COGNITIVE DEMAND AND THE LEVEL OF ALIGNMENT IN THE MATHEMATICS ITEMS OF THE STAAR TEST AND THE TEXTBOOK TASKS IN THE INTENDED CURRICULUM FOR 7^{TH}, 8^{TH}, AND ALGEBRA 1 STUDENTS IN SOUTH TEXAS

A Thesis

by

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This thesis meets the standards for scope and quality of
Texas A&M University-Corpus Christi and is hereby approved.

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ABSTRACT

This study examined the cognitive demand and the level of alignment between the mathematics items on the STAAR Test and the corresponding textbook tasks in the intended curricular for students in grades 7, 8, and Algebra 1 in South Texas. One of the primary drives for the present study was based on the notion that when there is a strong alignment between students assessment and the intended mathematics curriculum, educators and policymakers are better placed to evaluate students' performance in relation to the expected students learning at the respective grade levels, and thus, able to make appropriate policy decisions regarding students learning. The study, therefore, employed the *Mathematical Task Framework* developed by Stein and Smith (1998) with its four levels - memorization, procedures without connections, procedures with connections, and doing mathematics (in order from the lowest level to the highest) to examine the the cognitive demand between the curricular tasks and the assessment items on linear equations, inequalities, and functions on the STAAR Test and selected mathematics textbooks specifically developed for students in grades 7, 8, and Algebra 1 in South Texas. The results of the cognitive demand analysis conducted showed that each grade level textbook contained tasks at the four levels of cognitive demand. Each textbook contained the majority of its tasks at the *memorization, procedures without connections,* and *procedures with connections* levels of cognitive demand. There were few tasks at the *doing mathematics* level of cognitive demand. The STAAR Assessments contained items only at the *procedures without connections* and *procedures with connections* levels of cognitive demand. Because the STAAR Assessment is a timed standardized test, none of the assessments contained items at the *doing mathematics* level of cognitive demand; items at this level require larger amounts of time than the assessment could permit.

The results indicated a weak alignment with the linear equations STAAR Assessment items and the McGraw-Hill textbook tasks (curriculum) for 7th grade. Linear equations assessment items were properly aligned with the McGraw-Hill textbook tasks for 8th grade and Algebra 1. Linear functions were properly aligned for all three grade levels. Linear inequalities were poorly aligned for 7th and 8th grade because the 7th grade STAAR Assessments did not contain any linear inequatity items nor the textbook. And the 8th grade STAAR Assessment contained 2 linear inequality items but the textbook did not contain tasks. For Algebra 1, the linear inequality STAAR Assessment items were properly aligned with McGraw-Hill textbook tasks. Overall, the McGraw-Hill TEKS textbook series did a good job preparing students for the corresponding STAAR Assessments. It is the hope of the researcher that the results from this study will inform assessment practices, textbook development, classroom practices, as well as other educational policies at the local and state levels.

DEDICATION

This thesis and Master of Science Degree is dedicated to my husband and daughter. He encouraged me to earn a graduate degree and never once stopped telling me how proud he was of me. I could not have done any of this without his support.

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Finally, I must thank my husband, Drew. His love, support, and understanding throughout the entire graduate school and thesis writing process, helped me stay focused and motivated.

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CHAPTER 1:

Background of the Study

History of Education in Texas

In 1854, the Common School Law signed by Governor Elisha Pease officially launched the Texas Public School System. But in 1861, the funds set aside for education had to be used for the Civil War and as a result, public and private schools were shut down. In 1866 the Constitution required public school teachers to obtain certificates in order to teach. Per the reconstruction Constitution, local taxes were required to maintain school, student attendance was compulsory, and a state superintendent position was established as well as a State Board of Education in 1869. The Texas State Legislature gave any incorporated city the authorization to provide education for its school age children, thus creating the independent school district. In 1876 the Reconstruction Constitution was replaced by a new state Constitution and it abolished the compulsory school attendance laws and the office of State Superintendent. The office of the state superintendent was reinstated in 1884. In 1903, the Texas State Legislature created a textbook selection board to try and increase uniformity across the many independent school districts across the state. Schools began to provide students with textbooks in 1918. In 1928, the State Board of education was tasked to execute textbook contracts, among other things.

History of Standardized Testing in Texas

In 1949 the State Board of Education was replaced by the Texas Education Agency as the new statewide supervising agency for public schools. In 1979, the Texas Legislature implemented standardized tests to ensure that students would learn the curriculum and would be able to graduate high school ready for the workplace. The Texas Assessment of Basic Skills (TABS) was the first statewide test administered to students in grades 3, 5, and 9. The TABS test assessed students in three areas: reading, writing, and mathematics. In 1984 the Texas State Legislature required that students pass an exam in order to graduate high school. As a result, the Texas Educational Assessment of Minimum Skills (TEAMS) was created. It was a standardized test administered to students in grades 1, 3, 5, 7, 9, and 11. Passing this exam was required for high school graduation. In 1990, the third statewide standardized test, the Texas Assessment of Academic Skills (TAAS) was created and administered to students in grades 3, 5, 7, 9, and 11 in the subjects of reading, writing, and mathematics. And once again, passing the eleventh-grade test was required for high school graduation. In 1997, the Texas Essential Knowledge and Skills (TEKS) became the new Texas curriculum standards. These are the standards used today, with minor modifications made to the previous one. The Texas Assessment of Knowledge and Skills (TAKS) replaced the TAAS. The TAKS assessed student's skills from grades 3-11 in the areas of reading, math, writing, science, and social studies. Because the TAKS test assessed students in more subjects than previous state standardized tests, it became a concern that teachers were starting to teach the test. In 2011, the most recent state mandated standardized test, the State of Texas Assessment of Academic Readiness (STAAR) replaced the TAKS test. The STAAR assessed the same subjects as the TAKS but was more rigorous and required a twelve-course exit assessment. In 2013, the State Legislature eliminated the STAAR tests in Chemistry, Physics, Geometry, World History, Algebra 2, English 3, and World Geography. The only tests that remain are the English 1, English 2, Algebra 1, U.S. History, and Biology and they are referred to as End-of-Course (EOC) assessments at the high school level.

Need for Alignment

Ever since the first state mandated standardized test was implemented in 1979, there has been a need for alignment between the state curriculum and the state standardized test. Both curriculum and assessment are major parts of education. The curriculum determines what is going to be taught and assessment holds both students and educators' accountable for the recommended/intended curriculum. With the increased pressure and accountability from the state level for schools to perform well on the standardized test, there is an even larger need for the state curriculum and assessment to align for student learning to be meaningfully supported. This requires a closer look at the textbooks used in the classroom.

Some researchers have inferred that the content presented in textbooks and how educators use textbooks in their classrooms has a direct impact on what and how students learn mathematics (O'Keefe & O'Donoghue, 2015). The mathematics textbook is central to the implementation of the mathematics curriculum. Because of this, the National Commission for Certifying Agencies recommended in 2006 that one way to improve student learning and increase mathematical proficiency was to enhance the mathematics textbook (O'Keefe & O'Donoghue, 2015).

Quality mathematics assessments must focus on the interaction of assessment with teaching, learning, and curriculum. The National Research Council (NRC) (1993) states that, "assessment should enhance mathematics learning and support good instructional practice." Assessment is meant to give teachers and students an opportunity to identify areas of mastery and misconception. Instruction and assessment must be combined in a way that they support each other. When aligned, assessment and curriculum should communicate a full representation of students' proficiency in mathematics. Both should examine how well students can perform automated skills, whether they have managed to connect learned concepts, how well they can identify elemental principles and patterns, their sense of when to use learned processes and strategies, and if they can tie all these mathematical skills competencies together when needed (National Research Council, 1993).

These curriculum materials (which are defined largely by the Textbooks students use) have been found to be the major determinant of what is taught and learned in most classrooms in the United States, and in classrooms around the world (Grouws & Smith, 2000; Jones & Tarr, 2007). Robitaille and Travers (1992) noted that textbooks are present not only in classrooms but are also frequently used by teachers and students and influence the instructional decisions that teachers make daily. Thus, because textbooks as major curriculum material, have a marked influence on the teaching and learning of mathematics, it might be a worthwhile endeavor to investigate these materials that many students and teachers use, and their prospects in impacting students' opportunities to learn and acquire facility with the use of vital concepts such as variables in school mathematics. Results from such studies could provide pointers to possible links between some well-documented difficulties that students have with linear functions, equations, and inequalities and their treatment in the curriculum.

Statement of the Problem

As a public-school mathematics educator, I have seen the (demand) level of importance placed upon students, teachers, and school districts to have students perform well on the STAAR exam. I have also witnessed instances where students have performed well in the classroom but were unable to earn a passing score on the standardized test, and vice versa. This situation has always made me wonder about the disconnect students must be experiencing while learning, why this happens, and about the difference between the classroom mathematical tasks and the items on the STAAR exam. This apparent disconnect and the possible difference between the textbook and STAAR assessment tasks were the driving force behind my research. I wanted to examine the type of tasks presented to students in the classroom versus the type of tasks they complete on the STAAR exam; specifically, the mathematics assessment for seventh grade, eighth grade, and ninth grade - which is the Algebra 1 End of Course (EOC) exam. Within the textbooks and STAAR assessments, I chose to examine the tasks that focus on linear equations, inequalities, and functions. The reason I chose to focus my research on linear equations, inequalities, and functions is because these linear topics for each 7^{th}, 8^{th}, and Algebra 1 mathematics STAAR assessments comprise 37.5%, 38%, and 48% of the assessment tasks respectively. While it would be ideal to examine all the content areas in the selected textbooks and assessment, that would require an enormous amount of time that is beyond the timeline for this study.

Additionally, each minimum passing score is just above, near, or just below the percentage of the test that is comprised of linear equations, inequalities, and functions. Therefore, in theory, if a student were to answer every single assessment task on linear equations, inequalities, and functions, the student could receive a passing score on the STAAR assessment In Algebra 1, be close to a passing score in 7^{th} grade, and most recently, receive a passing score in 8^{th} grade (the raw passing scores for 7^{th} and 8^{th} grade have changed by more than two percentage points over the last few years).

Purpose of the Study

The purpose of this study, therefore, is to examine the *cognitive demand* of the mathematical tasks/items on linear equations, inequalities, and functions in the mathematics textbooks and the STAAR assessment for the selected grade levels, and to determine the level of alignment between the mathematics curricular tasks and the related items on the STAAR Test for grade 7, 8, and Algebra 1 students in the chosen topics. I will achieve these objectives by examining three mathematics textbooks published by a major textbook company specifically for the state of Texas for the above-mentioned grade levels and the corresponding STAAR Tests.

Research Questions

The following research question(s) guide(s) the study:

1. What is the nature of the Cognitive Demand[1] of the items pertaining to linear equations, inequalities, and functions on the 7th, 8th, and Algebra 1 STAAR mathematics assessments?

2. What is the nature of the *Cognitive Demand* of the items pertaining to linear equations, inequalities, and functions in the Mathematics textbooks used by 7th, 8th, and Algebra 1 students in South Texas?

3. What is the level of alignment in the *Cognitive Demand* of the items on STAAR Test and the tasks in the intended mathematics curriculum for students in the 7th, 8th, and Algebra I in South Texas pertaining to linear equations, inequalities, and functions?

Significance of the Study

Examining the *cognitive demand* of instructional mathematical tasks and the assessment items on the state standardized test is a very relevant and meaningful endeavor for teachers. By analyzing the *cognitive demand* of the instructional tasks, teachers can reflect on whether they are providing their students with worthwhile tasks that challenge the students and increase their understanding of mathematical ideas, concepts, or skills. Analyzing the *cognitive demand* of the instructional tasks presented to the students on the state standardized test is also important for teachers because of the immense amount of pressure placed on them, on students, and on schools for students to perform well on the state test. Specifically, the school rating considers how well

[1] Refere to page 8 and page 23 of this document for the definition and explanation of *cognitive demand.*

or how poorly students perform on the standardized test. Teachers feel the pressure because teachers who have low passing rates for the standardized test are not always offered a renewal contract for the following school year. Also, in order to graduate high school and receive a diploma in the state of Texas, students must pass all five of the state standardized tests: Algebra 1, Biology, English 1, English 2, and American History.

It is also important for teachers to examine the *cognitive demand* of mathematical tasks because the "highest learning gains on math-performance assessments are related to the extent to which tasks are set up and implemented in ways that engage students in high levels of cognitive thinking and reasoning," (Smith & Stein, 1998, pg 275). Because the nature and *cognitive demand* of the tasks presented to students predetermines what students learn, it is imperative to begin with high-level cognitively complex tasks. This helps to achieve the goal of students "developing the capacity to think, reason, and problem solve" successively and independently in the future (Smith & Stein, 1998). When teachers are selecting mathematical tasks for students to engage with in the classroom, teachers must consider all factors that contribute to the learning environment including the age of the students, their grade level, prior knowledge, and past experiences. Taking these factors into consideration helps to inform the teachers decision about the appropriate level of challenge for students (Smith & Stein, 1998).

Examining the alignment between the *cognitive demand* of the textbook tasks as well as the items on the STAAR assessment also provides valuable information for the textbook publishers and the item developers regarding future revision of these items to support student learning. The respective school districts using the selected curricula and taking the STAAR assessment could also benefit from this information. Information obtained from this study could also help explain (partly) the level of academic achievement of their students.

Limitations of the Study

This study has a few limitations. First, it only examined a few mathematics textbooks for the 7th, 8th, and Algebra 1 students. Second, the study examined only a few topics (i.e., linear equations, inequalities, and functions) in the mathematics textbooks and the STAAR assessment for the 7th, 8th, and Algebra 1 students. This does not provide comprehensive information on the level of engagement of mathematical curriculum. Third, the study did not observe students and teacher's engagement in the implementation of the intended curricular tasks in the classroom. Specifically, it could be possible that the intended curriculum may contain tasks of different cognitive complexities, and in reasonable proportions, but the implemented curriculum focuses predominantly on engagement with only one particular type of task. Also, this study did not interview the publishers of the selected mathematics textbooks nor the STAAR assessment developers about their perspectives on the *cognitive demand* of each task presented to the student or about what guided their inclusion of the specific task in the textbook or the STAAR assessment. This researcher is aware that obtaining such data could add some valuable insight to the results of the study, and hence, considers this as a limitation to the study.

