Murray State Theses and Dissertations

Graduate School

2019

The Impact of Content Mastery on Sequential Standards

Michael Newman

Michael Newman
Murray State University

THE IMPACT OF CONTENT MASTERY ON SEQUENTIAL STANDARDS

A Specialty Study

Presented to

the Faculty of the Department of Educational Studies

Murray State University

Murray, KY

In partial fulfillment

of the requirements for the Degree of

Specialist in Education

by

Michael Newman

September 2019

THE IMPACT OF CONTENT MASTERY ON SEQUENTIAL STANDARDS

DATE APPROVED: ________________________

____

Director of Specialty Study

____

Member, Specialty Committee

____

Member, Specialty Committee

____

College Graduate Coordinator

____

Dean of the College

____

University Graduate Coordinator

____

Provost

ACKNOWLEDGEMENTS

I would like to express my great appreciation to the faculty and staff at Murray State University. Through strong encouragement and support this specialty study goes out to you. Thank you, Dr. Mardis Dunham for being able to help a student in need of a mentor. You are a true gem to the University. Thank you to the wonderful math department and their great professors in guiding me through graduate course work that at times felt overwhelming. I have been a student at Murray State for the last ten years. It has been an amazing home for me to continue my education through so many different paths. Thank you to Ms. Cindy Thresher. Without Ms. Thresher I would have not been able to be a teacher. The support this university provides is unparalleled and I will be forever grateful for that.

TABLE OF CONTENTS

Abstract

Mastery of P-12 academic standards is based on a learning process that is sequential and that can be broken into key components for varying students. Key ideas need to be learned before others can be mastered and it is important to know which key ideas are needed before others can be presented. The common problem for students in mathematics is that the content scaffolds and for the teacher, it can be a difficult decision of when to proceed and when not to. Yet, high stakes testing mandates a fast pace of instruction which leaves many students chronically behind. The purpose of this study was to determine the relationship between passing scaffolded math standards and passing subsequent standards. Archival data from 481 sixth, seventh, and eighth grades were analyzed using chi-square. Results revealed that mastery of key concepts is needed before subsequent, higher–order applications can be learned.

CHAPTER ONE: INTRODUCTION

Background

Teachers are the frontline professionals in the educational system. Teachers are not only responsible for teaching social skills, but they must also provide educational instruction. Each state mandates what information is taught in its schools. By creating educational checkpoints and teaching the state-mandated standards, teachers determine the structure of how this information will be taught and translated to the students in their classroom. Most classrooms are populated with very diverse learners and this heterogeneity often presents significant challenges for teachers (Aud et al, 2010). One of these challenges is how teachers can address the needs of their lower achieving students without holding the entire class behind and hindering the higher achieving students. Another challenge facing teachers is deciding the correct time to move to the next standard and place the current standard behind them.

Students in classes that have scaffolding content often start struggling when they fall behind the standards and they will continue struggling throughout their educational career until they are back on track. Once a student falls behind academically, it is incredibly difficult to catch up (Swanson et al, 2014). Missing previous standards often has a significant negative impact on mastering new standards when students are trying to learn them. Through this buildup of material, classes can become increasingly difficult if students have not mastered the prerequisite content.

When children show high levels of academic achievement during childhood, it typically augurs well for healthy and productive functioning later in life (Swanson et al, 2014). In contrast, underachievers are at increased risk for delinquency, dropping out of high school, criminal activity, and chronic joblessness (Swanson et al, 2014). U.S. students continue to lag behind peers in other industrialized nations in math and science (Aud et al, 2010). An understanding of methods to promote math achievement during the elementary years is essential given its relation to later academics. Students need to be on grade level during early years of academics or this set students on a foundation that increases their risk of becoming underachievers (Swanson et al, 2014).

Purpose of the Study

In a typical classroom, a student can be hindered by negative performances on previous standards that create major hurdles later. These hurdles can often be too difficult to overcome (Swanson et al, 2014). Teachers, however, often have a strict pacing guide that they must follow. This study investigated the academic impact of failing to master prerequisite standards upon the mastery of subsequent standards.

Research Questions and Hypotheses

Is it critical to student success that mathematics standards are mastered before subsequent standards are taught? Do middle school math students who fail earlier level math standards fail subsequent math standards? A foundational standard in scaffolded math concepts is critical to student success in the sequential content. Student achievement in the classroom in respect to mastering the standards should improve overall if specific standards are mastered. This approach to teaching the standards should result in a significant increase in content mastery. The standardized testing aspect of student achievement should also reveal a significant increase for students in respect to courses which implement a standards-based mastery approach to teaching. It was hypothesized that students who fail pre-standards will continue to struggle on subsequent standards.

Terms and Definitions

- TVAAS: The Teacher Value-Added Assessment System (TVAAS) measures student growth year over year, regardless of whether the student is proficient on the state assessment. In calculating TVAAS score, a student's performance is compared relative to the performance of their peers who performed similarly on past assessments.
- CASE: Collaborative Assessment Solution for Educators, is a purchased assessment that will aid teachers to identify particular areas of need for students and supports their teaching in accordance to their state.
- DOK: Depth of Knowledge, or DOK, is a way to think about content complexity, not content difficulty. Level 1 DOK is recall and recognition. Level 2 is about using a skill or concept. Level 3 require strategic thinking. Level 4 requires extended thinking over a period, including gathering information, analyzing findings, and presenting findings.
- TN Ready: TN Ready is a part of the Tennessee Comprehensive Assessment Program (TCAP) and is designed to assess true student understanding, not just basic memorization or test-taking skills. It is a way to assess what the students of Tennessee know and what can be done to help them succeed in the future.

Chapter 2: Review of Related Literature

Introduction

The true goal for educators is for students to master the standards that teachers are responsible for presenting. Teachers must be aware of the timing when certain standards occur and if that is in the best interest of their students. An effective place to start would be to examine the developing child's cognitive skills. Through this research an approach from Piaget's Theory of Cognitive Development can produce some meaningful referencing points. Piaget believed that the intellectual development of a child occurs through a continuous transformation of thought processes (Ojose, 2008). These thought processes develop though a process of assimilation and adaptation. This developmental sequence, which can be predictable, also varies. Although students are almost always grouped by chronological age, their developmental levels may differ significantly, as well as the rate at which individual children pass through each stage (Weinert & Helmke, 1998). These stages are often determined by age group which is defined via grade levels. It is well known that students can often be off grade level (i.e. ahead of, or below). Piaget believed that children develop steadily and gradually throughout the varying stages and that the experiences in one stage form the foundations for transitioning to the next (Ojose, 2008). This implies older children, and even adults, who have not passed through later stages, process information in ways that are characteristic of young children at the same developmental stage (Eggen & Kauchak, 2000).

