ms and asks if they are divided into five groups, how many would be in each groups and since she can think of the problem in a way that she understands and can visualize, she's usually able to solve the problem. Mackenzie, Emily and Gwen's parents agree that multisensory approaches have increased understanding as well.

Both teachers interviewed commented that they see more achievement across the board with multisensory techniques. When asked about Emily and Gwen, their teacher mentioned that Emily is someone who needs to see it on paper, along with Gwen. They both need to work with manipulatives, pictures, diagrams, etc. in order to increase their understanding. In order to address this, the teachers usually start with a visual way of explaining first and add in manipulatives and strategies of that nature to the classroom. The teachers agreed that it is mostly the visualization that helps the students the most.

#### One-on-One Instruction and Review

All four students receive help for their homework at home and have other forms of one-on-one instruction. Whether it is just answering questions, going through steps or explaining concepts, each student gets a level of homework one-on-one help at home. The parent of Mackenzie and Emily even attributes their confidence to having had one-on-one instruction because they feel like they have a firm grasp of the concepts. The teacher of Mackenzie, Emily and Gwen does weekly reviews that consist of a worksheet given to the students on Monday and it is due the following Monday. This helps all three of the students with retention and they are able to review the concepts, which helps them better understand it. Emily and Mackenzie stay after school on Mondays to get extra help and that one to one attention that is so critical to their understanding. Their teacher is able to review material and answer questions during this time. Abby sees a tutor twice a week for 30 minutes as well as works with her teacher after school and during recess on occasion. In addition, when students are working in groups, she usually pairs Abby with someone else who is struggling and will spend more time with those students and give them extra one on one help. The teachers agree that repetitiveness, constant review and one to one attention greatly helps these students achieve in math.

### Technology

Technology has been a great tool for the students and their understanding of mathematics. At home, Emily and Mackenzie use Khan Academy and it has proved to be helpful because it presents the material in a different way and they can repeat it however many times that they need, which increases retention and understanding as discussed previously. At home, Abby uses a computer website and app called dream box. Her

confidence increases when using dreambox because it consists of “the type of activities that has her engaged and that she is comfortable doing and it is focused on those conceptual understandings”. This has helped her overall confidence in math as well as her conceptual understandings in math. From the book, the students are able to get an online version of their book that has videos, tutorials and explanations for certain problems and that has greatly helped their understanding; so much so that the parents are asking for the website so they can utilize it to help their student(s).

### Instruction

The teachers have a similar method of instruction. Both teachers are implementing the CCSS into their curriculum. However, both are experiencing a learning curve that many teachers are also experiencing. Both teachers have transitioned into fully incorporating the standards into their classroom. The teachers agree that their biggest instructional implication under the new standards is showing multiple ways to do a single task, such as, multiplication, addition of fractions, division, etc. They both note that there has been more student achievement with the multitude of ways because students are more likely to make sense of one of the ways shown in order to increase their understanding of the concept or procedure. There has also been a large emphasis on conceptual understanding and use of real-world applications that stem from that in the classroom. The students seem to have a little bit more of a difficulty with these types of problems, but once understood, they greatly support one's understanding of the concept as a whole. Finally, the teachers both use multisensory techniques in their classroom and spend time

with students one-on-one in order to better educate them and explain concepts that are more difficult.

### Test Scores

The exam scores were all taken from the official Ohio Department of Education website. For the spring of 2015, 65.4% of students in the 5<sup>th</sup> grade scored proficient in math. In addition, 6<sup>th</sup> graders reached 65.3% proficiency, 7<sup>th</sup> graders reached 65% proficiency and 8<sup>th</sup> graders reached 53.1% proficiency. These test scores reflect student performance on the PARCC exams. With respect to the Ohio Achievement Assessment, in 2014, 67.57% of 5<sup>th</sup> grade students, 76.9% of 6<sup>th</sup> grade students, 73.35% of 7<sup>th</sup> grade students, and 71.49% of 8<sup>th</sup> grade students scored proficient. In 2013, 68.6% of 5<sup>th</sup> graders, 75.41% of 6<sup>th</sup> graders, 73.56% of 7<sup>th</sup> graders, and 77.32% of 8<sup>th</sup> graders scored proficient. Finally, in 2012, 67.11% of 5<sup>th</sup> graders, 80.14% of 6<sup>th</sup> graders, 73.78% of 7<sup>th</sup> graders and 79.76% of 8<sup>th</sup> graders scored proficient. There is evidence of score decrease between the Ohio Achievement Assessment and PARCC exams. In addition, there is a difference in test composition and scoring techniques. The Ohio Achievement Assessment is composed of more multiple choice questions that require a lower level of critical thinking, while the PARCC exams include more extended response questions that require critical thinking, mathematical reasoning and justification, which is the basis for how the exam is scored.