Definition of Terms

For the purpose of this study, the following terms and definitions were used:

Cognitive Demand: Cognitive demand is defined by Stein, Smith, Henningsen, and Silver as "the kind and level of thinking required of students in order to successfully engage with and solve a task," (2000, pg. 11). This framework for analyzing mathematical tasks is the first phase of the Mathematical Task Framework and focuses on tasks before the lesson begins, that is, as the task appears in print or as it created by the teacher.

Content Analysis: Content analysis is a research tool/technique used to determine the presence of certain words or concepts within texts or sets of texts. Researchers quantify and analyze the presence, meanings and relationships of such words and concepts, then make inferences about the messages within the texts, the writer(s), the audience, and even the culture and time of which these are a part. Texts can be defined broadly as books, book chapters, essays, discussions, articles, historical documents, conversations, advertising, informal conversation, or any occurrence of communicative language. To conduct a content analysis on any such text, the text is coded, or broken down, into manageable categories on a variety of levels–word, word sense, phrase, sentence, or theme and then examined using one of content analysis' basic methods: conceptual analysis or relational analysis.

Mathematics Curriculum Materials: The National Research Council (NRC, 2004) defines school mathematics curriculum as "a set of materials for use at each grade level, a set of teacher guides and accompanying classroom assessments, a listing of prescribed or preferred classroom manipulatives or technologies, materials for parents, homework booklets, and so forth" (p. 38). There are three main aspects of the curriculum: the intended curriculum, the implemented curriculum and the achieved curriculum. The intended curriculum refers to the aims and objectives of a given program as specified by the program and the materials to support its introduction and use. The implemented curriculum concerns what happens in practice in the classroom, the teaching approaches, the learning activities and materials teachers draw on using the program. The attained curriculum relates to the outcome of the program: the knowledge, skills, understanding, and the attitude displayed by the students who experienced the program. The intended curriculum is the focus of this study.

Linear Concept: A linear concept is any concept in mathematics that is related to a line. The English word Linear comes from the Latin *līneāris*, which means "belonging to a line. Linear concepts are concepts that involve the single dimension and variable that are in the first degree. Linear concepts are relationships between quantities that are proportional to each other. Linear concepts have one independent quantity and one dependent quantity.

Linear Equation Task: A linear equation task will be defined as any task that requires students to use or create a linear equation.

Linear Inequality Task: A linear inequality task will be defined as any task that requires students to use or create a linear inequality.

Linear Function Task: A linear function task will be defined as any task that requires students to use or create a linear function.

Mathematical Task: A mathematical task is defined as a set of problems or a single complex problem that focuses' student's attention on a particular mathematical idea (Stein, Grover, & Henningsen, 1996). This study will use the term mathematical tasks to refer to the textbook tasks or textbook problems for students to solve.

Assessment Item: An assessment item is a mathematical task that is completed by the student without any interjections from the teacher. The purpose of assessment items is evaluation, formative or summative. This study will use the term assessment items to refer to the mathematical tasks on the STAAR Assessment.

Summary

In this chapter, I provided a background to the study and a brief history on the education and standards testing in Texas. This was followed by the statement of the problem, the purpose of the study, the research questions, the significance of the study, and the limitations of the study.

Chapter 2 presents the literature review on prior studies on mathematical tasks and assessment and the various frameworks used to analyze mathematical tasks and assessment items. Chapter 3 contains the methodology and the design of the study. Chapter 4 presents the results of the study. The summary of the results, discussion of the results, the implications and recommendations for instruction, assessment, curriculum development, and future studies are presented in Chapter 5.

CHAPTER 2:

Literature Review

In this chapter, I present the theoretical framework that constitutes the conceptual basis of my study. I defined mathematical tasks, mathematical assessment, and research on alignment between the intended curriculum and assessment. I also discussed some common taxonomies used to analyze mathematical tasks and assessment items (e.g., Webb's Depth-of-Knowledge, Bloom's Taxonomy, Galbraith and Haines three-tier taxonomy, MATH Taxonomy, and The Mathematical Task Framework). Findings from various studies that examined mathematical tasks and assessment items are also presented.

Mathematical Tasks

Mathematical tasks are defined as 'a set of problems or a single complex problem that focuses students' attention on a particular mathematical idea,' concept, or skill (Boston & Smith, 2009). A single task may contain several related problems or "extended work up to an entire class period or a single complex problem," (Stein & Smith, 1998). "The tasks used in the classroom form the basis for student learning," (Stein & Smith, 1998). The nature of mathematical tasks to which students are exposed determines the material and the extent to which students learn mathematics (Smith & Stein, 1998). Tasks that are truly problematic for students as opposed to a disguised task that merely has students practice a previously learned algorithm, are the meaningful and worthwhile tasks (Stein, Grover, Henningsen, 1996). The best mathematical tasks force students to establish meaning and structure, make judgements about what the goal is and how to accomplish this goal, and interpret the reasonableness of their solutions and procedures (Stein, Grover, Henningsen, 1996). These mathematical tasks can be identified by attributes such as possessing more than one solution method, having multiple representations, and requiring that students are able to convey and defend and rationalize their strategy and understanding in written form, oral form, or both (Stein, Grover, Henningsen, 1996).

Mathematical tasks start out in the curricular or instructional materials (i.e. textbooks). The task is then set up by the teacher during classroom instruction; this is referred to as a learning task and can be used to introduce new concepts and skills, make connections between old and new concepts, or illustrate the application of concepts in problem solving. Some factors that influence how the teacher sets up the mathematical task are the teachers' goals, the teachers subject matter knowledge, and the teacher's knowledge of the students. While the teacher is setting up the mathematical task, the task features and *cognitive demand* are identified. Once the task is set up by the teacher, the mathematical task is implemented by students in the classroom; this is when task features are enacted and cognitive processing by the students begins and students are working on the task.

The classroom norms, task conditions, the teacher's instructional habits and dispositions, as well as the students learning habits and dispositions are all factors that will affect the implementation and understanding of the mathematical task. All this then leads to students learning (Stein, Grover, Henningsen, 1996). The highest mathematical learning gains made by students are related to the degree to which tasks are set up and implemented in ways that engaged students in high levels of cognitive thinking and reasoning (Smith and Stein, 1998). Which is why starting with high level, cognitively complex tasks are extremely important; it helps contribute to the ultimate goal of having students develop the capacity to think, reason, and problem solve on their own (Smith and Stein, 1998). When tasks ask students to perform a procedure from memory with a familiar process, it only leads students to one type of opportunity for student thinking (Stein and Smith, 1998). But, when tasks require students to think conceptually and stimulate students to make connections, this leads to a different and larger set of opportunities for student thinking (Stein and Smith, 1998).

Another type of mathematical task is a review task. These are tasks that are set up by the teacher to review previous knowledge. The third type of tasks is a practice or assessment task. These are completed by the student without any interjections or interventions from the teacher. The purpose of assessment tasks is to evaluate the students' knowledge and understanding.

Mathematical tasks with different cognitive demands are likely to induce different kinds of learning. Higher *cognitive demand* tasks result in higher levels of learning and lower *cognitive demand* tasks result in lower levels of learning.

The *cognitive demand* of a mathematical task depends on the mathematical form of the initial task as well as the manner in which the task is executed in the classroom. Therefore, the *cognitive demand* of a mathematical task can change as tasks are introduced to students by the teachers and as the students interact with the mathematical task during instruction (Stein, Grover, & Henningsen, 1996). There are four phases of the tasks life – tasks as represented in the curricular and instructional materials, tasks as set-up by the teacher in the classroom, tasks as implemented by the teacher and students during instruction, and how the tasks result in student learning (Stein, Grover, & Henningsen, 1996), and the level of *cognitive demand* of a task often changes as it passes through each phase.

Assessment

Mathematical Assessment

Assessment is the means by which educators determine what a student knows and can accomplish and conclude (NRC, 1993). It lets educators, policymakers, students, and parents know what a student has learned. Mathematical assessments evaluate the mathematical terms students recognize and can use, the procedures they can apply to new situations, the kind of mathematical thinking they can do, the concepts they comprehend, the level of critical thinking they possess, and the tasks they can formulate and solve (NRC, 1993). Assessment items can help educators evaluate curriculum as well as survey the level of student understanding. The NRC states that “assessment that is out of synchronization with the curriculum and instruction gives the wrong signals to all those concerned with education,” (1993). There are two types of assessment, internal and external. Internal assessment provides information to teachers about student performance for instructional decisions while external assessment provides information about mathematics programs to state and local agencies, funding bodies, policymakers, and the public (NRC, 1993).

The National Science Foundation developed an assessment framework called the Balanced Assessment Project. The Balanced Assessment Project sought to provide students, teachers, and administrators with a set of assessment packages for various grade levels that outline a fair and deep characterization of student attainment in mathematics (NRC, 1993). The seven main dimensions of the framework are as follows: content, thinking processes, products, mathematical point of view, diversity, circumstances of performance, and pedagogics-aesthetics (NRC, 1993). The first four dimensions pertain to the mathematical ability students are asked to express while the last three dimensions pertain to the attributes of the assessment as well as the conditions in which the assessment is taken (NRC, 1993). The Balanced Assessment Project can be used at the level of the individual task as well as at the level of the assessment as a whole. Test items that assess one isolated portion of students’ mathematical knowledge and that are not set in reasonable context, do not show how a student connects mathematical ideas and they hardly ever permit students to explain or justify their line of thinking (NRC, 1993).

According to the National Academy of Sciences, "the thinking processes students are expected to use are as important as the content of the assessment tasks," (1993). The key issue is whether the assessment tasks require students to use the types of scholarly processes needed to express mathematical reasoning, problem solving, communicating, making connections, etc. This becomes especially important as 'interesting' assessment tasks are developed that may have the façade of mathematics but can be executed without students employing serious mathematical thinking (NRC, 1993).

Alignment

"Alignment is the degree to which expectations and assessments are in agreement and serve in conjunction with one another to guide the system toward students learning what they are expected to know and do" (Webb et al., 1997, p. 4). Bhola, Impara, and Buckendahl (2003) identified four commonly used models for calculating alignment in educational expectations and assessments: *Achieve Methodology*, *Webb Alignment Tool* (WAT), *Surveys of Enacted Curriculum* (SEC), and *Council for Basic Education* (CBE) model.

This study will use the WAT model to determine the alignment between the *cognitive demand* of the curricular tasks and the STAAR Assessment items because the WAT model fits best with the type of data that will be collected in the study. The WAT model is also preferred for this study because of its precise descriptions of the procedures used in calculating alignment measures (Newton & Kasten, 2013). Additionally, the WAT model is recommended by the Council of Chief State School Officers (CCSSO) as the preferred framework for use in the design and implementation of alignment studies (Roach et al., 2008). Webb (2007, 1997) described five criteria for computing alignment between standards/curricular and assessments in his WAT Model: a) *Categorical Concurrence,* b) *Depth-of-Knowledge Consistency*, c) *Range-of-Knowledge Correspondence*, d) *Balance-of-Representation,* and e) *Source of Challenge*.

Categorical Concurrence measures the extent to which the same or consistent categories of content appear in the curriculum (textbooks) and the assessments. The criterion is met for a given standard if there are more than five assessment items targeting that standard/curriculum. *Depth-of-Knowledge Consistency* measures the degree to which the knowledge elicited from students on the assessment is as demanding cognitively within the context area as what students are expected to know and do as stated in the standards. The criterion is met if more than half of targeted objectives are hit by items of the appropriate complexity. *Range-of-Knowledge Correspondence* determines whether the span of knowledge expected of students based on a standard corresponds to the span of knowledge that students need in order to correctly answer the corresponding assessment items/activities. The criterion is met for a given standard if more than half of the objectives that fall under that standard are targeted by assessment items. *Balance of Representation* measures whether objectives that fall under a specific standard are given relatively equal emphasis on the assessment. And, *Source of Challenge* identifies items on which the major *cognitive demand* is inadvertently placed and is other than the targeted skill, concept, or application. This criterion is met if the primary difficulty of the assessment items is significantly related to students' knowledge in the content area as represented in the standards.

Prior Studies on Mathematical Tasks and Assessment Items

Several studies have examined mathematical tasks and assessment items using various frameworks (e.g., Cai, Lo, & Watanabe, 2002; Dogbey & Dogbey, 2016; Jones, 2004; Johnson et al., 2010).

Jones and Tarr (2007) analyzed probability content in selected popular middle-grades mathematics textbooks (6, 7 and 8) from a historical perspective, selecting two series, one popular and the other alternative, from four recent eras of mathematics education in the United States (New Math, Back to Basics, Problem Solving, and the Standards) to determine the extent to which probability content was treated, the types of instructional devices used and the cognitive level of the probability tasks in these textbooks. Jones and Tarr found that Standards era textbook series devoted significantly more attention to probability than other series, with more than half of all tasks analyzed located in Standards era textbooks. In addition, a little over 85% of tasks for six series required low levels of cognitive demand, whereas most tasks in the alternative series from the Standards era required high levels of cognitive demand.

Dogbey and Dogbey (2016) examined the Core Mathematics assessment of the West African Senior School Certificate Examination (WASSCE) in terms of Depth of Knowledge and Context Characteristics of the items over a 20-year period. In all, 1245 assessment items were analyzed. The results indicated that nearly 80% of the items assessed students' ability to either recall basic facts or perform straightforward routine procedures (i.e., low level of cognitive demand). In terms of the context characteristics, the results showed that about 70% of the items was framed within abstract context, with about 15% each framed within semi-reality and real-life reference contexts, respectively.

The American Association for the Advancement of Science (AAAS) conducted a study under Project 2061 (AAAS, 2000). This project developed a methodology and used it to review selected middle-grades mathematics curricula and some high school algebra materials in reference to the Curriculum and Evaluation Standards for School Mathematics from the National Council of Teachers of Mathematics (NCTM, 1989). The team of researchers analyzed the curriculum materials for alignment between instruction and the selected learning goals. This involves, among others, estimating the degree to which the materials (including their accompanying teacher's guides) reflect what is known generally about students' learning and effective teaching, and the degree to which the materials support students' learning of the specific knowledge and skills for which a content match has been found (NRC, 2004).