Regarding math instruction, there exists a predictable and sequential order to teaching the concepts (Kamii & Lewis, 1990). For example, students must first recognize what numbers are and how they represent an idea. Students must mix concrete ideas of numbers and intertwine conceptual ideas of being able to count objects. Then students often move into basic operations, such as addition and subtraction. Now students can easily demonstrate if they can recognize and comprehend the symbol “3” denoted as “three,” but many still struggle to grasp that “3” means “three items.” Regularly, students will develop misconceptions in their thinking comprehension, for example, that “3” is only “three” (Kamii & Lewis, 1990). Therefore, even if a student comprehends what is “3” he/she can still have difficulties using that number to perform operations. However, lacking knowledge of numbers, a child will be unable to perform operations. An addition. “3 + 6 = 9” will literally have no meaning if the student has no concept of numbers. Therefore, the student has demonstrated that the mathematical structure has major prerequisites. Without those prerequisites, the sequential ideas can become meaningless and impossible to understand (Kamii & Lewis, 1990).

In reality, no one can teach mathematics (Mathematical Sciences Education Board [MSEB] and National Research Council, 1989). Effective teachers are those who can stimulate students to learn math (Clements & Battista, 2009), as math is a massive continuation of rules and logics that link to each other. These rules are all based on foundations of basic understandings. As the study of mathematics branches into further topics, those rules are examined more extensively and understood more deeply to apply those concepts to learning new ideas. For example, mathematics starts out with the strong understanding of using numbers as quantities. Two or “2” cows is a count of how many cows that are referenced. This same thought can be advanced into the count of two of anything. Later, one can place a dash or negative sign in front of the two to represent an opposite of that two. This is just a brief example of how an idea can begin and start out looking one way, but then can branch into a related other idea that quite different.

It is important that students are taught to become math learners and that teachers provide guidance through the trials of logics and sequences. Educational research offers compelling evidence that students learn mathematics well only when they *construct* their own mathematical understanding (MSEB and National Research Council, 1989). Unfortunately, many educators are focusing on alterations in content compared to recommendation for fundamental changes in instructional practices. These instructional changes can be understood from a constructivist perspective (NCTM, 1989).

Constructivism

Constructivism is the philosophy that learning occurs as students or learners are active and involved (Clements & Battista, 2009). Here, intellectual development is conceived as the building of increasingly complex and interacting structures. The structures of developed interact to create patterns of greater complexity, and thus generate an ever-increasing intellectual competence. Each structure also builds upon itself through self-initiated thinking activities (Moshman, 1982). This process of meaning and knowledge contrasts the “sit and get” style of education environments. Most traditional mathematics instruction and curricula are based on the transmission, or absorption, view of teaching and learning (Clements & Battista, 2009). In this view, students passively “absorb” mathematical structures invented by others and recorded in texts or known by authoritative adults. Teaching in this scenario, consists of transmitting sets of established facts, skills, and concepts to students (Cobb, 1988).

Constructivism offers a sharp contrast to this view. Its basic tenets, which are embraced to a greater or lesser extent by different proponents, fall into the following categories: Exogenous, Endogenous, and Dialectical (Gagne, 1968). Exogenous constructivism emphasizes the reconstruction of structures preformed in the environment. Endogenous constructivism emphasizes the coordination of previous organismic structures. Lastly, dialectical constructivism emphasizes the construction of new structures out of organism/environment interaction. The development of knowledge by the child is actively created or invented and is not a reception or absorption that occurs with the child simply being placed in the room. This idea can be illustrated by the Piagetian position that mathematical ideas are made by children, not found like a pebble or accepted from others like a gift (Steffe & Cobb, 1988).

To illustrate this thought, imagine the idea of a number. The number “three” cannot be detected by a child’s senses. It is not something that can be absorbed. It is an idea of a representation of quantity. This idea must be understood so that a child can superimpose it on a set of objects. A teacher will create and demonstrate many ways to use the number “three” for the child. The child eventually will create the thought that “three” is a representation of quantity and then store that understanding. Students do not “discover” the way the world works like Columbus found a new continent (Cobb, 1988). Rather they invent new ways of thinking about the world (Clements & Battista, 2009). These new ideas of mathematical thought are created by the children. The thoughts become knowledge by reflecting on their physical and mental actions. When these ideas are integrated with prior information and interaction occurs is when a teacher can say that a student has transferred this information into knowledge.

Students must be able to construct meaning of lower standards before they can grasp the higher-order standards. For students to reach a level of mastery that translates to success in testing the learners need to be actively involved in the construction of knowledge. This study is observing how students perform on sequential standards in relation to previous standards. Constructivist teaching says that students must become actively involved in that learning process early on in order to create a foundation that is always growing.

Learning Mathematics

According to Clements and Battista (2009), learning mathematics should be thought of as a process of adapting to and organizing one's quantitative world, not discovering pre-existing ideas imposed by others. This is certainly consistent with Piaget's ideas and constructivism. Piaget's theory on constructivism argues that people produce knowledge and form meaning based upon those experiences (Bruner, 1986). This process of adaptation and organization is a social process in which children grow into intellectuals based on those thoughts and people around them (Bruner, 1986). Modern culture has established the world of math. In other words, society has an agreed upon set of rules and discoveries that work with each other and the world. This culture is like a constructivists classroom in which students are involved not only in discover and invention but in a social discourse involving explanation, negotiation, sharing, and evaluation (Clements & Battista, 2009).

Mathematics is often perceived of as a procedural work of art. Many problems in advanced mathematics could be broken down into a procedural process based on steps, much like instructions for building a model car. The emphasis, however, is sometimes lost in translation, ignoring an understanding of why you are doing what you are doing (Cobb, 1988). Students tend to mimic the methods by rote so that they can appear to achieve the teacher's goals (Bruner, 1986). As such, their beliefs about the nature of mathematics change from viewing mathematics as sensible to viewing it as learning set of procedures that make little sense (Clements & Battista, 2009).

Conceptual metaphor plays a central, defining role in mathematical ideas within the cognitive unconscious (Lakoff & Nunez, 2000). For example, understanding the value of time in terms of money. Through the use of blending resources such as different text and learning strategies that appeal to different learning styles, learners build major connections to previously learned materials that aid them in successfully working towards mastery of new concepts. When learners are discovering mathematics, the instructor's role becomes more of a guide in the combination of leading learners in different directions. Vertical alignment throughout the curriculum must be followed with a clear path. It is important that the teacher sees the path of where their students are coming from and the route for the future or vertical alignment of the curriculum.

Part of the learning process can be identified through the framework of Dubinsky. Dubinsky developed an epistemological framework referred to as Action-Process-Object-Schema, or APOS (Dubinsky, 1991). This framework outlines the steps the learners of mathematics go through as they work towards understanding an abstract concept. The framework first considers how the learners are developing a mathematical concept. As they transfer from an action to a process through internalization to which students make these skills, thoughts, and knowledge a part of themselves. Once students can work through the thoughts and skills to make the new idea a part of their own knowledge, they are on a strong path towards mastery. That subsequent process can be captured into an object. The results of using this framework allow students to understand a concept. The students then can provide a schema or outline of the theory as they have now moved into mastery (Cottrill, 2003). It is this idea that undergirds the premise of scaffolding. Scaffolding is the process of moving students progressively towards a stronger understanding of an idea—that is, mastery. In terms of the current study, when standards are broached before learners have developed mastery of previous standards, Dubinsky would say this is unrealistic and unmeaningful for children.