### **Section #4: Discussion**

Discovered in the process of interviewing the two teachers, both were implementing the Common Core State Standards although not for very long at a fully integrated level. Both noted the changes that went along with standards that included a higher incorporation of real-world applications and a multitude of ways to do a problem. They incorporated activities that focused on conceptual understanding and building upon earlier concepts. The successful implementation of the CCSS shows an accurate reflection of student achievement with the new standards in place. According to the research, the teachers are reaching the standards accurately and are still able to keep their unique instruction while modifying it to achieve the mastery of standards as called for by the policy makers.

The students are clearly exhibiting symptoms of dyscalculia. Abby, Mackenzie and Emily have more a visual-spatial and procedural difficulty, as to where Gwen has more of a language difficulty, likely due to her struggles with reading in general. Each exhibit a difficulty in understanding processes and applying it to different situations given a real-world application or in Gwen's case, a word problem. This shows a presence of varying degrees of dyscalculia among the students, which give the basis we needed for the study in order to see the effect of the Common Core on these students.

The research suggests a positive correlation between student achievement and implementation of the standards should be present. In the interviews, this seemed to have been the case. Most of the students respond well to the new types of instruction and new emphasis because it gets the students thinking about the reasoning behind what they're doing and although it is a new perspective that the students are not used to, they are able to analyze and not focus on the procedure as much as the concept.

Another reason the students perform better is because there are multiple ways to do one task as introduced in the text books that correspond with the new standards. This is promoting student achievement likely due to the fact that the students are able to pick the way that best suits their understanding and building onto former concepts and are able to understand and utilize one of the many ways. The students are also responding well to multi-sensory instruction, which is encouraged while teaching the new standards because it assists in showing the different ways to solve a single problem. These intervention strategies for students with dyscalculia do indeed coincide with the instructional implications under the Common Core State Standards and therefore cause a higher rate of understanding and achievement for these students.

In relation to the test results. There are a few reasons that the PARCC exams scores showed a lower amount of students scoring proficient. For example, since the PARCC exams were new and computer based, students as well as teachers were unsure of what to expect. This uncertainty makes it difficult for teachers to prepare their students for the exams. In addition, because of the different make-up of the exams and different scoring rubrics, the tests really cannot be compared side by side on just an objective score basis. These different factors are contributing components to the scores and their differences.

### **Section #5: Summary**

This study investigated the Common Core State Standards, their implications for instruction and the effects of those on students with dyscalculia. The teachers who participated in this study incorporated the Common Core State Standards into their

curriculum in the ways intended for by the creators of the standards. The students who participated in the study also exhibited symptoms of dyscalculia in mostly the visual-spatial aspect, but also in the linguistic aspect as well. The research suggested that a positive correlation should occur between the implementation of the standards in the classroom and the achievement of students with dyscalculia. The interviews conducted confirmed the research. Because of the way the standards are constructed, teachers are able to teach concepts in many different ways with encouragement of multisensory techniques as an effective way to show these different ways while focusing on conceptual understanding and application instead of strict procedural practices. The intervention strategies for dyscalculia line up with this type of instruction and thus higher student achievement is accomplished.



## **Chapter 5: Summary, Conclusions and Recommendations**

### **Section #1: Significance of the Study**

This study examined several components of the Common Core State Standards for Mathematics and the instructional implications through its implementation. In addition, it examined the intervention strategies for students with dyscalculia and evaluated the connection between the two. The instructional implications and the intervention strategies were researched separately because there is no research to date that includes both as the focus of the study. This research is included in the Chapter 2, Review of the Literature. The methodology consisted of interviews with students, their parents and their teachers and an analysis of the PARCC exams and the Ohio Achievement Assessment. The interviews examined the way the CCSS-M were being implemented and the effects that were observed on students with dyscalculia.