The report explained that the focus on examining the learning goals was to look for evidence that the materials have a sense of purpose; build on students' ideas about mathematics; engage students in mathematics; develop mathematical ideas; promote students' thinking about mathematics; assess students' progress in mathematics; and enhance the mathematics learning environment. With respect to algebra in the high school mathematics curriculum, the review encompassed ideas from functions, operations, and variables. Similar topics examined in the middle-grades include number concepts, number skills, geometry concepts, geometry skills, algebra graph concepts, and algebra equations. Thirteen contemporary mathematics textbook series written specifically for middle grades students between 1994 and 1999 were evaluated according to a set of benchmarks related to the aforementioned core content that should be present in mathematics instruction. Each textbook series was rated as having most, partial, or minimal content according to each benchmark. The research team found that only four of the textbook series addressed four or more benchmarks in depth, and no series sufficiently addressed all the benchmarks. In terms of quality, none of the popular textbooks were among the best rated.

Thompson, Senk, and Johnson (2012) conducted a study addressing the nature and extent of reasoning in the intended curriculum of 20 contemporary high school mathematics textbooks. They examined both the narrative and exercise sets for all lessons that related to exponents, logarithms, and polynomials. They concluded that "about 50% of the identified properties in the 3 topic areas were justified, with about 30% of the addressed properties justified with a general argument and about 20% justified with an argument about a spedific case," (Thompson, Senk, Johnson, 2012, pg. 253). But, "less than 6% of the exercises in the homework sets involved proof related reasoning, with developing an argument and investigating a conjecture as the most frequently occurring types of proof related reasoning," (Thompson, Senk, Johnson, 2012, pg 253).

Frameworks used to Analyze Mathematical Tasks and Assessment Items

Some common taxonomies used to analyze mathematical tasks and assessment items are: Webb's Depth-of-Knowledge (Webb, 2002), Bloom's Taxonomy (Clark 1999), Galbraith and Haines three-tier taxonomy (Dogbey and Dogbey, 2016), MATH Taxonomy (Dogbey and Dogbey, 2016), KIT (Dogbey and Dogbey, 2016), and The Mathematical Task Framework (Stein and Smith, 1998), which is the framework used to conduct the content analysis of mathematical tasks presented in the mathematics curriculum and on the STAAR assessment.

Webb's (2002) Depth-of-Knowledge

Webb's Depth-of-Knowledge has four levels of cognitive complexity (from lowest to highest); recall, skill/concept, strategic thinking, and extended thinking (Webb, 2002). These four levels determine the *cognitive demand* necessary to answer an assessment item or mathematical task (Dogbey & Dogbey, 2016). Each of the four level describes the kind of thinking involved and the complexity of the task (Dogbey & Dogbey, 2016). The lowest level, *recall*, involves recalling facts, definitions, terms, simple procedures, and performing an uncomplicated algorithm to solve mathematics problem (Webb, 2002). The second level, basic application of a skill or concept, includes some intellectual processing beyond an automatic response (Webb, 2002). Mathematical tasks presented at this level require more than one step and for students to make judgements about how to advance toward the solution to the task.

The third level of Webb's DOK is strategic thinking. Mathematical tasks at the strategic thinking level require reasoning, planning, using evidence, a higher level of thinking, for students to explain their thinking, and for students to make conjectures (Webb, 2002). Tasks that have more than one possible solution and require students to justify a response are at the third DOK level (Webb, 2002). The fourth and highest level of the DOK taxonomy is extended thinking. Tasks at this level require complex reasoning, developing, planning, and thinking over an extended period of time (Webb, 2002). These tasks challenge students to make several different connections, to relate ideas within the mathematical content area to other content areas, and to elect one path among many on how the task or situation should be solved (Webb, 2002).

Bloom's (1956, 1999) Taxonomy

Bloom's Taxonomy is a very common taxonomy used in education and was developed in 1956 by Dr. Benjamin Bloom. He was an educational psychologist and his purpose for developing this taxonomy was to promote higher forms of thinking in education as opposed to memorizing facts (Clark, 1999). He stated that there are three domains of learning or educational activities: the cognitive domain, the affective domain, and the psychomotor domain which are sometimes referred to as the knowledge domain, the attitudes domain, and the skills domain respectively (Clark, 1999). The cognitive taxonomy is broken down into six categories: knowledge, comprehension, application, analysis, synthesis, and evaluation. In the mid-nineties, Lorin Anderson and David Krathwohl revised Bloom's taxonomy. The new categories are remembering, understanding, applying, analyzing, evaluating, and creating, with remembering as the lowest category. Remembering is simply recalling or retrieving information previously learned. Understanding is comprehending the meaning, translation, interpolation, and interpretation of instructions and problems (Clark, 1999).

Applying uses a concept in a new situation or is the unprompted use of abstraction. It is also applying what was learned in the classroom to novel situations in the workplace (Clark, 1999). Analyzing separates material into component parts so that its organizational structure may be understood and distinguishes between facts and inferences (Clark, 1999). Evaluating is making judgements about the value of ideas or materials (Clark, 1999). Creating is building a structure or pattern from diverse elements or putting parts together to form a whole, with emphasis on creating a new meaning or structure (Clark, 1999). Bloom's Taxonomy is more suited for creating learning objectives as opposed to analyzing mathematical tasks.

Galbraith and Haines (1995) Taxonomy

Peter Galbraith and Christopher Haines developed a three-layered taxonomy to classify and analyze mathematical tasks. This taxonomy differentiates among 'three key developmental skills in increasing order of mathematical tasks," mechanical, interpretive, and constructive (Dogbey and Dogbey, 2016). Mechanical tasks in this category require students to execute typical algorithm/procedure that is hinted at in the question (Galbraith and Haines, 2000). Tasks that fall into the interpretive category "require the retrieval of conceptual knowledge and its application" and do not require students to perform previously memorized procedures (Galbraith and Haines, 2000). Construction mathematical tasks incorporate the link between conceptual and procedural knowledge and compel the student to establish and organize their own vital procedures (Galbraith and Haines, 2000). Galbraith and Haines (2000) state that responses to constructive mathematical tasks involve the construction of a solution rather than the selection of an alternative.

Mathematical Assessment Task Hierarchy (1996)

A group of mathematicians and mathematics educators designed a taxonomy to analyze and develop mathematical tasks and ensure that students were being evaluated on a broad spectrum of mathematical knowledge and skills (Dogbey and Dogbey, 2016). This taxonomy was a modification of Bloom's Taxonomy and is referred to as the MATH (Mathematical Assessment Task Hierarchy) taxonomy. MATH separated mathematical tasks into three categories comprising of eight descriptors:

- Group A – factual knowledge, comprehension, and routine use of procedures;
- Group B – information transfer and application in new situations;
- Group C – Justifying and interpreting implications, conjectures, and comparisons and evaluation.

Cox's (2003) KIT Taxonomy

William Cox constructed a practitioner-friendly, simple, three-tier taxonomy for analyzing mathematical tasks which he referred to as KIT (Dogbey and Dogbey, 2016). K stands for knowledge, for example, knowledge of routines, procedures, and techniques; I stands for interpretation, for example, internalization into concepts or the understanding of these concepts; and T stands for transfer, for example, adaptation of knowledge and skills to new contexts and applications (Dogbey and Dogbey, 2016).

Stein and Smith (1998) Mathematical Task Framework (Cognitive Demand)

As part of the QUASAR (Quantitative Understanding: Amplifying Student Achievement and Reasoning) Project, Stein and Smith (1998) formulated *The Mathematical Task Framework* to describe the different levels of *cognitive demand* of mathematical tasks: *memorization, procedures without connections, procedures with connections*, and *doing mathematics*, in order from lowest *cognitive demand* to highest respectively. This is the framework that will be used to analyze the mathematical tasks in the selected curriculum and the mathematical items on the STAAR assessment. This framework is explained in detail in Chapter 3.

Summary

In this chapter, I present the research that constitutes the conceptual basis of my study. I defined mathematical tasks, mathematical assessment, and research on alignment between the intended curriculum and assessment. This was followed by the discussions on some common taxonomies used to analyze mathematical tasks and assessment items (e.g., Webb's Depth-of-Knowledge, Bloom's Taxonomy, Galbraith and Haines three-tier taxonomy, MATH Taxonomy, and The Mathematical Task Framework). Findings from related content analysis in mathematics education, mathematical tasks and assessment items are also presented. Chapter 3 contains the method, the design, and a description of the data analysis techniques. Chapter 4 presents the results of the study. The summary of the results, discussion of the results, the implications and recommendations for instruction, assessment, curriculum development, and future studies are presented in Chapter 5.

CHAPTER 3:

Research Methodology and Research Design

In this chapter, I present the method and the design of the study. My discussion is organized into four sections. First, I identify and explain the three research questions that guided the study. This was followed by the definition of content analysis, and a more detailed explanation on the analytical framework that was used to examine the mathematical tasks and the assessment items *The Mathematical Task Framework* (Stein and Smith, 1998). Next, I describe the sample of mathematics textbooks for the study and provide rationales for selecting each of the mathematics textbooks and assessment that is intended for examination in the study. I ended the chapter with an illustration of the analytical framework with some specific mathematical tasks and assessment items from the materials that were examined in this study.

Research Questions

The purpose of this study is to analyze the level of alignment in the *cognitive demand* of the linear equations, inequalities, and functions items on the STAAR test and the intended mathematics curriculum for 7^{th}, 8^{th}, and Algebra 1 students. This will be achieved by addressing the following research questions:

1. What is the nature of the *Cognitive Demand* of the items pertaining to linear equations, inequalities, and functions on the 7^{th}, 8^{th}, and Algebra 1 STAAR mathematics assessments?
2. What is the nature of the *Cognitive Demand* of the items pertaining to linear equations, inequalities, and functions in the Mathematics textbooks used by 7^{th}, 8^{th}, and Algebra 1 students in South Texas?

3. What is the level of alignment in the *Cognitive Demand* of the items on STAAR Test and the tasks in the intended mathematics curriculum for students in the 7^{th}, 8^{th}, and Algebra I in South Texas pertaining to linear functions, equations, and inequalities?

These questions will be answered by examining the mathematical tasks related to linear equations, inequalities, and functions in the 7^{th}, 8^{th}, and Algebra 1 McGraw-Hill Education mathematics textbooks created for the state of Texas and the corresponding mathematical items on the STAAR assessment using content analysis. For this study, the *Webb's Depth-of-knowledge consistency* will be used to determine the alignment between the *cognitive demand* of the curricular tasks and the STAAR items. The process for conducting the depth-of-knowledge consistency in this study will be done in three stages. In the first stage, the researcher (and the other raters) will code the depth-of-knowledge or cognitive demands of the tasks in the curricular (textbooks). Similarly, in the second stage, the researcher (and the other raters) will code the depth-of-knowledge or cognitive demands of assessment items. Following this, the alignment between the STAAR items and curricular tasks will be calculated as the percentage of items rated greater than or equal to the cognitive demands of the matched curricular. The degree of alignment will be rated "Proper" if the measured alignment is 50% or greater, "Weak" if the measured alignment is at least 40% but less than 50%, and "Poor" otherwise (Webb, 2007).

Content Analysis

There are many definitions of content analysis, but on a basic level, content analysis can be said to be the analysis of the content of some type of message or symbol. Stone, Dunphy, Smith and Ogilvie (1966) defined content analysis as "…. any research technique for making inferences by systematically and objectively identifying specific characteristics within text" (p. 5). Similarly, Krippendorff (2004) defined content analysis as: "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use" (p.18). In content analysis, researchers quantify and analyze the presence, meanings and relationships of such words and concepts, then make inferences about the messages within the texts. Texts can be defined broadly as books, book chapters, essays, interviews, discussions, newspaper headlines and articles, historical documents, speeches, conversations, advertising, theater, informal conversation, or any occurrence of communicative language.

Magid, McKnight, McKnight and Murphy (2000) identified five main steps in the process of developing a content analysis: 1) identify documents that are relevant to the research purpose; 2) select a sample document to analyze; 3) develop a category-coding procedure; 4) conduct the content analysis; and 5) interpret the results. That is, to conduct content analysis, the researcher must first identify documents that are relevant to the research purpose or identify documents to be examined based on the research questions. After these documents have been identified, the researcher must decide on an appropriate sample size to be used. Krippendorff (1980) recommends that the sample size be large enough to provide enough information, yet small enough for the analysis to be feasible. Often, the sample size is also dictated by trade-off between available resources (time, money, and people) and the desire for generalizability: a larger sample size may involve more resources but be more generalizable.

Once a sample has been selected, the next task is devising a system of encoding information from the sample. In qualitative approaches, this is usually done by some sort of categorizing. When a categorizing approach is used, the first step is to determine what units (words, sentences, syntactical units, referential units, pages, math problems and the likes) will be placed in which categories. A coding process can also be designed to include matrices, charts, tables, or other ways to display whatever information the researcher will be analyzing (Magid, McKnight, McKnight & Murphy, 2000).

The next task is to determine categories. According to Holsti (1969), categories should "reflect the purposes of research, be exhaustive, be mutually exclusive, independent, and be derived from a single classification principle" (p. 95). Although it is possible to use categories that are not mutually exclusive, Weber (1985) noted that this can lead to problems in statistical analysis. Weber added that, if the categories are not exhaustive, an "other" category can be added so that all units are coded. The final stage of content analysis is to interpret the results. In doing so, it is highly recommended that one considers the contexts within which the data were collected, and the purpose of the study. Regardless of the approach used or the purpose for the content analysis, it is also prudent to discuss what practical or theoretical implications can be drawn from the findings, any major shortcomings or limitations of the methodology used, and directions or suggestions for future research.