When is Mastery Obtained?

Mastery is the main goal of education. Educators would be overjoyed and have many of their problems automatically addressed if all students were successful in reaching mastery. This ideal is aspirational and not reality. A quick scan of community colleges' remedial math courses illustrates that there are high numbers of students graduating high school who did not reach benchmark. Research completed by Bahr shows that 61% of students nationally do not complete and successfully exit remedial math in community colleges (2013).

Consummate skill of the highest degree, would seem to require a complex and challenging task (Wiggins, 2014). Consummate skill is the mastery of the task or idea presented. Benjamin Bloom, the founder of modern mastery learning, finessed the question of when mastery is achieved. Bloom never defined mastery; he only proposed that one can set an absolute criterion at the local level (Bloom, 1968). His thought is that teachers must have a level at which they want the students to perform. Many local schools and state departments over time have interpreted this as a score that can be obtained on a test (Kubina & Morrison, 2000). Mastery, then, is often operationalized as a score of some percentage on a test. However, this definition is severely lacking. The idea that one test defines how much a child knows is not an accurate representation of the child's knowledge (Wiggins, 2014). Additionally, the depth of knowledge a student possesses can vary widely based on the concepts being examined. Thus, it is extremely difficult to determine the true level of comprehension a student possesses on a state assessment (Wiggins & McTighe, 2005).

The lack of an overall vision or defined parameters could be a result of the questions surrounding what constitutes as mastery level learning. Specialists wonder if teaching bit by bit is beneficial to the development for the students. This is a possible strategy that captures the entire vision of the complex curriculum design. Consider a large concept, such as mathematics. To illustrate, modern educators break math instruction into strings of bits. Educators label these bits as grade levels and determine the student readiness primarily by age. Teachers then begin to teach their own little bit of the concept. A third-grade teacher instructs his students that came to him from the second grade. The third-grade teacher prepares students to move onto to fourth, and so on. Once a student completes a rigid sequence of instruction and testing, this completion of the sequence is labeled as “mastery.” Although intentions are good, this practice leads more students down needlessly fractured and boring work. This is ultimately ineffective learning that never prepares students to be fluent and skilled in authentic work (Wiggins, 2014).

Early attempts to use and implement mastery learning were faulty (Guskey, 2005). Bloom’s ideas had correct intentions; however, education’s interpretations of these ideas were often narrow and inaccurate (Guskey, 2005). After Bloom presented his ideas on mastery learning, others described procedures for implementation and numerous programs based on mastery learning principles sprung up in schools throughout the United States and worldwide (Guskey, 2005). These programs focused on low-level cognitive skills, attempted to break learning down into small segments, and insisted students “master” each segment before being permitted to move on. Teachers in these programs were regarded as little more than managers of materials and record-keepers of progress made by the students. Nowhere in Bloom’s writing can the suggestion of this kind of narrowness and rigidity be found (Wiggins, 2014). Bloom always considered thoughtful and reflective teachers vital to the successful implementation of mastery learning and continually stressed flexibility in its application (Guskey, 2005). When educators break complex performance into bits, often they incorrectly look to find mastery in incorrect ways (Wiggins, 2014). Mastery is then defined as a recall of terms from the vocabulary and isolated facts. Mastery should be facility and power of the content.

Educators should move forward in a way that is helpful for their students. One proposal is the use of fluency and frequency of correct performance as key components (Kubina & Morrison, 2000). For example, teachers can then move forward with a better definition of mastery. Mastery is effective transfer of learning in authentic and worthy performance (Wiggins, 2014). Students have mastered a subject when they are fluent, even creative, in using their knowledge, skills and understanding in key performance challenges when measured against valid and high standards. Mastery is tested by administrating authentic tasks and scenarios, not through descriptive prompts. The teacher's instruction must be designed backwards from this thought. The end should be in mind when designing the curriculum and lessons (Wiggins, 2014).

State Testing

Standardized testing, often referred to as high stakes testing, illustrates the problem of balancing cost, time, and measurement of "mastery." Standardized testing became a larger topic in recent history. The idea is focused upon the development of identities and agency specific to practices and activities situated in historically contingent, socially enacted, culturally constructed worlds (McNutt, 2014). While standardized testing pre-dates studies into identity and has been a part of life in the United State since the 1920s. In the 1970s only a minority of states used them (McNutt, 2014). The situation rapidly changed in the years following the passage of No Child Left Behind (McNutt, 2014). This act forced all states to use a standardized testing form of accountability that created high stakes environments with funding tied to them. Since then standardized state testing has grown more controversial (Meador, 2019).

Standardized testing can be a controversial topic for many involved with education (Meador, 2019). There are a lot of supports for both sides of the argument. One side to the argument is that education needs a form of accountability. Many people believe in standardized testing. There are pros in support of that argument as well. For example, standardized testing provides a form of accountability for educators and schools. Standardized testing is a tool that many look on as an indicator to whether schools are doing their job in the state's view (Meador, 2019). Many also view the process as an objective way to grade and evaluate teachers, students, and schools.

Those opposed to high-stakes testing find testing to be inflexible, a waste of time, and too stressful (Meador, 2019). Teachers express concern that measuring a student by a test does not provide an accurate scope of what they have accomplished or are capable of accomplishing (Meador, 2019). Ironically, teachers are well noted for teaching to the test (Wiggins, 2014). This approach could improve test scores but not improve student knowledge around the standards. This process adds a lot of stress to both the school systems and students. A large concern that teachers cite is the "politics" of testing. With public and charter schools competing for similar funding, politicians and educators have come to rely more on testing scores to determine where those funds are allocated (Meador, 2019). Some opponents of testing argue that low-performing schools are unfairly targeted by elected officials who use academic performances to further political gains (Meador, 2019).

TVAAS, CASE, and TN Ready

Tennessee Department of Education uses the Tennessee Value-Added Assessment System (TVAAS) to measure student achievement and the impact teachers have on students' academic growth. TVAAS was created on the foundational belief that "society has a right to expect that schools will provide students with the opportunity for academic gain regardless of the level at which the students enter the educational venue (Taking Note, 2014, p1). To summarize, teachers and schools described as most effective by a TVAAS measure should be those who provide strong quality opportunities for all students regardless of their educational foundation. These TVAAS data are how the State of Tennessee monitors its teachers to be able to identify which teacher is developing student growth on state assessments.

Collaborate Assessment Solutions for Educators (CASE) assessments are a purchased assessment that school systems can use to have data on their students. This data is used to progress monitor student’s advancement throughout the course to track their performance levels. CASE assessments attempt to mimic the TN Ready state test to give teachers direction for their instruction in the classroom. The CASE assessment is a powerful tool for teachers to forecast how their students will perform on the end of the year standardized testing.