As mentioned above, these topics are relatively new and have not been researched extensively. The uniqueness of this study that combines two topics with minimal research individually signifies the study. The Common Core State Standards is a new initiative only put in place since 2012 and dyscalculia is a learning disability that has only recently been acknowledged so there is ever-changing and little research about CCSS as well as dyscalculia.

A part of the unique connections between the CCSS and dyscalculia is that CCSS does not directly address how teachers should teach, especially in instances working with students who have learning disabilities. The Common Core instead just sets the criteria

for what standards need to be met, the means of meeting those criteria are up to the individual states and schools. Although the CCSS does not directly mandate how to work with students with dyscalculia, many of their instructional implications for the general classrooms to achieve those standards coincide with intervention strategies for dyscalculia, which is the basis of this study.

The states who have adopted the Common Core are implementing the standards at a different pace, which makes this study interesting. Although it is adopted in almost all of the states, the pace of implementation varies based on states as well as individual school districts. The private school system is not required to adopt the Common Core State Standards, however, many of them do to stay on track with the public school system. The study examined students and teachers of a private school who is implementing the Common Core, but is not required to. Due to the lack of necessity, these teachers implement it at different levels and in different ways than those schools who are regulated by it.

This study is relevant because both topics are recent and have little research. From this study, more awareness is brought to dyscalculia and the effects of Common Core implementation. There is a lot of politics that surround the CCSS and a lot of controversy brought up about the implementation and how it is changing education. This study shows the positive effects of the CCSS and how they can be used in intervention with students with learning disabilities in the general classroom. For the schools that are required to implement the Common Core this is very helpful, especially the classrooms with students who have dyscalculia.

## Section #2: Summary of the Study

The study examined the instructional implications under the Common Core State Standards and their effects on students with dyscalculia. The research suggested a correlation between the two due to the correspondence between the CCSS and the intervention strategies for students with dyscalculia. Many of the intervention strategies for the students who have dyscalculia are naturally implicated for achievement of the standards, which suggests a positive correlation in the general classroom as well as with different RTI strategies and IEPs for students diagnosed with dyscalculia. These included multi-sensory strategies, a higher emphasis on conceptual understanding, multiple methods to solving a problem, academic vocabulary emphasis and use of technology.

The methodology was comprised of interviews conducted to the students who showed symptoms of dyscalculia as well as their parents and math teachers. Out of the four students interviewed, three seemed to have more of the visual-spatial difficulty piece and one had more of a language processing difficulty, and also was identified as a slow reader. The students seemed to have noticed improvement in themselves since their school started implementing the new standards, and their parents have observed the same. Many of the students had the same general struggles with math, but also slightly differed in a few areas, especially the student who had the most trouble in language processing in mathematics.

Teachers have noticed an increase in understanding of these particular students as well as a higher understanding in their general classroom. The use of multi-sensory strategies, technology and a teaching style that centers around emphasis on conceptual understanding has shown improvements for all students, especially those diagnosed with

dyscalculia because it allows them to think about math in a variety of ways. The teachers interviewed implemented the CCSS in similar ways, but also discussed their slow transition into the standards, since they themselves are learning it along with the students. Both said that they were incorporating multiple strategies to do the same task, multi-sensory strategies, academic language use and real-world application into their general classroom as well as using these strategies in greater amounts when working with the struggling students in particular.

The second component of my methodology was data analysis of test scores and test components of the Ohio Achievement Assessment, the standardized test used before the Common Core's test, the PARCC exam. I examined these test scores and pieces to analyze the differences in student performances and make-up of the exams (i.e. what they are testing). I found that a lower percentage of students scored proficient or above on the PARCC exams compared to the percentages for the Ohio Achievement Assessment. In addition, the tests were a different make up. The OAA exams consisted of majority multiple choice questions with the 20% of extended response looking for procedural fluency, while the PARCC exams consisted of a majority extended response questions where justification, mathematical reasoning and conceptual understanding were analyzed. Thus, one cannot compare these two tests side by side in an analysis of data according to test scores.