In this study, I used content analysis (Krippendorff, 2004; Magid, McKnight, McKnight, & Murphy, 2000) to collect and analyze data in order to address the research questions. And, in the conduct of this study, I followed the five steps of content analysis outlined above to examine the *cognitive demand* of the intended curriculum and the STAAR assessment for grades 7, 8, and Algebra 1 in order to determine the level of alignment between the curricular tasks and assessment items.

Analytical Framework for Examining the Mathematical Tasks and the STAAR Items

While different studies have employed different frameworks to analyze mathematical tasks, the present study will use the Mathematical Task Framework (*Cognitive Demand)* developed by Smith & Stein (1998).

From 1990 to 1995, Stein and Smith (1998) conducted research as part of the QUASAR (Quantitative Understanding: Amplifying Student Achievement and Reasoning) Project and studied the mathematics education reform in urban middle schools. They collected data about many aspects of teaching, including how educators used small groups in their classrooms; the tools available for students to use, such as, manipulatives and calculators; and the nature of mathematics tasks (Smith and Stein, 1998). For this project, Stein and Smith created *The Mathematical Task Framework* to describe the four varying levels of *cognitive demand* to classify a mathematical task (*memorization*, *procedures without connections*, *procedures with connections*, *doing mathematics*) (Dogbey and Dogbey, 2016). Mathematical tasks in the *memorization* and *procedures without connections* groups have a lower *cognitive demand* level while tasks in the *procedures with connections* and *doing mathematics* groups have a high *cognitive demand* level. The four levels of *cognitive demand* are disjoint; one task or item may be classified as requiring one level of cognitive demand.

The two lower level tasks are classified as *memorization* and *procedures without connections* to understanding, meaning, or concepts (which will be referred to as *procedures without connections* from here on out) (Stein, Smith, Henningsen, Silver, 2000). The higher-level tasks can be classified as *procedures with connections* to understanding, meaning, or concepts (hereby referred to as *procedures with connections*) or *doing mathematics* (Stein, Smith, Henningsen, Silver, 2000).

Memorization tasks include reproducing formerly learned facts, rules, formula, or definitions or committing these to memory (Stein, Smith, Henningsen, Silver, 2000). *Memorization* tasks cannot be solved using a procedure because a procedure does not exist; they also have no connection to the concepts or meaning that are central to the facts, rules, definitions, or formula learned or reproduced (Stein, Smith, Henningsen, Silver, 2000). *Memorization* tasks are also not ambiguous. These types of tasks call for the exact reproduction of already seen material and what is to be replicated is clearly and directly stated (Stein, Smith, Henningsen, Silver, 2000).

The next level of *cognitive demand* is *procedures without connections*. This is a lower level cognitive demand, but it is higher than *memorization*. *Procedures without connections* tasks are algorithmic; the use of the procedure or algorithm is either specifically called for or its use is apparent based on prior instruction, experience, or placement of the task (Stein, Smith, Henningsen, Silver, 2000). There is little to none ambiguity about what needs to be done to accomplish the task or how to go about it; these tasks require limited *cognitive demand* in order to be completed successfully (Stein, Smith, Henningsen, Silver, 2000). *Procedures without connections* tasks do not have a connection to the concepts or meaning that support the procedure being used; they are focused on producing correct responses as opposed to developing mathematical understanding (Stein, Smith, Henningsen, Silver, 2000). These types of tasks either do not ask for an explanation or the explanation only focuses on describing the procedure used (Stein, Smith, Henningsen, Silver, 2000).

Procedures with connections tasks operate at a higher level of cognitive demand. These types of tasks 'focus students' attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas' (Stein, Smith, Henningsen, Silver, 2000). Tasks at the procedures with connection *cognitive demand* level suggest routes to follow (explicitly or implicitly) that are broad general methods that have close connections to elemental conceptual ideas in contrast to narrow algorithms that are opaque with respect to the elemental concepts (Stein, Smith, Henningsen, Silver, 2000). *Procedures with connections* tasks are frequently represented in multiple ways, making connections among multiple representations in these tasks helps to develop meaning, and these tasks require some degree of cognitive effort (Stein, Smith, Henningsen, Silver, 2000). For these type of tasks, conventional procedures can be followed, but they cannot be followed thoughtlessly. In order to complete the task and develop understanding, students need to engage with the conceptual ideas that underlie the procedures (Stein, Smith, Henningsen, Silver, 2000).

Doing mathematics tasks do not have an anticipated or well-practiced approach or course of action plainly suggested by the task, the task directions, or a similar worked-out example; these tasks require intricate and non-algorithmic thinking (Stein, Smith, Henningsen, Silver, 2000). Tasks that function at the *doing mathematics cognitive demand* level expect students to explore and understand the nature of mathematical concepts, processes, or relationships as well as to self-monitor and self-regulate their own cognitive processes (Stein, Smith, Henningsen, Silver, 2000). Tasks that function at this *cognitive demand* level challenge students to explore the task and actively consider any task constraints that may limit possible solution strategies and solutions (Stein, Smith, Henningsen, Silver, 2000). This type of task may cause students some level of anxiety because of the variable nature of the solution process and because they involve a considerable amount of cognitive effort (Stein, Smith, Henningsen, Silver, 2000).

There are many surface features of tasks that can be distracting to the student; this contributes to the difficulty in determining the *cognitive demand* of a tasks. There are many lower level tasks that act like higher level cognitive tasks because of the reform-oriented characteristics. Some of these characteristics are requiring the use of a manipulative; using real world conditions; involving multiple steps, actions or judgements; and/or making use of a provided diagram (Stein, Smith, Henningsen, Silver, 2000). It is extremely important to move beyond the surface features when determining the type of thinking the task requires and the *cognitive demand* of a task. It is also important to consider the student when determining the *cognitive demand* of tasks: the student's age, grade level, prior knowledge, experiences, and the classroom norms and expectations (Stein, Smith, Henningsen, Silver, 2000). Teachers must consider all these factors in order to be sure that the instructional task the teacher produced or simply assigned to the students, presents an appropriate level of challenge. It is important for teachers to remember when sorting tasks or simply determining the *cognitive demand* of a task, that considering how and why tasks differ is important because these differences can have an impact on opportunities for student learning (Stein, Smith, Henningsen, Silver, 2000).

Selection of the Mathematical Materials Used in this Study

Mathematics Textbooks

Researchers who analyze mathematics textbooks and their effects on achievement generally use some criteria for selecting textbooks: e.g., they attempt to select widely-used series and both NSF-funded and non-NSF-funded curricula (Hodges et al., 2008; Johnson, Thompson, & Senk, 2010; Tarr et al., 2008). For example, Hodges et al. selected Glencoe's Math Connects because it was "a popular textbook in the middle schools with which we were familiar" (p. 79) and selected Connected Mathematics and Math Thematics because they are NSF-funded series. Similar, Tarr et al. chose textbook series with "significant market share" (p. 253) and chose both traditional and NSF- funded textbooks. Tarr et al. used the Glencoe publication as the non-NSF-funded curriculum and Connected Mathematics as the alternative curriculum.

The mathematics textbooks chosen for this content analysis were published by McGraw-Hill Education. The 7th and 8th grade textbooks were copyrighted in 2015 and the Algebra 1 textbook was copyrighted in 2016. Public schools have textbook adoption years every five to eight years. The school allows teachers to go to textbook conferences, check out potential new textbooks, collect sample textbooks, review the content of the textbook, and ultimately select a new textbook. I selected these textbooks because McGraw-Hill Education is a nationwide publisher and created textbooks specifically for the state of Texas. These textbooks are designed to align with the Texas Essential Knowledge and Skills (TEKS) state standards.

Both the 7th and 8th grade textbooks are broken down into two separate consumable books, volumes one and two. Consumable textbooks are textbooks that are a cross between a workbook and a textbook. There are traditional textbook pages with definitions, examples, etc., but there are also pages where the student can tear the page out and treat it like a worksheet with independent practice problems. The tear away pages provide the student with space to show their process and arrive at a solution. The traditional textbook pages have space in the margins for students to take extra notes and write solutions to guided practice problems. The Algebra 1 textbook is a more traditional textbook. It is just one hardcover book that contains explanations, examples, guided practice problems, and independent practice problems for various topics.

Textbook Adoption Process

In South Texas, teachers can adopt a new textbook every five to eight years (depends on the school district's budget and allocation of funds). Each district has an instructional materials allotment (IMA) that the Texas Education Agency calculates and dispenses every two years. The IMA is the money given to districts by the state to purchase instructional materials, technological equipment, and technology-related services. The first step in the textbook adoption process is for teachers to attend a textbook book fair where they can meet with different publishers and attain samples of various textbooks. Teachers are also able to request different textbook publisher representatives to come to their campus and present to the math department or team of content teachers (i.e. the Algebra 1 teachers on a campus or in a district) the various online features and pros of their company's textbook. After the teachers have narrowed down their textbook selection to three or four, they are required to have one or two parents evaluate the textbooks. The school district provides the parents with a form to fill out evaluating the textbook and stating their opinion on certain features and the overall quality of the textbook. Once the teachers receive the feedback from the parents, the team of teachers select a textbook and let the administration know which textbook they will be recommending for adoption. From there, the administration orders the textbook from the publisher provided it is in the budget.

Selection of Content to Analyze

I chose to only examine the mathematical tasks associated with linear equations, inequalities, and functions because these topics, for each 7th, 8th, and Algebra 1, comprise the majority of the STAAR assessment. Linear equations, inequalities, and functions is 37.5% of the 7th grade STAAR assessment, 38% of the 8th grade STAAR assessment, and 48.1% of the Algebra 1 STAAR EOC assessment. Consequently, the minimum raw passing score for the above mentioned STAAR assessments for the 2017 – 2018 school year were 40%, 45%, and 39% respectively. Since the minimum passing raw score for each assessment was near the percentage of the test assessing linear equations, inequalities, and functions, in theory, if a student answered every single assessment task on linear equations, inequalities, and functions correctly, they would only need a few more questions correct to receive a passing score on the STAAR assessment. (Except for Algebra 1, answering every linear assessment task correctly would result in a passing score) I find this very concerning. Linear equations, inequalities, and functions is just one component of mathematics and just one part of the TEKS for each of the 7th, 8th, and Algebra 1 curriculum. But, because it is tested so heavily on the STAAR assessment, I feel that it is a good use of my time and resources to analyze the *cognitive demand* and level of alignment between the curriculum and assessment tasks associated with these topics.

Another reason I felt analyzing the *cognitive demand* and level of alignment between the curriculum and assessment tasks for linear equations, inequalities, and functions, is because this topic is taught from middle grades mathematics through high school Algebra 2 courses and these topics present themselves heavily on the STAAR assessment. In the next section, I breakdown the STAAR assessment content.

The State of Texas Assessments of Academic Readiness

The State of Texas Assessments of Academic Readiness (STAAR) as set forth by the Texas Education Agency (TEA) in conjunction with Texas Higher Education Coordinating Board (THECB) was established in response to the legislation set forth by the 80^{th} and 81^{st} Texas State Legislatures. The assessment program (STAAR) was intended to quantify the degree to which students have learned and are able to apply the knowledge and skills outlined in the state-mandated curriculum standards, the Texas Essential Knowledge and Skills (TEKS). Each question on the STAAR exam is designed to directly align with the TEKS standards practiced for the specific grade, subject, or course being assessed.

The state of Texas has an accountability and accreditation system that considers how students in a specific school/district perform on the STAAR exam every year. The STAAR results are used in each domain that the state of Texas uses to rate schools and districts.
There are three domains the state of Texas uses to calculate the overall rating of each school: The Student Achievement Domain, the School Progress Domain, and the Closing the Gaps Domain. The Student Achievement Domain and the School Progress Domain account for a total of seventy percent of the school rating and the Closing the Gaps domain accounts totals thirty

percent of the overall school rating. The Student Achievement Domain is broken down into three categories: the STAAR test which is forty percent of this domain; college, career, and military readiness which is also forty percent; and the graduation rate which is twenty percent. In the Student Achievement Domain, the percentages of students who approach grade level or above, who meet grade level or above, and master grade level on the STAAR exam are calculated. Each of these percentages are averaged together and part of the student achievement score is calculated.

The STAAR test results are also used in the School Progress Domain. This domain is broken down into two categories: academic growth and relative performance. Whichever category receives a higher scaled score, that is the score that counts for the School Progress Domain. In the academic growth category, all assessments with a STAAR progress measure are included. Schools earn credit for results that maintain proficiency or meet STAAR growth expectations. The relative performance category evaluates the achievement of all students relative to districts or campuses with similar socioeconomic statuses.

The Closing the Gaps Domain also utilizes the results of the STAAR assessment. The percentage of students that meet grade level or above on the STAAR ELA/Reading and STAAR Math for each student group are used to calculate the overall domain grade.

The Reporting Categories are the different categories of questions on the STAAR exams. The seventh-grade math STAAR assessment has four Reporting Categories. Reporting Category two, Computations and Algebraic Relationships, is 37.5% (15 questions) of the exam. The eighth-grade math STAAR also has four Reporting Categories and Reporting Category two is also Computations and Algebraic Relationships. This Reporting Category comprises 38% (16 questions) of the exam. As for the Algebra 1 STAAR assessment, Reporting Categories two and three, Describing and Graphing Linear Functions, Equations, and Inequalities and Writing and Solving Linear Functions, Equations, and Inequalities, respectively, comprise 48% (26 questions) of the exam. All these Reporting Categories constitute the majority of each STAAR exam and each of these Reporting Categories covers linear functions, equations, and inequalities. Therefore, the majority of each of the seventh grade, eighth grade, and Algebra 1 STAAR math exams are mostly comprised of tasks related to linear functions, equations, and inequalities.

While students are only scored on 40 questions for the 7th grade STAAR, 42 questions for the 8th grade STAAR, and 54 questions for the Algebra 1 STAAR, there are also field test questions. All STAAR assessments have embedded field test questions that do not contribute to the students score. The state embeds field test questions to gather item-level student performance data which helps determine how well the items will perform for the intended purpose. There are up to eight multiple-choice field test questions embedded in each STAAR assessment. In order to pass the 7th grade STAAR assessment, students must receive a raw score of at least 22; which means 16 out of 40 questions answered correctly. To pass the 8th grade STAAR assessment, students much earn a raw score of at least 19 and a raw score of at least 21 to pass the Algebra 1 STAAR assessment.