The Department of Education in Tennessee uses a testing platform called TN Ready to monitor student growth and achievement. TN Ready testing is the basis for the TVAAS data. These TN Ready tests are administered once per school year usually around April of the spring semester. All students take the TN Ready tests via different formats. The state is currently making the transition into computer-based tests from paper and pencil format. These results are reported through the TVAAS platform to the teachers in the Fall semester following that school year.

The objective for schools is to give students the best opportunity possible to master all standards. Part of that learning process is devoted to identifying and outlining how students learn and work towards that mastery. Understanding how students learn math, including their need to construct their own meaning and schemas and their need to master previous standards before presenting subsequent standards, is important. This research study looks at how important that foundation is in math standards for success in sequential learning.

CHAPTER THREE: METHODS

Introduction

This research study examined the possibility that scaffolding mathematical standards influences students' understanding of sequential standards based on statewide achievement testing using CASE assessments. The information gathered during this research was based on a supplemental assessment purchased by the school system used in this study called the CASE Benchmark Assessment. This assessment tool is used by schools to improve teaching accuracy by giving teachers insight regarding how their students should perform on their respective state's administered tests. The CASE Benchmark Assessment is a tool organized by TE 21, or Training and Education in the 21st Century. The CASE assessment provides detailed feedback to the schools about the individual performances by each student, each grade level, and each school (if applicable).

Research Questions and Hypothesis

How significant to student achievement is it that a standard with sequential or scaffolding standards is mastered prior to progressing to a new standard? Should the design of classrooms' pacing guides be altered to improve student achievement by targeting specific standards? The current research analyzes CASE assessments that provide a simulation of the TN Ready state assessment that these students will take. The results should determine the relationship between scaffolded standard mastery.

It was hypothesized that student success on certain prerequisite math standards would be associated with success on more advance standards. It is well known that students must have prerequisite knowledge prior to moving forward, but this study was designed to better identify just how much a student needs to understand prior to progressing further.

Participants

Archival data from 481 students from three middle schools in Northwest Tennessee were included in this study. Specifically, all 6th, 7th, and 8th graders who had complete data regarding standards performance taught in the fall vs standards performance that were taught in the spring were included in this study. Absolutely no identifying information was collected; although demographic data were collected, these were not matched to the standards data obtained. Regarding ethnicity for the 6th grade participants, there were 87% Caucasians and 13% minority students. Male and female participants were equal, at 50% each. Ninety-one percent of the 7th graders were Caucasian and 9% were minority. Fifty percent of the 7th grade student participants were male and 50% female. Lastly, for the 8th grade participants, 91% were Caucasian and 9% were minority. There were 53% males and 48% females. Only the students that were present and enrolled and took both CASE assessments were included in this study. There were 160 sixth graders, 187 seventh graders, and 147 eighth graders. All students were taught with the same curriculum and equivalent pacing guides for the respective grade levels. Lastly, the school district whose data were obtained for this study is largely rural, with a population of 32,263 people and a median income of $40,415 (Data USA, 2017). All the students were enrolled in the same school system for the 2019-2020 school year.

Procedures

Data were collected over the course of the school year shortly after each CASE assessment was administered. The company that provides the CASE assessment provides detailed feedback for each student in the data report. When the data were reported to the schools, the principals then dispersed the information to their teachers. Then, the school system's middle school curriculum coordinator anonymized all data for protection of student information. Thus, the data used for this study were anonymous. Murray State University IRB approved the study protocol.

The data collection sequence was 1) CASE Assessment One or Pretest on September 15 2) CASE Assessment Two or Posttest on November 12. The initial tests CASE results are presented in simple percentages to measure student achievement for each standard. Those data were then used to track the progression of that same standard moving into subsequent parts of that standard. To clarify, the achievement level of that standard was compared to the retesting of that standard in a later CASE assessment. Data were compared to sequential standards that follow either as sequential standards or closely related to the previous. Multiple standards were targeted and singled out in each grade.

Table 1 displays the standards that were targeted in this research. These standards were chosen because they made the most logical sense to compare. The analysis was split into different categories. Depth of knowledge or DOK is a rating developed by the CASE authors to rate the level of difficulty a question is presented. The scale ranges from one to three. A rank of One refers to a surface level understanding that asks only foundation focused questions whereas a rank of Three represents a difficult problem with deeper understanding of the standard required.

Math instruction in the sixth grade was focused on scaffolding on depth of knowledge. Several standards were assessed on test one (pre-test) with a depth of knowledge of one or two. Since sixth grade testing has a procedural approach on the standards that were covered by these components, this creates an ideal situation for these standards to be compared by examining depth of knowledge. Those same standards were assessed on test two (post-test) with a depth of knowledge of a two or three. The sixth-grade data were observed from a perspective of improving achievement on the same standards while increasing the rigor of questions and depth of knowledge. Pre-test/post-test comparisons were designed to determine how students performed on a test with a lower depth of knowledge question versus the advancement of the standard in test two with a higher depth of knowledge question. Put another way, test one in all three standards tested the students at a lower depth of knowledge rating than test two for the same standard listed.

The seventh and eighth grade standards were analyzed by comparing standards that are closely related. The standards were cross examined to ensure that the ideas tested at pre- and post-test were conceptually related. The math material in seventh and eighth grade starts to gradually move away from procedural mathematics into more theoretical applications.

Analyses

CASE pass/fail data from the 481 students were deidentified and entered into Excel. The data were then uploaded to SPSS for analysis. Pre/post-test comparisons were made by examining percentages of pass rates for each of the standards. In order to determine the proportional relationship among the variables, a series of chi square tests were computed. The chi square is used to determine when differences in proportions are statistically significant. For all comparisons, a p value of .05 or lower was employed as an indication of statistical significance.

CHAPTER FOUR: RESULTS AND DISCUSSION

Results

Data from 481 students who were enrolled in the same school system and were either in sixth, seventh, or eighth grade were included in this study. The focus of the comparisons was to discover the importance of mastering standards before sequential standards were taught. This could be critical to student success throughout the grade level.

Table 1 displays the specific standards that were tested and the depth of knowledge of the questions (DoK). The depth of knowledge rating was evaluated by the CASE assessment creators. Tables 2-4 displays those results for comparison. The sixth-grade standards tested were very similar on both CASE assessments. Therefore, the method was to compare the depth of knowledge questions that were asked and find any links between the two tests. The types of questions presented in this exam are described by the standards in Table 1. The questions are computation heavy, like the following example: What is the quotient of 35,612 divided by 78? The depth of knowledge increases the rigor of this question by expanding to larger numbers with less familiar territory to test to see if the student understands their work or if they are reproducing a strict procedure that may have been memorized. Those data were recorded by observing student success on those standards across multiple questions in the CASE assessment. The percentage of mastery is displayed on the Test 1 column of Table 1. The Test 2 column indicates those same standards with a more rigorous set of problems in test 2.