This study has a different implication for the public school system. The public school system is required to adopt the Common Core by policy and have less space and flexibility to transition into the new standards because their students are expected to achieve them right when implementation starts. This study centered around students and

teachers who were enrolled or worked in a private school and therefore and more flexibility in terms of their teaching and what they were required to achieve. However, this study is still very useful to all school systems because students with dyscalculia exist everywhere and the Common Core is being implemented in all public schools and many private as well . This study shows teachers the different intervention strategies for students with dyscalculia while showing how they correlate with CCSS and the implementation of both in the classroom.

### **Section #3: Conclusions**

A few surprising results appeared from my interviews that contradicted the research, but much of it reaffirmed the previous research that I had done. One surprising aspect was the lack of understanding stemming from the use of real-world applications. However, researching more about the symptoms and effects of dyscalculia it also makes sense because real-world application requires a higher level of thinking, which is difficult for those students to obtain. The conceptual basis from the beginning allows them to better understand how to engage in critical thinking, but it is a slower process. I was also surprised at the similarities between how the two teachers that I had interviewed incorporated the CCSS into their curriculum. Since they are not required by law to implement the standards due to the private school status of their work, I was surprised to find that they were both transitioning to using the standards in very similar ways. They both incorporated multiple strategies to solve a problem, conceptual understanding, multisensory strategies as well as real-world application into their curriculum in order to fulfill the standard achievement required.

One concept that stood out after the interviews was the idea that although the standards was the ultimate goal of the general classroom, student attention and tailoring the curriculum to the students' needs proved to be the most significant part of the achievement for the students. Although the general transition helped improve student achievement, one-on-one instruction and individualized attention seemed to be the biggest factor in student achievement. The regulations of CCSS around learning disabilities centers around the idea that the students are still expected to maintain the same level of achievement as those students who do not have a learning disability, however, the means of achieving those standards can be done through methods such as RTI, IEP programs, 504s, etc. This shows the importance for educators to tailor their lessons and teaching to the needs of their students. Although achievement can be raised due to changes in the general classroom, there is still a huge importance on accommodating to students' learning styles and their needs.

The study showed that students with dyscalculia were overall at higher levels of achievement with the implementation of the new standards. As mentioned previously, they all showed symptoms of dyscalculia. Three of the student participants had more of the visual-spatial difficulties, while the other had more of a language processing difficulty, which is likely due to her identification as a slow reader. All of the students had trouble estimating their answers, doing mathematical operations in a reasonable time, mathematical procedures and applying what they had learned to other situations. However, with the emphasis that the CCSS places on understanding the mathematical reasoning and concept behind mathematical operations and problems, they are able to

work on those skills and improve them, which in turn improves their understanding and achievement in math.

#### **Section #4: Implications**

This study provided information for educators in a wide range of contexts. First, it brought a higher awareness of the presence of dyscalculia and the symptoms that may be detectable in a student who has it. Also, it showed intervention strategies that are most effective for student achievement in those situations. Awareness of symptoms can bring more diagnoses and awareness of students who have the learning disabilities so their needs can be met. These students will be able to get more specialized attention and awareness of intervention strategies will allow them to get the most helpful and accurate help. Dyscalculia is present in up to 6% of the school-aged population and is co-morbid with dyslexia 50% of the time. The likeliness of an educator having a student with dyscalculia in their class is likely, and with the knowledge of its co-morbidity will be able to increase awareness especially when approached with a student with dyslexia. Awareness to students and their parents was a critical part of this study as well. Student approaches to learning and self-reflection and assessment will be highly effective knowing that they have dyscalculia because they will be more aware of what struggles they have and what helps them understand. This information is useful for parents because they will be more informed on what their students are struggling with and how they can help at home.

School systems across the country struggled with the effectiveness of implementing the CCSS and how to implement CCSS for students who have disabilities.