The Algebra 1 STAAR EOC assessment is administered to first time testers in May. If a student does not pass the May administration of the assessment, they can re-test in June. If a student does not pass the June administration or does not take the June administration of the Algebra 1 EOC assessment, they must re-take the exam in December. So, over the course of a school year, the Algebra 1 assessment is administered three times and students who do not pass the exam will continue to take it until they pass.

The 8^{th} grade Mathematics STAAR assessment is administered to first time testers in March or April (depending on how the calendar falls that year). If a student does not pass the March/April administration of the exam, they must re-test in May. If they do not pass the May administration of the STAAR assessment, they must re-test in June. That is the students last opportunity to re-test because in order to move on to high school, they must pass the 8^{th} grade STAAR Mathematics assessment.

For the 7^{th} grade STAAR mathematics assessment, schools administer the assessment in May. There is no re-test for this assessment because it is not required for students to pass to move onto the next grade level.

Unit of Analysis and Coding the Data

I consider linear equations, inequalities, and functions to be the unit of analysis. Specifically, any task that uses linear equations, inequalities, or functions and fits the descriptions provided in the analytical framework is considered a linear textbook task or assessment item. To identify these tasks, I examined each page of the textbooks, beginning from the first page of the first chapter to the last page of the last chapter and selected the mathematical textbooks for linear tasks. I also did the same for each of the STAAR assessments; I examined every assessment item and identified the linear items. In the 7^{th} grade consumable textbook linear topics are found on 100 of 800 pages; 137 of 700 pages in the 8^{th} grade consumable textbook; and 193 of 800 pages in the Algebra 1 textbook.

If I find an item like the one in Figure 1, I would classify it as "*Doing Mathematics"*. This task does not have a similar worked out example for the students to follow. This task requires students to explore and understand the nature of mathematical concepts and processes as well as to self-monitor and self-regulate their own cognitive processes.

A seventh grade class is playing a game of *Guess My Rule*. As a student makes a guess, the teacher tells what number the rule gives back. Is it possible for a student to guess 10 with the teacher response being 3? Write a two-step equation that describes the rule to justify your answer.

Student Guess (x)	Teacher Response (y)
2	-1
5	8
0	-7
6	11

Figure 1. “Doing Mathematics” Task, *TEKS Course 2* pg. 540 Q. 21, Adapted from *TEKS Course 2: Volume 2* (2015), published by McGraw-Hill Education

An item such as the one from Figure 2 would be classified as *“Procedures with Connections”*. This task requires some degree of cognitive effort. For this task, conventional procedures can be followed, but they cannot be followed thoughtlessly.

Ricky is saving money to buy a TV listed at $936. He currently has $40. He charges $20 for every lawn he mows, and spends about $6 in gas for every three lawns. He also has a paper route, which earns his $45 per month.

a. In how many weeks will he have enough money if he mows three lawns per week?

b. Explain your solution process.

c. What assumptions did you make?

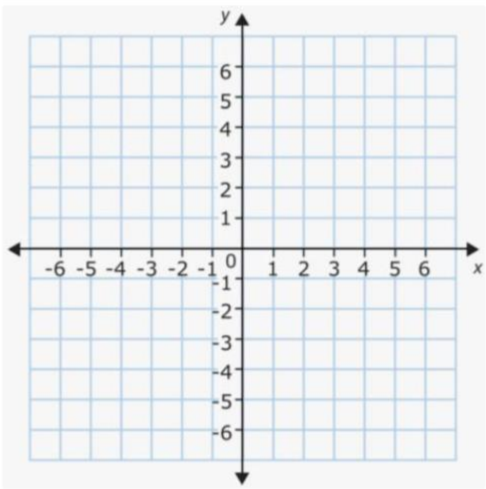
Figure 2. “Procedures Without Connections” Task, *TEKS Algebra 1* pg. 231 Q. 46. Adapted from *TEKS Algebra* 1 (2016), by Carter, Cuevas, Day, Malloy, published by McGraw-Hill Education

An item such as the one in Figure 3 would be classified as “P*rocedures without Connections”* because students have seen examples like this task prior. There is little to no ambiguity about what needs to be done to accomplish the task or how to go about it. This task does not have a connection to the concepts or meaning that support the procedure being used; it is focused on producing a correct response as opposed to developing mathematical understanding.

Solve each pair of simultaneous linear equations by graphing.

d. $y = \frac{2}{3}x + 3$

$3y = 2x + 15$



e. $y - x = 1$

$y = x - 2 + 3$

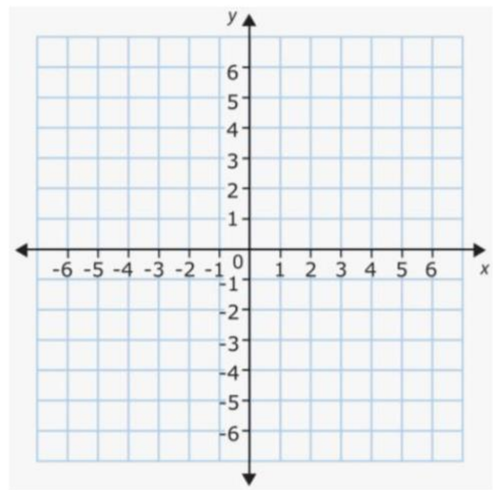


Figure 3. “Procedures without Connections” Task, *TEKS Course 3* pg. 455 Q. 4, Adapted from *TEKS Course 3: Volume 2* (2015), published by McGraw-Hill Education

The item in Figure 4 would be classified as a *“Memorization”* task. This task only requires students to recall a definition or previously seen image or example; it does not require students to follow a procedure because a procedure does not exist for this item.

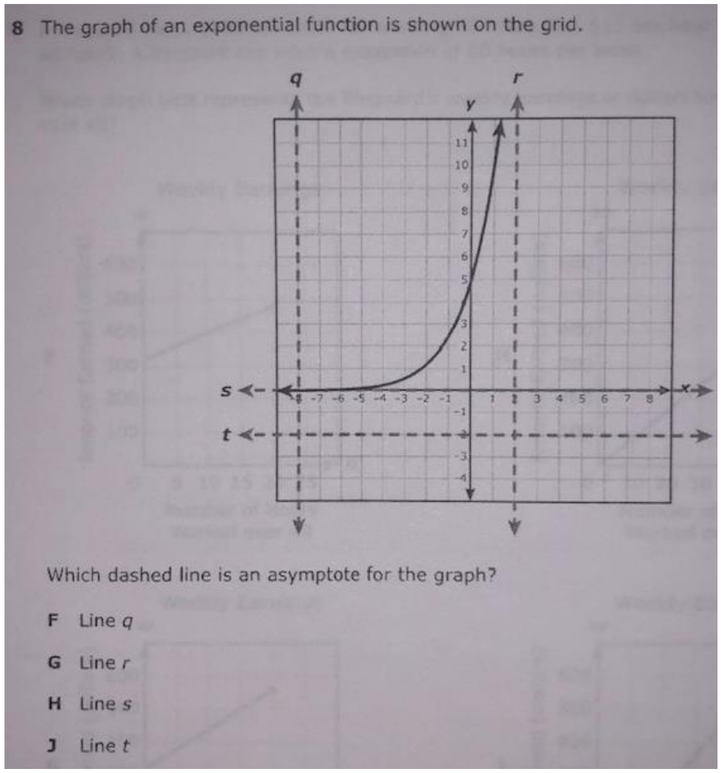


Figure 4. Texas Education Agency. (2017). State of Texas Assessments of Academic Readiness (STAAR) Mathematics Released Items, Algebra 1. Retrieved from https://tea.texas.gov/sites/default/files/STAAR-EOC-2017-Test-AlgebraI-f.pdf

In order to answer the research questions, I will examine every linear task in the textbooks as well as the linear items on the three most recent 7th, 8th, and Algebra 1 STAAR assessments. I will find the ratio of tasks/items for each level of *cognitive demand* and determine the level of alignment between the textbook's tasks and the assessment items. I am anticipating there to be more lower level items on the STAAR assessments compared to the textbook tasks.

Reliability Measures (inter-rater reliability)

A key ingredient in content analysis is the reliability of the coding procedure. That is, in content analysis, it is imperative that categories be designed clearly, and instructions made specific enough so that when the coding procedure is applied, it remains consistent both over time by the same coder and among different observers. Krippendorff (1980) defined three types of reliability: stability, reproducibility, and accuracy. Stability means that the contents are coded the same by the same coder at different times. The problem that may arise here may be from ambiguities in the text, ambiguities in the coding rules, simple recoding errors, and cognitive changes within the coder (Weber, 1985). For instance, by the time a coder has finished a lengthy coding process, he or she may have made subtle changes in his or her judgments about the placements within different categories, and this may affect the stability of the coding.

The possibility of coder fatigue may also affect the stability of the coding as the number of documents to be examined was relatively large (i.e., 24 textbooks for this study). In order to reduce coder fatigue and enhance reliability, my coding schedules considered the length of units that was coded at any given time and ensured that only a reasonable number of units was coded during any given period of coding.

The second type of reliability is reproducibility. This is often called inter-coder reliability. Reproducibility deals with the extent to which the coding of materials is consistent among two or more different coders. According to Krippendorff (1980), this gives one of the surest measures of whether coding categories are clear and consistent or not.

Accuracy, the third type of reliability, measures the extent to which a process conforms to a known standard (Krippendorff, 1980). Accuracy is usually established by comparing the performance of one coder with what is known to be a correct performance (Krippendorff, 1980). This is the strongest measure of reliability, but perhaps, the most difficult to achieve since a known standard with regards to the research objectives may not exist. Krippendorff made the point that in the more problematic parts of content analysis, such as the interpretation and transcription of complex textual matter, suitable accuracy standards are not easy to find. That is, because interpretation can be compared only with other interpretations, attempts to measure accuracy presuppose the privileging of some interpretations over others, and this puts any claims regarding precision or accuracy on epistemologically shaky grounds (Krippendorff, 1980). Thus, the use of accuracy is limited to coder training and other areas where objective standards are readily available.

In order to assure my research is reliable, I guarded against instability by recoding an earlier-coded section near or at the end of the coding process. This will help me determine how consistent my coding was, and/or if there had been any changes. To establish inter-coder reliability, I employed the assistance of a fellow high school mathematics teachers who were familiar with my work to perform check-coding (Miles & Huberman, 1994). I had my colleague examine a total of 392 textbook tasks and assessment items combined. After the first round of coding, my colleague and I agreed upon the level of *cognitive demand* of 324 tasks/items (82.65%) and disagreed upon 68 tasks/items (17.35%). The 68 tasks/items my colleague and I disagreed upon went through a second round of coding. We refreshed ourselves with the research literature of Stein, Smith, Henningsen, and Silver, and discussed in depth what exactly each of the 68 tasks/items were asking the student to perform and what the students prior knowledge would be at that point in the curriculum. After the second round of coding, both my colleague and I agreed upon 100% of the items analyzed.

With respect to the present study, there was no known objective standard for examining the alignment between the level of *cognitive demand* of the curricular (textbook) mathematical tasks and the STAAR Assessment items from a mathematics curricula perspective. The lack of known standards made it difficult to document accuracy measures in this study.

Summary

In this chapter, I described the research methods and design I used in this study. I also described the criteria and rational for selecting the mathematics textbooks and the assessment materials used in this study. Further in the chapter, described the data collection tool, coding scheme, reliability and validity measures, and tested the applicability of the data collection and analysis framework through a pilot coding of some mathematical tasks and assessment items. Chapter 4 presents the results of the study. The summary of the results, discussion of the results, the implications and recommendations for instruction, assessment, curriculum development, and future studies are presented in Chapter 5.

Chapter 4

Results of the Study

In this chapter, I present the results of the study. I organized the chapter by providing an overview of the *cognitive demand* of the mathematical tasks and the assessment items in the selected mathematics curricula and the STAAR assessments. This was followed by the answers to each of the three research questions investigated in this study.

Brief Overview of the Tasks on Linear Concepts in the Textbooks

The 7th grade McGraw-Hill textbook examined in this study devoted 100 pages to the teaching and learning of Linear Equations, Functions, and Inequalities. This represents approximately 12.5% of the entire textbook pages devoted to this concept. When broken down into the three content areas under examination, approximately 12% of these pages were devoted to Linear Equations, 0.5% of the pages were devoted to Linear Functions, and 0% of the pages were devoted to Linear Inequalities.

Similarly, the 8th grade McGraw-Hill textbook that was examined in this study devoted 137 pages to the teaching and learning of Linear Equations, Functions, and Inequalities. This represents approximately 19.6% of the entire textbook devoted to the topics of interest in this study. When broken down into the three content areas, approximately 17% of these pages were devoted to Linear Equations, 2% of these pages were devoted to Linear Functions, and 0% of these pages were devoted to Linear Inequalities.

Likewise, the McGraw-Hill Algebra 1 textbook that was examined in this study devoted 193 pages to the teaching and learning of Linear Equations, Functions, and Inequalities. This represents approximately 24% of the entire textbook devoted to the topics under examination. When broken down into the three content areas, 23% of these pages were devoted to Linear

Equations, 0.5% of the pages were devoted to Linear Functions, and 0.5% of the pages were devoted to Linear Inequalities.

Brief Overview of Items on Linear Concepts on the STAAR Tests

For the 7th grade STAAR Test, the 2014, 2016, 2017, and 2018 STAAR Assessments were examined. The 2015 and 2019 assessments were not available for analysis, and thus, were excluded from this study. For the 4 years of assessments examined, there were a total of 188 assessment items covering various mathematics topics. Specifically, there were 54 items for years 2014, 54 items for 2016, 40 items for 2017, and 40 items for 2018 on the STAAR Assessment. Of these 188 total items, 29 items addressed students' knowledge pertaining to linear equations, functions, and inequalities. This number of items on linear concepts represents 15.4% of the total number of items examined for the four years of assessment. Of these 29 linear items, 23 items (representing 12.2%) addressed student's knowledge of linear equations, 6 items (representing 3.2%) addressed students' knowledge of linear functions, and there were 0 items that addressed students' knowledge of linear inequalities.