The seventh-grade tests had very little direct standard overlap between the two. Therefore, the data were analyzed by cross referencing the larger two standards that were assessed on each test. There was some direct overlap in progressing standards from test 1 to test 2 like that indicates in the sixth-grade tests. The standards observed on the seventh-grade portion of the CASE assessments are described in Table 1 and the data from the student tests is displayed in Tables 3 and 6.

The 7th grade observed how students performed in standards that were very similar to the previous standards but increased in rigor. Standards in test 1 are different but relatable to standards in test 2. The key components are similar, but the context of the problem set is different. The higher DoK problems are application based. Standard RP.A.3 had a sample question based on reading problems with proportions such as using a recipe to make cookies. The lower DoK is foundational. Standard 7.RP.A.3 is cross referenced with 7.NS.A.2.d, which includes additional detail and interpretation of fractions as decimals. A potential gap that could exist is a discomfort with partial numbers. Both standards are heavily embodied in dealing with partial numbers that could provide difficulties for students who are not proficient when working with decimals and fractions.

The second pair of standards observed with the seventh-grade materials required setting up equations. The emphasis of the second pair of standards is on setting up equations for a given situation. While both standards are tested with a depth of knowledge level of two, there is a significant level of difficulty added to the test two standard. Test one is building comprehension of setting up equations given situations with a variable that is a representation of time. Test two is building comprehension of vocabulary words that can hinder students from working the problem if they are unable to work through the vocabulary. This added difficulty of the vocabulary can cause students to struggle without increasing the depth of knowledge on the problem. These problem sets incorporate more components into the assessed standards.

Eighth graders were tested in a similar method to both the sixth and seventh graders. The test had direct overlap in increasing rigor of a standard assessed on both tests. The CASE assessment also had different focus material on test one and test two. Test one had a strong geometry component while Test two focused on expressions and equations completely. Table 4 presents the findings of the tested eighth graders.

The results displayed in tables 4 and 7 revealed that students struggled with these standards across the pre-test and the post-test. There was no standard that indicated high percentages of mastery. The depth of knowledge presented to the eighth graders maintained one- and two-level problems. There were no high level three DoK problems. Standard 8.EE.A.4 was the only standard to be represented on both tests. This standard requires using scientific notation. Students appeared to have a similar outcome whether they were tested on a DoK 1 or DoK 2 problem. This could implicate the understanding of rules. The geometry concepts presented on test one was heavily linked to the use of Pythagorean Theorem. The ability to solve right triangles and understand the logic of how to apply the theorem was the emphasis of test one's geometry unit. Test two had geometry-based context but required the students to use pre-algebraic concepts. Therefore, the students needed to possess a geometry foundation to understand the context of the sequential problems.

Three pairs of standards for the 8^{th} graders were analyzed using chi square. Chi square test is a statistical method used in this research to test how likely it is that the data set collected is due to chance. This chi square test is providing statistical representation of the relationship between the pre and post-test for the data collected to provide information regarding the standards tested. Data from 147 eighth grade students were included in this study. First, starting with standard 8.EE.A.4 as the pre-test and using standard 8.EE.A.4(b) as the post test, results of the chi square revealed no significant differences in proportions (χ^2= 1.15, 1, p = .294). This means that the proportion of students who earned a score of 1 on the pretest remained statistically the same for the post-test. This same pattern was repeated for standard 8.G.B.5 as the pre-test and 8.EE.C.7b as the post-test (χ^2= .376, 1, *p* = .540), and for standard 8.G.B.6 as the pre-test and standard 8.EE.B.6 as the posttest (χ^2 = 3.38, 1, *p* = .066) although this second comparison neared significance. A summary of the cross tabs for these three comparisons is provided in Table 7.

Two pairs of standards for the seventh graders were compared. Data from 187 seventh grade students were included in the study. Regarding standard 7.RP.A.3 as the pre-test and standard and 7.NS.A.2d as the post-test, the proportions of novice and mastery were statistically different from expectations (χ^2= 5.19, 1, *p* = .023). This means that significantly fewer students who passed the pre-test passed the post-test and that this proportion was statistically lower than expected. Specifically, 35.3% of students who passed the pre-test passed the post-test standard. For the second comparison, the pre-test standard was 7.EE.B.4a while the post-test standard was 7.G.B.4 Here, the proportions were non-significant (χ^2= 1.67, 1, *p* = .197). These results are provided in Table 6.

Lastly, three pairs of sixth grade standards were analyzed. Here, data from 147 students were included in this group. First, the pre-test standard was 6.NS.B.2 and the post-test standard was 6.NS.B.2. These results were non-significant (χ^2= 1.15, 1, *p* = .284). For the second comparison, the pre-test standard was while the post-test standard was 6.NS.B.3. This comparison was non-significant as well (χ^2= 3.38, 1, *p* = .066), although this comparison neared significance. For the last comparison, the pre-test standard was 6.RP.A.3.b and the post-test standard was 6.RP.A.3.b. This comparison too was non-significant (χ^2= .376, 1, *p* = .540). These results are provided in Table 5.

Discussion

The data analyzed for this study revealed that students' achievement scores remained rather static across the mastery levels. The sixth-grade students displayed gains in only one of the three focus standards of both test one and two. Specifically, about standards NS.B.2 and NS.B.3, these two standards directly scaffold. Standard NS.B.2 is a foundation to NS.B.3 and NS.B.3 is an extension of NS.B.2. It is fair to assume that students would need to demonstrate mastery level work before proceeding on. The ideal situation does present itself here—NS.B.3 is dealing with all basic operations of multi-digit decimals using a standard algorithm for each. The preceding standard, NS.B.2, is requires division. Therefore, if a student is at mastery level for B.2, then that student should be primed for success for B.3. The statistics support this thought. Students displayed 77.5% mastery on test one with a DoK of 1. That figure decreased slightly to 73.1% mastery on test two when the DoK increased to level 2. This added rigor caused minor difficulties for students which resulted in a small decrease in mastery level students. This decrease is expected. When tracking B.3 with all operations, there were better results for content mastery among students. With 83.1% mastery (DoK 2) on the first exam and 75% mastery (DoK 3) on the second exam it could be that students understand some parts of the standard but not others. With the added components between the two standards and the differences in the mastery levels when students were tested over all operations, they performed better than when only division was tested. The recommendation could be made to the instructor that familiarity with division could be the potential hazard for students when working problems from the standard B.3 where all operations are were addressed.

The standard 6.RP.A.3b requires that students understand using unit rate problems in a specific context or real-life situation. Students are asked to find unit rates and proportions without the aid of a calculator. This brings the previous two standards back into play as this standard scaffolds off them. Here, 33.8% (DoK 1) of students achieved mastery on this standard in test one. This percentage increased to 81.3% (DoK 2) on test two. One potential inconsistency here could be how much time was dedicated to this standard before the test was administered. If that were not the case, then the teachers targeted the standard as a weakness after test one and implemented a plan to improve the mastery level substantially. The problem could have been lack of understanding in the vocabulary that would lead to misunderstandings in the problem.