This study informs the schools that the CCSS has instructional implications that line up with the interventions strategies for students with dyscalculia by means of the general classroom. This is informative because educators can now implement the CCSS with ease knowing that it will innately help students with dyscalculia achieve. However, that in itself is not enough for full student achievement. From the interview conducted, it was found the one of the most helpful tools was one-on-one instruction with the students and teachers. Although the implications for instructions under the CCSS are found to help students with dyscalculia under general instruction, one-on-one instruction as well as different RTI strategies are needed to help the students succeed and achieve the standards.

#### **Section #5: Recommendations for Further Research**

The CCSS is still in its first years of being implemented and the effectiveness is still being measured. Research on the effectiveness of the CCSS as a whole need to be further investigated especially in the areas of learning disabilities and dyscalculia to particular. This study is a small piece of the entire scope of CCSS and learning disability study, further research can be done once the CCSS is in implementation for a few years and new accommodations and research is done. Since this study was done recently after the CCSS were implemented, attitudes and and implementation could have changed over time.

This study only examined students who were female between the 5<sup>th</sup> grade and 8<sup>th</sup> grade. The studies in the future should examine a larger range of grade levels and have different genders as participants. The study only examined this small range due to availability so a recommendations of a greater range of participants both age wise, who are experiencing different levels of difficulty and are different genders. In addition, due to



availability, I could only do the interviews in a private school setting. Private schools are not required to implement the CCSS and although this particular one did implement it, it was not in full compliance with the regulation of CCSS. This study only examined dyscalculia and did not acknowledge how the CCSS would impact students with other learning disabilities and how they would inform student instruction and achievement. Further study should examine the implications for student achievement under the CCSS for students with learning disabilities and the best interventions strategies to raise awareness as well as better prepare the teachers.

### **Section #6: Summary of Chapter 5**

This study answered the question, “*Would instructional implications under the Common Core State Standards help students with dyscalculia achieve?*”. The study encompasses a review of the literature, a methodology to finding the answer, an analysis of the results and finally, recommendations and conclusions. *Chapter 5* began by examining the significance of this study. This study is significant because it brings awareness of dyscalculia to educators, students and parents alike. It will bring a higher awareness in the presence of symptoms and more information about different intervention strategies that may help the student achieve. This study also examined the Common Core State Standards. As a newly in place educational initiative, there is still much debate and research on the effectiveness of the CCSS. As a result, this study will help inform the effectiveness of CCSS for students with dyscalculia. This study also informs educators and parents on different ways that the Common Core works for student learning and students can also self-assess themselves based on knowledge of the new standards and how they work.

The summary of the study included the review of the literature, methodology and the data analysis. In the study we examined research on the Common Core State Standards and dyscalculia separately and evaluated the correspondence between the instructional implications under the new standards and the intervention strategies for students with dyscalculia to see if there was any correlation between the two. The methodology involved 4 students who showed symptoms of dyscalculia. They ranged from grades 5<sup>th</sup> through 8<sup>th</sup>. These students attended a small, private, catholic school that was implementing the CCSS into their curriculum. The data analysis showed that there was correspondence between student achievement and the new standards being put in place due to the correlation between the intervention strategies for dyscalculia and the instructional implications under the CCSS. The data also suggested that one of the strongest methods of intervention for those students was the one-on-one instruction informing educators that although the general classroom implications under CCSS will help students with dyscalculia. The conclusion of the study suggested just that; although the students were achieving at higher levels when the CCSS were put in place, the most helpful intervention for those students was still one-on-one instructional and individualized assistance.

In recommending for further research, the participants and time frame of this study could be more generalized to study a bigger population in a wider context. This study only examined females from ages 5-8 that attended the same private school. Recommendations included researching a wider array of students with different levels of dyscalculia that were different genders and ranged in grade level and schools. In addition, since this study was conducted at a certain time frame after the implementations there

was still a lack of research on the effectiveness of the standards in the general classroom as well as the effective intervention strategies for dyscalculia, although a bit more common than CCSS. Attitudes and implementation of standards may change over time as well as new discoveries on dyscalculia, which would need to be accounted for in a future study that would be helpful in keeping a recent on-going study on the correlation between the instructional implications under the CCSS and intervention strategies for students with dyscalculia.

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