Similarly, for the 8th grade STAAR Assessment, the 2014, 2016, 2017, and 2018 assessment items were examined. As in the case of the 7th grade STAAR Assessment, the 2015 and 2019 assessments were not available for analysis and thus, were excluded from this study. For the 4 years of assessment items examined, there were a total of 196 STAAR items covering various mathematics topics. Of these 196 items, 65 were items that addressed students' knowledge pertaining to linear equations, functions, and inequalities. This represents 33% of the total assessment items related to linear concepts on the 8th grade STAAR Assessment during the 4 years of assessments period in this study. Of these 65 items, 40 items (representing 20.4%) addressed student's knowledge of linear equations, 23 items (representing 11.7%) addressed students' knowledge of linear functions, and 2 items (representing 1%) addressed students' knowledge of linear inequalities.

Likewise, for the Algebra 1 STAAR Assessment, the 2014, 2016, 2017, and 2018 STAAR Assessments were examined. The 2019 assessment was not available for analysis. Although the 2015 assessment was available, it was excluded from the study to ensure consistency in the years of STAAR Assessment examined in this study (i.e., because the 2015 assessment items were not available for 7th and 8th grades). For the 4 years of assessment items examined, there were a total of 237 items covering various mathematics topics. Of the 237 assessment items examined 104 items were items assessing linear concepts. This is equivalent to 43.9% of the total assessment items examined during the 4 years. Of these 104 items, 62 items (representing 26.2%) addressed student's knowledge of linear equations, 32 items (representing 13.5%) addressed students' knowledge of linear functions, and 10 items (representing 4.2%) that addressed students' knowledge of linear inequalities.

Analysis Based on Cognitive Demand

Cognitive Demand of the Curriculum Tasks in the Textbooks

The following tables (Tables 1, 2, 3, and 4) provide information on the *cognitive demand* analysis of the mathematical tasks in the Textbooks that relate to linear concepts in the McGraw-Hill Textbooks examined in this study.

Table 1

Textbook Tasks Cognitive Demand				
	Memorization	*Procedures w/o Connections*	*Procedures with Connections*	*Doing Mathematics*
7th (148 total tasks)	11 tasks (7%)	47 tasks (32%)	83 tasks (56%)	7 tasks (5%)
8th (242 tasks)	4 tasks (2%)	103 tasks (43%)	129 tasks (53%)	6 tasks (2%)
Algebra 1 (855 tasks)	5 tasks (0.6%)	446 tasks (52%)	343 tasks (40%)	61 tasks (7%)

Table 2

Textbook Tasks Cognitive Demand: Linear Equations					
	Total number of tasks/items	*Memorization*	Procedures w/o Connections	*Procedures with Connections*	*Doing Mathematics*
7^{th} grade	131	11 (8.4%)	38 (29%)	76 (58%)	6 (4.6%)
8^{th} grade	219	4 (1.8%)	88 (40.2%)	121 (55.3%)	6 (2.7%)
Algebra 1	715	2 (0.3%)	375 (52.4%)	281 (39.3%)	57 (8.0%)

Table 3

Textbook Tasks Cognitive Demand: Linear Functions					
	Total number of tasks/items	*Memorization*	Procedures w/o Connections	*Procedures with Connections*	*Doing Mathematics*
7^{th} grade	17	0 (0%)	9 (52.9%)	7 (41.2%)	1 (5.9%)
8^{th} grade	23	0 (0%)	15 (65.2%)	8 (34.8%)	0 (0%)
Algebra 1	97	3 (3.1%)	39 (40.2%)	55 (56.7%)	0 (0%)

Table 4

Textbook Tasks Cognitive Demand: Linear Inequalities					
	Total number of tasks/items	*Memorization*	Procedures w/o Connections	*Procedures with Connections*	*Doing Mathematics*
7^{th} grade	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
8^{th} grade	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Algebra 1	43	0 (0%)	32 (74.4%)	7 (16.3%)	4 (9.3%)

A cursory examination of the data in the tables show that most of the textbook tasks are procedural in natures. Specifically, from Tables 1, 2, 3, and 4, one can observe that approximately 90% of the mathematical tasks on linear related concepts classified as either procedure without connections or procedure with connections. Thus, there seems to be an emphasis on students being able to perform algorithms repeatedly with accuracy in these textbooks. Although there are many tasks at the *procedures with connections* level, this does not mean there is a lack of algorithmic thinking. One thing that distinguishes a task from being procedures with or without connections is the use of multiple representations to help develop meaning. Because this study examined linear equations, functions, and inequalities, there are many tasks that involve a mixture of graphs, tables, and equations to help the student understand the relationship between all three representations.

Cognitive Demand of the Assessment Items on the STAAR Test

Similarly, *Tables* 5, 6, 7, and 8 provide information on the *cognitive demand* analysis of the assessment items on the STAAR Test on Linear Equations, Functions, and Inequalities.

Table 5

STAAR Assessment Items Cognitive Demand: Overall				
	Memorization	*Procedures w/o Connections*	*Procedures with Connections*	*Doing Mathematics*
7th (29 total items)	0 items (0%)	17 items (59%)	12 items (41%)	0 items (0%)
8th (65 items)	0 items (0%)	23 items (35%)	42 items (65%)	0 items (0%)
Algebra 1 (104 items)	0 items (0%)	52 items (50%)	52 items (50%)	0 items (0%)

Table 6

STAAR Assessment Items Cognitive Demand: Linear Equations					
	Total number of items	*Memorization*	*Procedures without Connections*	*Procedures with Connections*	*Doing Mathematics*
7th grade	23	0 (0%)	13 (56.5%)	10 (43.5%)	0 (0%)
8th grade	40	0 (0%)	14 (35%)	26 (65%)	0 (0%)
Algebra 1	62	0 (0%)	34 (55%)	28 (45%)	0 (0%)

Table 7

STAAR Assessment Items Cognitive Demand: Linear Functions					
	Total number of items	*Memorization*	*Procedures without Connections*	*Procedures with Connections*	*Doing Mathematics*
7th grade	6	0 (0%)	4 (66.7%)	2 (33.3%)	0 (0%)
8th grade	23	0 (0%)	7 (30.4%)	16 (69.6%)	0 (0%)
Algebra 1	32	0 (0%)	16 (50%)	16 (50%)	0 (0%)

Table 8

STAAR Assessment Items Cognitive Demand: Linear Inequalities					
	Total number of items	*Memorization*	*Procedures without Connections*	*Procedures with Connections*	*Doing Mathematics*
7th grade	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
8th grade	2	0 (0%)	2 (100%)	0 (0%)	0 (0%)
Algebra 1	10	0 (0%)	2 (20%)	8 (80%)	0 (0%)

As can be seen from the tables above (*Tables* 5, 6, 7, and 8), the majority of the *linear equation* assessment items for the 7th grade was at the *procedures without connections* level of cognitive demand; 13 items equivalent to 56.5%. The majority of the *linear function* items were at the *procedures without connections* level of cognitive demand; 4 items equivalent to 66.7%. There were no linear inequality items to analyze.

Similarly, for the 8th Grade STAAR Assessment **(**as shown in Tables 5, 6, 7, and 8), the majority of the linear equation assessment items were at the *procedures with connections* level of cognitive demand; 26 items equivalent to 65%. The majority of the linear function items were at the *procedures with connections* level of cognitive demand; 16 items equivalent to 69.6%. The majority of the linear inequality items were at the *procedures without connections* level of cognitive demand; 2 items equivalent to 100%.

For Algebra 1, the majority of the linear equation assessment items were at the *procedures without connections* level of cognitive demand; 34 items equivalent to 55%. The linear function items were split down the middle at the *procedures with connections* and *procedures with connections* levels of cognitive demand; 16 items for each level equivalent to 50%. The majority of the linear inequality items were at the *procedures with connections* level of cognitive demand; 8 items equivalent to 80%.

Cognitive Demand Alignment of Curriculum Tasks and Assessment Items

For the purpose of determining the *cognitive demand* alignment between the mathematical tasks in the selected textbooks and the STAAR assessment items, Tables 9, 10 and 11 provide information on the *cognitive demand* analysis of the textbook tasks and assessment items on linear equations/inequalities/functions. For these tables, M represents *memorization*, P/WT/C represents *procedures without connections*, PWC represents *procedures with connections*, and DM represents *doing mathematics*.

Table 9

Cognitive Demand Comparison: Linear Equations

Linear Equations	Textbook Tasks					STAAR Items				
	M	P/WT/C	PWC	DM	Mostly	M	P/WT/C	PWC	DM	Mostly
7^{th}	8.4%	29%	58%	4.6%	PWC	0%	56.5%	43.5%	0%	P/WT/C
8^{th}	1.8%	40.2%	55.3%	2.7%	PWC	0%	35%	65%	0%	PWC
Alg 1	0.3%	52.4%	39.3%	8.0%	P/WT/C	0%	55%	45%	0%	P/WT/C

Table 10

Cognitive Demand Comparison: Linear Functions

Linear Functions	Textbook Tasks					STAAR Items				
	M	P/WT/C	PWC	DM	Mostly	M	P/WT/C	PWC	DM	Mostly
7^{th}	0%	52.9%	41.2%	5.9%	P/WT/C	0%	66.7%	33.3%	0%	P/WT/C
8^{th}	0%	65.2%	34.8%	0%	P/WT/C	0%	30.4%	69.6%	0%	PWC
Alg 1	3.1%	40.2%	52.3%	0%	PWC	0%	50%	50%	0%	P/WT/C & PWC

Table 11

Cognitive Demand Comparison: Linear Inequalities

Linear Inequalities	Textbook Tasks					STAAR Items				
	M	P/WT/C	PWC	DM	Mostly	M	P/WT/C	PWC	DM	Mostly
7th	0%	0%	0%	0%	N/A	0%	0%	0%	0%	N/A
8th	0%	0%	0%	0%	N/A	0%	100%	0%	0%	P/WT/C
Alg 1	0%	74.4%	16.3%	9.3%	P/WT/C	0%	20%	80%	0%	PWC

Results Based on the Research Questions

Research Question 1**:** *What is the nature of the Cognitive Demand of the items pertaining to linear equations, inequalities, and functions on the 7th, 8th, and Algebra 1 STAAR mathematics assessments?* This first research question addresses the *cognitive demand* of the 7th, 8th, and Algebra 1 STAAR Assessment items pertaining to linear equations, functions, and inequalities.

7th Grade STAAR Assessments

Based on the data, the results indicated that the 7th grade STAAR Assessments for 2014, 2016, 2017, and 2018 assessment years contained 23 linear equation assessment items. Of these 23 items, 13 items were at the *procedures without connections* level of *cognitive demand* while 10 were at the *procedures with connections* level of cognitive demand. This shows that the majority of items (56.5%) was at the *procedures without connections* level. There were not any assessment items at the *memorization* or *doing mathematics* levels of cognitive demand. For linear functions concepts, there were a total of 6 assessment items analyzed for 2014, 2016, 2017, and 2018 assessment years; 4 items at the *procedures without connections* level and 2 at the *procedures with connections* level. Thus, the majority of linear function items were at the *procedures without connections* level which equaled 66.7% of the total linear function items. There were not any assessment items at the *memorization* or *doing mathematics* levels of cognitive demand. There were no linear inequality STAAR Assessment items to be analyzed for exams given during 2014, 2016, 2017, and 2018 assessment years for the 7th grade.

8th Grade STAAR Assessments

For the 8th grade STAAR Assessments examined (i.e., years 2014, 2016, 2017, and 2018 assessments), there were a total of 40 linear equation items analyzed. Fourteen (14) items were at the *procedures without connections* level of cognitive demand. The majority of linear equation items were at the *procedures with connections* level of cognitive demand; 26 items equaling 65%. For the 23 linear function items analyzed, 7 items were at the *procedures without connections* level of cognitive demand. Most of the linear function assessment items were at the *procedures with connections* level of cognitive demand; 16 items equaling 69.6%. There were two linear inequality assessment items analyzed from the 4 years of 8th grade STAAR Assessments. Both of these items were categorized at the *procedures without connections* level of *cognitive demand* totaling 100% of the linear inequality items.

Algebra 1 STAAR Assessments

The Algebra 1 STAAR Assessments for years 2014, 2016, 2017, and 2018 contained a total of 62 linear equation assessment items. Of these 62 items, the majority of the items were at the *procedures without connections* level of cognitive demand; 34 items equaling 55% of the total linear equation assessment items. The rest of the items were at the *procedures with connections* level of cognitive demand; 28 items equaling 45%. The 32 linear functions items for the Algebra 1 STAAR Assessments analyzed contained an equal number of procedures with connections and *procedures without connections* items. Both levels of *cognitive demand* containing 16 items each, which is 50% of the total. There was a total of 10 linear inequality assessment items for Algebra 1. Two (2) items were at the *procedures without connections* level of cognitive demand. The majority of the linear inequality assessment items were at the *procedures with connections* level of cognitive demand; 8 items equaling 80% of the total.

Research Question 2: *What is the nature of the Cognitive Demand of the mathematical tasks pertaining to linear equations, inequalities, and functions in the mathematics textbooks used by 7th, 8th, and Algebra 1 students in South Texas?* This second research question addresses the *cognitive demand* of the 7th, 8th, and Algebra 1 Mathematics Textbook tasks pertaining to linear equations, functions, and inequalities.

7th Grade McGraw-Hill Textbook Tasks

The 7th grade mathematics textbook chosen for examination is from the McGraw-Hill Education publishing company and was copyrighted in 2015. This textbook is broken down into two volumes and 100 of the pages (out of 800) are dedicated to the teaching and learning of linear equations, functions, and inequalities. This is approximately 12.5% of the textbook. Of this 12.5%, 12% is dedicated to linear equations, .5% is dedicated to linear functions, and 0% is dedicated to linear inequalities. Of these 100 pages, there were a total of 148 linear textbook tasks that were analyzed. Of these 148 textbook tasks, 131 tasks were related to linear equations, 17 were related to linear functions, and 0 were related to linear inequalities. The majority of the tasks on linear equation were at the *procedures with connections* level of cognitive demand; 76 tasks equivalent to 58%. The majority of the tasks on linear function were at the *procedures without connections* level of cognitive demand; 9 tasks equivalent to 52.9%. There were no linear inequality tasks analyzed.