Seventh grade is the time in which mathematics begin to make more transitions into conceptual ideas. Sixth grade is where loose ends with operations of whole and partial numbers are tied up. Most of the foundational skills needed with numbers have been formed by the seventh grade. Seventh grade starts to home in on understanding proportions and ratios in many fashions. Therefore, the material is spread out quite a few concepts. Test one examines students' knowledge of standards 7.RP.A.3 and EE.B.4.a. RP.A.3 focuses on proportional relationships for example: simple interest, tax, markups and markdowns, etc. Standard EE.B.4.a provides the student with conceptual understanding of key ideas. Solving contextual problems leading to equations is the desired skill that students need to master for this standard. An example of this standard would be: What is the width of a rectangle with a perimeter of 24 and length of 2?

Test two for the 7th grade focused on a different set of standards. Here, standard 7.NS.A.2.d measures students' ability to convert rational numbers into decimals without the aid of technology. Along with that students need to know the terms for repeating and terminating decimals. Standard 7.G.B.4 is a step back into geometry. This standard informs students about how to use special angles such as supplementary, complementary, etc. to write and solve simple equations.

The standards 7.RP.A.3 and 7.EE.B.4.a were covered on test one. Students of the seventh grade in test one performed at 26.9% mastery (DoK 2) and 43.1% (DoK 2). Test two focused on standards 7.NS.A.2.d and G.B.4. Those standards shared results of 37.5% (DoK 1) and 38.1% (DoK 2) respectively. Standard 7.NS.A.2.d tested problems with a level one depth of knowledge. This means that there will often be only one step to solving the problem. Whereas standard 7.RP.A.3 is a contextual problem that possess multiple steps to solving. These problems are often labeled at a depth of knowledge level 2 or higher. The mastery between these two is linked by the use vocabulary and the length of the problems. The lesser DoK problem has just one step of a specific process. The more difficult DoK 2 problems have the students repeat that process multiple times. This higher depth of knowledge is connected to previous foundational skills that are required to have obtained at mastery level in order to be successful in a sequential standard. This is where the students could create errors in their work or incorporate a misconception because of the added rigor. The data concludes that students need to possess the mastery to complete one step problems before attempting to move into multi step problems of this context.

The other comparison to be drawn is based on standards 7.EE.B.4.a and 7.G.B.4. Both standards were tested at a level two depth of knowledge. The primary difference in these two standards is the added difficulty of mathematical vocabulary. Both standards are asking the student to complete relatively similar tasks. However, the geometry standard (7.G.B.4) incorporates geometry vocabulary that will be new to the student. This added rigor is not an increase in depth of knowledge because the standard is based on a different foundation but the two have connections. Both are setting up real world applications. Standard 7.EE.B.4.a is using familiar context with money that students can draw from past experiences to relate with. 7.G.B.4 is using geometry concepts to do a similar task. Geometry context can often be less relatable for students because the context does not appear as often for students at this age. The data shows that achievement levels are very close. The more relatable standard has slightly higher mastery level.

Eighth grade in Tennessee is where students begin to refine and develop pre-algebra and algebra one skills needed for success in high school math. Standard 8.EE.A.4, over scientific notation was assessed on both exams. The results from the data showed the improvement of standard 8.EE.A.4 on test one to test two. Test one displayed student mastery at 19.7% (DoK 1) and improved to 20.4% (DoK 2) on the second test. Students showed a marginal improvement in mastery from test one to test two. This data supports the findings that mastery in a level one depth of knowledge problem is important to student success in level two problems. Nearly the same number of students displayed mastery on these problems sets from test one to test two with 97 compared to 101 students. This data reinforces the practice that students should master lower level depth of knowledge problems before moving to more rigorous challenges. Students will most often not be able to find mastery on more difficult problems if they are unable to successfully work fewer challenging questions.

Eighth grade CASE assessment one had a large geometry component that was not present in assessment two. The next set of standards that were tested and compared where 8.G.B.6 and EE.B.6. 8.G.B.6 measures the ability for students to use the Pythagorean theorem on a coordinate place to find the distance between coordinates. Standard 8.EE.B.6 asks students to use similar triangles to find missing sides. These two standards have links between them using triangles. When finding the distance between two coordinates in a coordinate plane a successful strategy used early on would be to design a right triangle, if applicable. The distance formula will become a go to later for students but, the distance formula is not introduced to students by the eighth grade. 21.7% of students were tested to have mastery in finding the distance between a pair of coordinates using right triangles and the Pythagorean theorem (DoK 1). For standard EE.B.6 (DoK2), 33.3% of students displayed mastery where they were asked to use similar triangles to solve for unknowns. The Pythagorean Theorem is not provided for the students on the tests. Therefore, remembering the theorem would be an obstacle very similar to how the vocabulary is for the similar triangles. It is possible that the low mastery rates for these standards could be a result of remembering key components. The first guidance provided to improve both standards would be to work through memorization components. Standard 8.G.B.5 asks students to use the Pythagorean Theorem strictly with solving triangles. Standard 8.EE.C.7.b is measuring students' ability to solve equations with rational coefficients. Students tested at 31.9% mastery (DoK 2) on standard 8.G.B.5. Students displayed a slightly lower level of mastery at 26.5% (DoK 2) when working through solving equations on standard 8.EE.C.7.b. This comparison showed that students were able to setup a problem when it followed a physical model that was easy to draw, such as a triangle. When students were asked to solve an equation and set it up from just numbers and words without context it proved to be more difficult. Both standards are asking students to setup an equation or problem from a description of words. For example: A right triangle has two sides equal to 8 and 17 units. What is the missing side? Versus If 6 more than a number, n, is 12 less than twice that number, what is the value of the number? The second problem tested in standard 8.EE.C.7.b provides very little connection to life experiences for students to connect to. In the previous example, students could draw a triangle and easily visual what the problem is asking of them. This connection is key to why students were able to perform better when working with problems that have context that is familiar.

Summary

Throughout the data collection and results section, it was apparent that students' mastery levels could sometimes be predicted by their performance on preceding standards. Mastery percentages decreased on students when depth of knowledge was increased. This result of the added rigor could be expected. Students in the sixth grade displayed improvements in the added rigor as the progress of the standard became more difficult. Seventh grade students needed foundational knowledge that required them to attain mastery in order to be successful in the sequential standard. The vocabulary and context were often a hurdle that caused students to have difficulties. Some standards are loaded with necessary previous knowledge to be able to obtain mastery. This prerequisite is the key for students to have long term success. It is a well-known fact that mathematics builds up constantly. The standards this research focuses on display this hurdle firsthand.

Throughout the research of standards and sample problems one discovery became clear. When assessment questions presented context, students were often more successful in completing the problem successfully. Questions without much context that were theoretical displayed low levels of mastery. This discovery is important for teachers to understand that links and context to personal experiences is a key to success for students. This discovery is a key component in support for better teacher practices.

CHAPTER FIVE: CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

Introduction

Educators are always seeking new ways to improve their craft in the classroom. Discoveries and researching new strategies and ideas are what make the best teachers in the classroom. When examining opportunities to improve their craft, some teachers may analyze at the layout of standards and how important mastery is to sequential learning standards.

This study has arrived at the proceeding conclusions. Mastery on standards can in select standards have an impact on sequential standards. Mastery percentages diminished on students when the rigor was increased with more difficult questions and standards. This result of the added depth of knowledge could be anticipated. Student success on standards that are preceding other standards is critical sometimes. The data showed that in specific standards, there was no link. In other standards such as 8.G.B.6, had minor predictability for student success in 8.EE.B.6. After analyzing such standards, it was confirmed that key thoughts existed that students needed in order to be successful. Students displayed increased mastery when standards focused around a true application of an idea or concept. Standards that were pure math without any context were increasingly difficult for students in complete.

The research revealed at an unexpected discovery. Standards where students had strong context to real life connections had higher levels achievement. This was discovered across all the standards that the CASE assessments focused on in all three grade levels. This provides great recommendation for teachers to include large amount of contextual thoughts in their questioning. The ability for students to see the application of a mathematical process provided an increase in mastery on all the standards this research focused on.

This research arrived at the conclusion that mastery is a key component to student success on sequential standards. The data supported the idea, explained in constructionism, that standard mastery was needed. There existed instances such as the seventh grade with 7.RP.A.3 where students displayed higher performances than they did on the sequential standard of 7.NS.A.2.d. The unexpected discovery of the emphasis on contextual concepts is a great discovery that this research did not intend to uncover.

As stated before, mathematics is often perceived of as a procedural work of art (Lakoff & Nunez, 2000). These results from the CASE assessments shows that students of the 6^{th} and 8^{th} grade followed a line of thought that prerequisite standards are monumental to the success in sequential standards. Wiggins discussed the need for students to understand the work of the past (2014). The vision for the future is also important. Ineffective learning will not prepare students to be fluent in the work of the future (Wiggins, 2014).

Limitations

This study examined for information regarding student achievement across standards, the data analyzed for this study were obtained from the previous school year and included students' CASE assessment scores and the two assessment scores following the first assessment scores. The schools in which the data were collected are in Henry County School System which resides in Northwest Tennessee. Within that school system are three different middle schools. Students from these three different schools were administered the CASE assessments at the same time. Students who transferred into the school system did not take the prior exam(s) for comparisons and that is why the number of students taking each exam can vary. This group makes up all of the county middle school students in this school system from grades six through eight.

Kubina & Morrison emphasized the use of fluency and frequency of correct performance as key components to building mastery (2000). A great extension to this study would be to gather more information about the instruction that occurred for the students that the data was collected around. That kind of information would build an extension to the research into another direction that would provide more discoveries and discussion regarding the results in the data. As standardized testing can change teaching goals, those strategies would be beneficial to the researcher to improve understanding in the data (Meador, 2019).

Probably the most limiting aspect of this study is the time restraint. This study occurred over the course of one year and this was the first year the CASE assessment has been administered. Another limitation to the study is a small sample size of students. Next, there was no clear way of matching standards, controlling for teaching methods, or controlling for student motivation or attention.

Recommendations for Future Research

First, would be to involve the teachers of the data into the study. The approach to how students were prepared for the CASE assessments would provide more insight and examination for the data collected. As of this study has little to no information of how the students were prepped exactly beyond basic assumptions. This information would provide more explanation and improve results as to how the successful the learning process is in accordance with the strategies being implemented in the classrooms.

Next, like most research, this study generated more questions that remain that have potential benefits for the education process to be answered. This research focused on several standards from the math middle school grades. It would be beneficial to expand this research further to explore other subjects to find links and to include more standards. There could be success in a math classroom spillover for other subjects that have not been acknowledged for this demographic. The demographic in this research was small and could be expanded by a researcher with access to larger data sets. This topic can be immersive. There is substantial room for a capable researcher with access to data to expand the research in many directions. Those conclusions will lead to better teaching practices and better growth for students.

Table 1:

6th Grade:	(Test 1 & Test 2 standards were scaffolded)
6.NS.B.2	Fluently divide multi-digit numbers using a standard algorithm.
6.NS.B.3	Fluently add, subtract, multiply, and divide multi-digit decimals using a standard algorithm for each operation.
6.RP.A.3.b	Solve unit rate problems including those involving unit pricing and constant speed. For example, if a runner ran 10 miles in 90 minutes, running at that speed, how long will it take him to run 6 miles? How fast is he running in miles per hour?
7th Grade:	(Standards were crossed referenced and scaffolded)
7.RP.A.3 (Test 1)	Use proportional relationships to solve multi-step ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.
7.EE.B.4a (Test 1)	Solve contextual problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?
7.NS.A.2d (Test 2)	Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.
7.G.B.4 (Test 2)	Know and use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.
8th Grade:	(Standards were cross referenced and scaffolded)
8.EE.A.4 (Test 1)	Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.
8.G.B.6 (Test 1)	Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.
8.G.B.5 (Test 1)	Know and apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.
8.EE.A.4 (Test 2)	Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

8.EE.B.6 (Test 2)	Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; know and derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical axis at b.
8.EE.C.7b (Test 2)	Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

All standards were cited from the Tennessee Department of Education.

Discussion

Table 2: 6th Grade		
Test 1 & 2 Standards:	Test 1 (% Mastery)	Test 2 (% Mastery)
6.NS.B.2	77.5% (DoK 1)	73.1% (DoK 2)
6.NS.B.3	83.1% (DoK 2)	75.0% (DoK 3)
RP.A.3.b	33.8% (DoK 1)	81.3% (DoK 2)

Table 3: 7th Grade			
Test 1 Standards:	Test 1 (% Mastery)	Test 2 Standards:	Test 2 (% Mastery)
7.RP.A.3	26.9% (DoK 2)	7.NS.A.2.d	37.5% (DoK 1)
7.EE.B.4.a	43.1% (DoK 2)	7.G.B.4	38.1% (DoK 2)

Table 4: 8th Grade			
Test 1 Standards:	Test 1 (% Mastery)	Test 2 Standards:	Test 2 (% Mastery)
8.EE.A.4	19.7% (DoK 1)	8.EE.A.4	20.4% (DoK 2)
8.G.B.6	21.7% (DoK 1)	8.EE.B.6	33.3% (DoK 2)
8.G.B.5	31.9% (DoK 2)	8.EE.C.7b	26.5% (DoK 2)