8th Grade McGraw-Hill Textbook Tasks

The 8th grade mathematics textbook chosen for examination is from the McGraw-Hill Education publishing company and was copyrighted in 2015. This textbook is broken down into two volumes and 137 of the pages (out of 698) are dedicated to the teaching and learning of linear equations, functions, and inequalities. This is approximately 19.6% of the textbook. Of this 19.6%, 17% is dedicated to linear equations, 2% is dedicated to linear functions, and 0% is dedicated to linear inequalities. Of these 137 pages, there were a total of 242 tasks in the 8th grade textbook on linear equations, linear functions, and linear inequalities that were analyzed. Of these 242 tasks, 219 tasks were related to linear equations, 23 were related to linear functions, and 0 were related to linear inequalities. The majority of the linear equation tasks were at the *procedures with connections* level of cognitive demand; 121 tasks equivalent to 55.3%. The majority of the tasks on linear function were at the *procedures without connections* level of cognitive demand; 15 tasks equivalent to 65.2%. There were no linear inequality tasks found or analyzed in the 8th grade textbook.

Algebra 1 McGraw-Hill Textbook Tasks

The Algebra 1 mathematics textbook chosen for examination is from the McGraw-Hill Education publishing company and was copyrighted in 2016. This textbook has 193 (out of 805) of the pages are dedicated to the teaching and learning of linear equations, functions, and inequalities. This is approximately 24% of the textbook. Of this 24%, 23% is dedicated to linear equations, 0.5% is dedicated to linear functions, and 0.5% is dedicated to linear inequalities. Of these 193 pages, there were a total of 855 tasks on linear equations, linear functions, and linear inequalities that were analyzed. Of these 855 tasks, 715 tasks were related to linear equations, 97 were related to linear functions, and 43 were related to linear inequalities. The majority of the tasks on linear equation were at the *procedures without connections* level of cognitive demand; 375 tasks equivalent to 52.4%. The majority of the tasks on linear function were at the *procedures with connections* level of cognitive demand; 55 tasks equivalent to 56.7%. The majority of the tasks on linear inequality were at the *procedures without connections* level of cognitive demand; 32 tasks equaling 74.4% of the total linear inequality tasks.

Research Question 3: *What is the level of alignment in the Cognitive Demand of the items on STAAR Test and the Tasks in the intended mathematics curriculum for students in the 7th, 8th, and Algebra I in South Texas pertaining to linear functions, equations, and inequalities?* ~~The third~~ This research question addresses the level of alignment in the *Cognitive Demand* of assessment items on the STAAR Assessment and the tasks in the intended mathematics curriculum (textbooks) for students in 7th, 8th, or Algebra 1 pertaining to linear equations, functions, and inequalities.

<u>*Degree of Alignment: 7th Grade Intended Curriculum and Assessment*</u>

The analysis of the data revealed that the 7th grade intended mathematics curriculum tasks from the McGraw-Hill textbook for linear equations was mostly at the *procedure with connections* level of cognitive demand; 58% of the linear equation textbook tasks. The 7th grade STAAR Assessment items for linear equations, on the other hand, was mostly at the *procedures without connections* level of cognitive demand; 56.5% of the linear equation assessment items. The 7th grade intended mathematics curriculum tasks from the McGraw-Hill textbook for linear functions was mostly at the *procedures without connections* level of cognitive demand; 52.9% of the linear function textbook tasks. The 7th grade STAAR Assessment items for linear functions was also mostly at the *procedures without connections* level of cognitive demand; 66.7% of the linear function assessment items. There were no linear inequality textbook tasks nor assessment items found or analyzed in the 7th grade intended curriculum or in the 7th grade STAAR Assessment. For 7th grade linear equations, the degree of alignment was weak because a higher percentage of curricular tasks operate at a higher level of *cognitive demand* than the STAAR Assessment items; for linear functions, the degree of alignment was proper because 100% of the assessment items for 7th grade linear functions were categorized at the same level or higher of *cognitive demand* as the textbook tasks; and there was no level of alignment for linear inequalities.

Degree of Alignment: 8th Grade Intended Curriculum and Assessment

The 8th grade intended mathematics curriculum tasks from the McGraw-Hill textbook for linear equations was mostly at the *procedures with connections* level of cognitive demand; 55.3% of the linear equation textbook tasks. Similarly, the 8th grade STAAR Assessment items for linear equations was mostly at the *procedures with connections* level of cognitive demand; 65% of the linear equation assessment items. The 8th grade intended mathematics curriculum tasks from the McGraw-Hill textbook for linear functions was mostly at the *procedures without connections* level of cognitive demand; 65.2% of the linear function textbook tasks. The 8th grade STAAR Assessment items for linear functions, on the other hand, was mostly at the *procedures with connections* level of cognitive demand; 69.6% of the linear function assessment items. The 8th grade intended mathematics curriculum did not have any tasks from the McGraw-Hill textbook for linear inequalities. The 8th grade STAAR Assessment items for linear inequalities was entirely at the *procedures without connections* level of cognitive demand; 100% of the linear inequality assessment items. 65% of the STAAR Assessment items analyzed were at the same level or higher of *cognitive demand* as the textbook tasks showing a proper degree of alignment for 8th grade linear equations. 100% of the assessment items were categorized at a level of *cognitive demand* greater than or equal to the level of *cognitive demand* of the textbook tasks. This indicates a proper degree of alignment for 8th grade linear functions. The degree of alignment for linear inequalities was poor because there were two linear inequality items on the STAAR Assessments but there were not any curricular tasks to be found in the textbook.

Degree of Alignment: Algebra 1 Intended Curriculum and Assessment

The Algebra 1 intended mathematics curriculum tasks from the McGraw-Hill textbook for linear equations was mostly at the *procedures without connections* level of cognitive demand; 52.4% of the linear equation textbook tasks. The Algebra 1 STAAR Assessment items for linear equations was also mostly at the *procedures without connections* level of cognitive demand; 55% of the linear equation assessment items. The Algebra 1 intended mathematics curriculum tasks from the McGraw-Hill textbook for linear functions was mostly at the *procedures with connections* level of cognitive demand; 56.7% of the linear function textbook tasks. The Algebra 1 STAAR Assessment items for linear functions, on the other hand, was mostly at the *procedures without connections* and *procedures with connections* levels of cognitive demand; each level of cognitive making up 50% of the linear function assessment items.

The Algebra 1 intended mathematics curriculum tasks from the McGraw-Hill textbook for linear inequalities was mostly at the *procedures without connections* level of cognitive demand; 74.4% of the linear inequality textbook tasks. Similarly, the Algebra 1 STAAR Assessment items for linear inequalities was mostly at the *procedures with connections* level of cognitive demand; 80% of the linear inequality assessment items. For Algebra 1 linear equations, functions, and inequalities, all were properly aligned. 100% of linear equation assessment items were at the level of *cognitive demand* greater than or equal to the level of the curriculum, 50% for linear functions, and 100% for linear inequalities.

Summary

This chapter presents the results of the study. First, I provided an overview of the nature of the *cognitive demand* of the mathematical tasks and the assessment items in the selected mathematics curricula and the STAAR assessments examined. This was followed by the answers to the three research questions investigated in this study. In the chapter that follows (Chapter 5), I present the summary of the results, the discussion of the findings in relation to the extant literature, the implications of the results and recommendations for instruction, curriculum development, assessment, and for future studies.

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CHAPTER 5:

Discussion

In this chapter I summarize the results of the study and discuss how this study related to other similar studies. I also discuss the implications and limitations of this study along with my recommendations for instruction, curriculum development, assessment, and future studies.

Summary of the Results

The purpose of this study was to examine the *cognitive demand* of the mathematical tasks/items on linear equations, inequalities, and functions in the mathematics textbooks and the STAAR assessment for the 7th grade, 8th grade, and Algebra 1 students, and to determine the level of alignment between the curricular tasks and the related assessment items on the STAAR Test for grade 7, 8, and Algebra 1 students in the chosen topics. These questions were addressed by first finding every linear equation, function, or inequality task in the three selected McGraw-Hill textbooks. Once each linear textbook task was identified, each task was analyzed to determine the level of *cognitive demand* for that specific task. The process was then repeated for the 2014, 2016, 2017, and 2018 STAAR Assessments for grade 7, grade 8, and Algebra 1. The coding of the curricular tasks and the assessment items into the various levels of *cognitive demand* was conducted with the help of a second rater (who was trained by the researcher) to ensure consistency and reliability of the coding process. At the end, 100% consensus was achieved between the two raters on all textbook tasks and assessment items.

As stated in Chapter 2, "alignment is the degree to which curricular expectations and assessments are in agreement and serve in conjunction with one another to guide the system toward students learning what they are expected to know and do," (Webb et al., 1997, p. 4). This study used Webb's Alignment Tool (WAT) to calculate the alignment between the textbook tasks and assignment items. Specifically, the *Depth-of-Knowledge Consistency* criteria. *Depth-of-Knowledge Consistency* criteria measures the percentage of items rated greater than or equal to the cognitive demands of the matched curricular. The degree of alignment was be rated “Proper” if the measured alignment is 50% or greater, “Weak” if the measured alignment is at least 40% but less than 50%, and “Poor” otherwise (Webb, 2007). This study used the McGraw-Hill textbook as the curricular/standards to which the assessment items were compared to. In this study, the level of *cognitive demand* for the linear equations, functions, and inequalities textbook tasks and assessment items was determined. For each linear sub-topic, the percentage of assessment items or textbooks tasks for each of the four levels of *cognitive demand* was calculated.

The results yielded that all of the assessment items were either at the procedures without connections level of *cognitive demand* or the *procedures with connections* level. Because *memorization* is the lowest level of cognitive demand, it could be that the reason there were not any assessment items at this level is because the STAAR Exam is a standardized test. Standardized tests are meant to provide data that informs about teacher accountability, allow for comparisons about of student achievement data, and help teachers make data driven decisions in the classroom. For this to happen, items have students reproduce facts and cannot be solved using a procedure are not best suited for a standardized test. Items at the *doing mathematics* level of *cognitive demand* require a larger amount of time for students to be able to complete them. Therefore, it is not reasonable for these types of items to be seen on a standardized test that is timed, such as the STAAR Mathematics Assessment. Let it be noted that while there were no *memorization* or *doing mathematics* items among the linear equation, function, and inequality items on the STAAR Mathematics Assessments analyzed, it could be that there were *memorization* or *doing mathematics* items among the other mathematics topics on the exam; statistics, volume and measurement, quadratics, number operations, etc.

The results also yielded that for the STAAR Mathematics Assessments available for 7th grade from years 2014 to 2018 (2015 was not available), most of the assessment items fell into the *procedures without connections* level of *cognitive demand* (59% – 17 tasks). These are items that are algorithmic; use of a procedure is either specifically called for or the use of it is apparent because of prior instruction. These assessment items also focused on producing correct solutions, require no explanation, have no connection to the concepts or meaning that underlie the procedure being used, and there is little ambiguity of the procedure that needs to be used and how to use it to produce a correct response.

The 8th grade STAAR Mathematics Assessment items from years 2014-2018 (2015 was not available) fell into the *procedures with connections* level of *cognitive demand* (65% – 42 tasks). This shows that most linear assessment items "focus students' attention on the use of procedures for the purpose of developing deeper levels of understanding" (Stein, Smith, Henningsen, Silver, 2000). Additionally, the findings of this study illustrate that most assessment items used multiple representations (i.e. graphs, tables, symbols, problem situations, manipulatives) to assess students' knowledge of linear equations, functions, and inequalities.

The Algebra 1 linear equation, function, and inequality STAAR Mathematics Assessment items from years 2014-2018 (excluding 2015) were mostly classified as items at the *procedures without connections* and *procedures with connections* levels of cognitive demand. Out of 104 linear assessment items analyzed, 52 items were classified as *procedures without connections* and 52 items were classified as *procedures with connections*; 50% for both. These results indicate that while half of the linear assessment items are algorithmic and do not require students to demonstrate mathematical understanding, the other half of linear assessment items use multiple representations and require students to “engage with the conceptual ideas that underlie the procedures in order to successfully complete the task,” (Stein, Smith, Henningsen, Silver, 2000).

For the 7th grade McGraw-Hill textbooks, 148 linear tasks were analyzed and 56% (83 tasks) were found to be at the *procedures with connections* level of cognitive demand. As stated above, tasks at this level have students use procedures. But the goal of these procedures is to expand students’ mathematical knowledge and promote a more in depth understanding. These tasks may suggest a path for students to follow that is broad and has a close connection to underlying conceptual ideas. Further, tasks at the *procedures with connections* level of *cognitive demand* use multiple representations to help students make connections and develop meaning.

In the 8th grade McGraw-Hill textbook, 242 linear equation, function, and inequality tasks were identified and analyzed. Of these 242 tasks, 129 (53%) were found to be at the *procedures with connections* level. Similarly, to the 7th grade textbook task analysis, tasks at this level have students use procedures but they are not explicitly stated. They use multiple representations such as graphs, tables, equations, manipulatives, and problem situations to help promote student understanding of mathematical concepts.

The Algebra 1 McGraw-Hill textbook contained 855 linear equation, function, and inequality tasks. Of these 855 tasks, 446 (52%) were classified as *procedures without connections* cognitive level of cognitive demand. All of these tasks are algorithmic, and the use of a specific procedure is explicitly stated or evident based on prior instruction, experience, or placement of the task (i.e. immediately following a similar worked out example). These tasks do not require a substantial amount of *cognitive demand* for students to complete successfully; very little confusion about what needs to be done and how to do it. There is no connection to the underlying concepts, are focused on producing correct answers, and require no explanations (or the explanations focus only on describing the procedure used).