Table 5

Summary of Cross-Tabs for Sixth Graders

		Standard 1 Post			Standard 2 Post			Standard 3 Post		
		1	2		1	2		1	2	
Pre	1	96	22	118	75	25	100	81	34	115
	2	21	8	29	33	14	47	17	15	32
		107	30		108	39		98	49	

Note: N = 147
Standard 1 Pre-test = EE.A.4; Post-Test = EE.A.4
Standard 2 Pre-test = G.B.5; Post-test = EE.C.7b
Standard 3 Pre-test = G.B.6; Post-test = EE.B.6

Table 6

Summary of Cross-Tabs for Seventh Graders

		Standard 1* Post 1				Standard 2 Post 1	2	
Pre	1	95	44	139	1	70	36	106
	2	24	24	48	2	46	35	91
		119	68			116	71	

Note: N = 187
*p = .023
Standard 1 Pre-test = RP.A.3; Post-Test = NS.A.2d
Standard 2 Pre-test = EE.B.4a; Post-test = G.B.4

Table 7

Summary of Cross-Tabs for Eighth Graders

		Standard 1 Post 1	2			Standard 2 Post 1	2			Standard 3 Post 1	2	
Pre	1	96	22	118	1	81	34	115	1	75	25	100
	2	21	8	29	2	17	15	32	2	33	14	47
		107	30			108	39			108	39	

Note: N = 147
Standard 1 Pre-test = EE.A.4; Post-Test = EE.A.4
Standard 2 Pre-test = G.B.6; Post-test = EE.B.6
Standard 3 Pre-test = G.B.5; Post-test = EE.C.7b

References:

Aud, S., Hussar, W., Planty, M., Snyder, T., Bianco, K., & Fox, M., Drake, L. (2010). *The condition of education 2010* (NCES 2010-028). Washington, DC: National Center for Education Statistics, Institute of Educational Services, U.S. Department of Education. Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid-2010028

Bahr, P. R. (2013). The Aftermath of Remedial Math: Investigating the Low Rate of Certificate Completion among Remedial Math Students. *Research in Higher Education*, *54*(2), 171–200. Retrieved from JSTOR.

Bell, F. (1978). *Teaching and Learning Mathematics (in secondary schools)*. Dubuque, IA: Wm. C. Brown.

Bloom, B. (1968). Learning for mastery. *Evaluation Comment*, 1(2). Published by the UCLA Center for the Study of Evaluation and Instructional Programs.

Bruner, Jerome. (1986). *Actual Minds, Possible Worlds*. Cambridge, Mass.: Harvard University Press, 1986.

Cleary, T. J., & Chen, P. P. (2009). Self-regulation, motivation, and math achievement in middle school: Variations across grade level and math context. *Journal of School Psychology*, *47*(5), 291–314. https://doi.org/10.1016/j.jsp.2009.04.002

Clements, D. H., & Battista, M. T. (2009). Constructivist Learning and Teaching. *Putting Research into Practice in the Elementary Grades*, 58, 6 – 8.

Cobb, Paul. (1988). “The Tension between Theories of Learning and Instruction in Mathematics Education.” *Educational Psychologist* 23 (1988): 87-103.

Cottrill, J. (2003). An Overview of Theories of Learning in Mathematics Education Research. *Periodical Title*, Volume(Issue), pp-pp.

Data USA. (2017). Retrieved September 2, 2019, from https://datausa.io/profile/geo/henry-county-tn/

Definition of CONSUMMATE. (n.d.). Retrieved August 26, 2019, from https://www.merriam-webster.com/dictionary/consummate

Dubinsky, E. (1991). Reflective abstraction in advanced mathematical thinking. In D. Tall (Ed.), *Advanced Mathematical Thinking* (pp. 231 – 250). Dordrecht, The Netherlands: Kluwer.

Eggen, P. D., & Kauchak, D. P. (2000). *Educational Psychology: Windows on Classrooms* (5th ed.). Upper Saddle River, NJ: Prentice Hall.

Gagne, R. M., (1968). Contributions of learning to human development. *Psychological Review*, 1968, 75, 177-191.

Guskey T, (2005, April). *Formative classroom assessment and Benjamin S. Bloom: Theory, research, and implications.*

Kamii, C., & Lewis, B. A. (1990). Constructivism and First-Grade Arithmetic. *Putting Research into Practice in the Elementary Grades*, 9 – 11.

Kubina, R., & Morrison, R. (2000). Fluency in education. *Behavior and Social Issues*, 10, 83 – 99. Retrieved from www.fluency.org/kubina_fluency_ed.pdf

Lakoff, G., & Nunez, R. E. (2000). *Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being.* New York: Basic Books.

McNutt, S. B. (2014). *"If I'm so smart...": Memories of assessment and the role of standardized testing in forming an intellectual identity* (PhD, University of Iowa). https://doi.org/10.17077/etd.33g31tzu

Meador, D. (2019, June 21). What You Need to Know About Standardized Testing. Retrieved August 26, 2019, from ThoughtCo website: https://www.thoughtco.com/examining-the-pros-and-cons-of-standardized-testing-3194596

Mathematical Sciences Education Board (MSEB) and National Research Council. (1989). *Everybody Counts: A Report to the Nation on the Future of Mathematics Education.* Washington, D.C.: National Academy Press, 1989.

Moshman, D. (1982). *Three Types of Constructivism and Knowledge*. Retrieved from https://www.academia.edu/8314971/Davide_Moshman_Three_Types_of_Constructivism_and_Knowledge

National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA.: NCTM, 1989.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *College of career readiness anchor standards for writing.* Washington, DC: Authors. Retrieved from www.corestandards.org/ELA-Literacy/CCRA/W

Ojose, B. (2008). Applying Piaget's Theory of Cognitive Development to Mathematics Instruction. *The Mathematics Educator*, 18(1), 26 – 30.

Piaget, J. (1977). *Epistemology and Psychology of Functions.* Dordrecht, Netherlands: D. Reidel Publishing Company.

Steffe, L., & Cobb, P. (1988) *Construction of Arithmetical Meaning and Strategies.* New York: Springer – Verlag, 1988.

Swanson, J., Valiente, C., Lemery, K., Bradley, R., & Eggum-Wilkens, N. D. (2014). Longitudinal relations among parents' reactions to children's negative emotions, effortful control, and math achievement in early elementary school. *Child Development*, *85*(5), 1932-1947.

Tate, Marcia L. (2009). *Mathematics worksheets don't grow dendrites : 20 instructional strategies that engage the brain.* Thousand Oaks, Calif. :Corwin, *Taking Note*. (2014, October). Measuring Student Growth in Tennessee. *Score*. Retrieved http://www.tnscore.org

Weinert, F. E., & Helmke, A. (1998). The neglected role of individual differences in theoretical models of cognitive development. *Learning and Instruction*, 8, 309 – 324.

Wiggins, G. & McTighe, J. (2005) *Understanding by design: Expanded edition.* Alexandria, VA: ASCD.

Wiggins, G. (2014). How Good IS Good Enough?. *Educational Leadership*, 71(4), 10 – 16.