Research Question 3 asked about the level of alignment between the *cognitive demand* of the intended mathematics curriculum of the McGraw-Hill textbook tasks and the items on the STAAR Mathematics Assessment for 7th, 8th, and Algebra 1 pertaining to linear equations, functions, and inequalities. To fully analyze the level of alignment between the textbook tasks and STAAR Assessment items, the level of *cognitive demand* was determined for each linear sub topic (equations, functions, inequalities) for each grade level (7th, 8th, Algebra 1) for the textbooks and STAAR Assessments. Then, using the *Depth-of-Knowledge Consistency* criteria from Webb's Alignment Tool, the level of alignment was calculated for each linear subtopic (equations, functions, inequalities).

All of these results indicated that for 7th grade linear equations, the curriculum and the STAAR Assessment had a weak level of alignment because 43.5% of the assessment items were at the same level of *cognitive demand* as the intended curricular. But linear functions for 7th grade were properly aligned because 100% of the assessment items for 7th grade linear functions were categorized at the same level or higher of *cognitive demand* as the textbook tasks. Because the 7th grade curriculum and assessment did not contain any linear inequality tasks or items, there was no level of alignment to be determined. For 8th grade linear equations and functions, the curricular tasks and STAAR Assessment items were properly aligned, meaning 50% or more of the STAAR Assessment items were categorized at the same level of *cognitive demand* as the curricular tasks. But the linear inequalities were poorly aligned because the STAAR Assessment contains linear inequality items while the textbook does not. Therefore, the percentage of items at the same or higher level of *cognitive demand* could was 0%. The Algebra 1 linear equations, function, and inequality curricular tasks and the corresponding STAAR Assessment items were all properly aligned because at least 50% of the assessment items are at the same or higher level of *cognitive demand* as the textbook tasks.

Discussion of the Results in Relation to the Extant Literature

In 2016, Dogbey and Dogbey examined the Core Mathematics Assessment of the West African Senior School Certificate Examination (WASSCE) in terms of Depth of Knowledge and Context Characteristics. They found that 80% of the items either asked the students to recall facts or perform a straightforward routine procedure. Similarly, in this study, the linear equation, function, and inequality Mc-Graw Hill Education curricular tasks mainly asked students to recall information or perform a procedure; 95% of items in the 7th grade textbook, 98% in the 8th grade textbook, and 93% in the Algebra 1 textbook. In the STAAR Assessments analyzed, all the items asked students to perform a procedure.

In 2000, the American Association for the Advancement of Science, analyzed the alignment between instruction and selected learning goals (benchmarks). Of the thirteen textbook series analyzed, only four addressed four or more benchmarks. There was no textbook series that addressed all benchmarks. Similarly, in this study, the Mc-Graw Hill textbook series analyzed did not supply a well-balanced blend of tasks at the different levels of *cognitive demand* for any of the three grades levels in relation to linear equations, functions, and inequalities. As stated above, 93% or more of the linear equation, function, or inequality curricular tasks required students to recall facts or perform a procedure.

Based on the findings of this study, I believe that although the Mc-Graw Hill textbooks are not all properly aligned for linear equations, functions, and inequalities, they do an acceptable job preparing students for the STAAR Assessment; mainly because the STAAR Assessment does not contain any items at the *doing mathematics* level of cognitive demand.

But I do not believe that the curricular tasks nor the STAAR Assessment items do a satisfactory job in preparing students for further studies that require a mathematical background or thinking. The lack of curricular tasks at the highest level of *cognitive demand* makes it so that students can memorize procedures and pass the course. These low-level tasks do not require students to understand the nature of mathematical concepts, processes, or relationships. Even if teachers supplement the instructional material (textbook) and provide students with the opportunity to demonstrate their mathematical understanding, there are so many different standards and objectives required by the state for teachers to cover in a set period of time. This does not leave much time for the high-level *cognitive demand* tasks that take longer to complete and understand than the more procedural tasks. In addition, the administration dates for the STAAR Assessment cut back on the amount of time teachers have with students in the classroom to facilitate the development of deeper mathematical understanding. There is also an immense amount of pressure for students to pass the STAAR Assessment and for teachers to have students perform well on the STAAR Assessment. The lack of time and amount of pressure combined does not provide a suitable environment for students to reach and develop a deeper mathematical understanding which often leads to a dislike for the study of mathematics.

Implications of the Results

Looking at the data, for nearly all of the linear sub-topics taught in 7^{th}, 8^{th}, and Algebra 1, the alignment suggests that students who are in a classroom that uses this textbook will be prepared for the STAAR Assessment at the end of the school year. While students may be prepared for the STAAR Assessment, this does not necessarily mean they understand the material taught in class or how to apply this knowledge to other STEM subjects. The textbook alone does not provide enough tasks at the *doing mathematics* level of cognitive demand. Tasks at this level 'require students to explore and understand the nature of mathematical concepts, processes, or relationships," (Stein, Smith, Henningsen, Silver, 2000). These tasks also require students to access relevant prior knowledge or experiences and make proper use of them as well as actively analyzing the task at hand. When students are presented with tasks at this level, the mathematical concepts used in these tasks are committed to memory because they are understood and not just memorized.

Recommendations for Instruction

Based on the findings of this study, the McGraw-Hill mathematics textbooks for 7^{th}, 8^{th}, and Algebra 1 do a decent job aligning the *cognitive demand* with the linear equation, function, and inequality topics on the corresponding STAAR Assessments. With this being said, the McGraw-Hill textbooks do not have a balanced number of tasks for the four different levels of cognitive demand. Many of the textbook tasks fall into the *procedures without connections* or the *procedures with connections* levels of cognitive demand. Because these are textbook tasks, the amount of time students have to work on them is not fixed or finite. Teachers can have students spend a few days working on a textbook task if it is at the *doing mathematics* level of cognitive demand. This cannot be done with tasks at the three other levels of cognitive demand; they are much more straight forward and do not require as much time or cognitive effort from the student. It should also be noted that most teachers do not solely use the textbook in their classrooms. The textbook is sometimes used as a pacing guide, as a place for teachers to gain inspiration or examples, or as a remediation tool. Many teachers supplement the textbook in their classrooms, modify the textbook content to fit their classroom needs, or entirely create their own content for their classroom. On that premise, teachers must remember that the textbook is not going to contain a complete, and well-balanced curriculum. Teachers must remember to provide students with lots of opportunities to demonstrate different levels of mathematical understanding because that is the way students will become proficient in and develop a deeper understanding of mathematics.

Recommendations for Curriculum Development

After conducting this study and getting a closer look at the levels of *cognitive demand* of the STAAR Assessment as well as a sample curriculum (McGraw-Hill textbooks), I feel that the curriculum does not challenge the students enough nor does it provide students with enough opportunities to fully understand the mathematics content being taught in class. For each textbook analyzed, there were less than 10% of the linear equation, function, and inequality tasks at the *doing mathematics* level of cognitive demand. Tasks at this level do not have a "predictable and well-rehearsed approach explicitly suggested by the task" (Stein, Smith, Henningsen, Silver, 2000). *Doing mathematics* tasks require students to explore and understand mathematical concepts and relationships as well as self-monitor their own cognitive processes. These tasks also require students to analyze and identify possible limitations to a solution and access relevant knowledge and experiences. These are the type of tasks that provide students with deeper mathematical meaning and connect the mathematical concepts to other areas of study and life.

When students are not provided with enough opportunities to show their mathematical understanding, and are not presented with tasks that challenge them, they quickly lose interest and begin to shut down in the classroom. This happens when the classroom teacher has students working problems from the textbook, a worksheet, or workbook day after day. Unfortunately, this is the reality for many mathematics classrooms across the state. For the amount of time teachers get to spend with students each day, and the amount of time teachers have to teach all of the required TEKS (Texas Essential Knowledge and Skills), it is not enough time to implement several *doing mathematics* tasks for each concept taught. This forces teachers to rely on *memorization, procedures without connections,* and *procedures with connections* tasks in the hopes that students will fully understand the taught mathematical concepts. The result is that students learn procedures, algorithms, and steps as opposed to developing true mathematical meaning that can be applied at a later date.

Teachers and school district curriculum developers should meet throughout the school year and figure out ways to implement more chances for students to demonstrate true understanding of the mathematical content that is different from the typical notes, classwork, homework, test, and standardized test protocol.

Recommendations for Assessment

The STAAR Assessment is based on the Texas Essential Knowledge and Skills (TEKS), which are the Texas State Standards, and not a textbook. Therefore, it would have made more sense for this study to compare the TEKS to the STAAR Assessment. But the TEKS are only objectives and do not contain any tasks or items and thus the level of *cognitive demand* of the STAAR Assessment items could not be compared to the TEKS. The STAAR Assessment is intended to be a cumulative, high-stakes standardized exam that students take towards the end of a school year to demonstrate understanding of the TEKS taught that school year. Because the STAAR Assessments goal is to measure student understanding, the STAAR Assessment should contain more items at the *procedures with connections* level of cognitive demand. Assessment items at this level require more cognitive effort than the two lower level cognitive demands.

Procedures with connections items also make use of multiple representations to help assess meaning and also require students to engage with the concepts in order to complete the item correctly. Assessment items at this level will provide teachers, administrators, schools, and TEA (Texas Education Agency) officials with better data; data that shows whether or not a student understood the material presented and assessed that year.

Recommendations for Future Studies

I only used one textbook by one publisher. If another researcher were to conduct this study at a later date, they could look at more textbooks. They would need to look at different textbook publishers as well as multiple textbooks for the same grade level. This would allow the researcher to find the level of alignment between different textbooks and the STAAR Assessment, but also find the textbook which is most aligned and had the largest variation of *cognitive demand* among its textbook tasks.

Another recommendation for future researchers is to look at all mathematics topics studied in a particular grade level. Because this study only looked at linear equations, functions, and inequalities, there were potentially some levels of *cognitive demand* that may have been excluded from the study among the textbook tasks or the assessment items. Also, analyzing the *cognitive demand* of all tasks for a given textbook or all items on a particular STAAR Assessment would give a more comprehensive analysis of the overall *cognitive demand* level of the textbook or exam. The *cognitive demand* level would still need to be broken down by topic in order for the alignment to be determined. But looking at all topics would allow the researcher to compare the cognitive level among topics and determine which topics are commonly assessed at a higher level of *cognitive demand* which are commonly assessed at a lower level.

If a researcher wanted to compare the TEKS to the STAAR Assessment, they could first select several years of a STAAR Assessment. They could then determine the TEKS assessed by that particular assessment item as well as the level of *cognitive demand* for that item. The researcher would then be able to see which TEKS are assessed more often than others as well as which TEKS are more frequently assessed at a higher level of *cognitive demand* and which are more frequently assessed at a lower level of cognitive demand. The only problem with this approach is that the researcher is not likely to find any assessment items at the highest level of cognitive demand, *doing mathematics*. Items at this level require complex, non-algorithmic thinking and a larger amount of time than a high-stakes standardized test can allow.

Limitations

There were a few limitations found in this study. One limitation is that only one textbook was used for each grade level. For a more comprehensive study, more textbooks for each grade level would need to be analyzed as well as textbooks from different publishers. This was not a possibility with the given timeline of this study.

Another limitation of the study was that only one task analysis tool was used. The use of a few different task analysis tools may have increased the validity of the results. But due to the time and scope of this study, this was not possible.

There were also no interviews conducted for this study with either educators, textbook publishers, or TEA STAAR Assessment creators. If this study were able to interview educators, educators could have given their input on whether they felt the textbook was comprehensive, if they felt the textbook was insufficient, or if they used a textbook in their classrooms at all. Educators could have also been interviewed on whether or not they supplemented any textbook material in their classrooms. The interviewer could have also asked teachers if they used any supplemental material, what they specifically used, and for which topics they used supplemental material for.

One more limitation of this study is that only linear equations, functions, and inequalities were examined. A more comprehensive study would have included textbook tasks and assessment items from multiple mathematics topics studied for a give grade level. This might have shown a wider variety of levels of *cognitive demand* in both the textbook and the STAAR Assessment. If the researcher were to examine multiple or all topics studied in a given grade level mathematics class, only one grade level would be used for the study. This is because the topics studied vary from grade level to grade level, especially in grades 9-12.

Summary and Conclusion

This study was designed to examine the level of *cognitive demand* of the textbook tasks from McGraw-Hill and the assessment items of the STAAR Exam for 7^{th}, 8^{th}, and Algebra 1 for linear equations, functions, and inequalities. Once each textbook task and assessment item was analyzed and the levels of *cognitive demand* determined, the level of alignment between the two for each grade level and linear subtopic was concluded using the *Depth-of-Knowledge* criteria from Webb's Alignment Tool.

The 7^{th} and 8^{th} grade Texas Edition McGraw-Hill textbooks chosen for this study were copyrighted in 2015 and the Algebra 1 Texas Edition McGraw-Hill textbook was copyrighted in 2016. These textbooks were chosen because of their "alignment" with the Texas State Standards (TEKS) as well as their inclusion of linear equations, functions, inequalities textbook tasks. Linear equations, functions, and inequalities were chosen as the topics to study because of their continuation in mathematics courses from 7^{th} grade to 8^{th} grade to Algebra 1. Linear topics are the only mathematics topics that are consistently taught and tested in the three mathematics levels mentioned above.

The design decisions for this study were influenced by the research literature and the researchers own classroom experience. The research literature states that textbooks are a key factor in the determination of content taught in classrooms. Textbooks are used most often to help teachers with planning, pacing, lesson content, and task selection. This material is the material students are given the opportunity to learn and the material chosen for classroom assessments. In conjunction, passing the Algebra 1 STAAR Assessment is a graduation requirement for all students and the students' scores are also a large part of a schools rating and funding. Many teachers are expected to have a very high percentage of students pass the STAAR Exam. Because of the pressure placed on students, teachers, and schools, this study this study decided to look at the degree of alignment between what is taught in classrooms (textbook tasks) and the STAAR Exam (assessment items).

Overall, this study found that the chosen McGraw-Hill Textbook tasks did an acceptable job aligning with the STAAR Assessment items for linear equations, functions, and inequalities. Educators must keep in mind that this study only examined the linear content in this textbook series and on the STAAR Assessment. The remaining content may not be as well aligned as the linear topics were.

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