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The Comparison of the School District Curriculum Alignment with Algebra Content Standards

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THE COMPARISON OF THE SCHOOL DISTRICT CURRICULUM ALIGNMENT WITH ALGEBRA CONTENT STANDARDS

by

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ABSTRACT

The purpose of this study was to analyze school district curriculum alignment with state and national standards to find content omissions that may contribute to low Algebra End-of-Course exam scores in ninth grade. The study primarily looked for algebra course content omissions in the algebra, functions, and statistics' domains of the algebra curriculum. These three categories were chosen because low achievement for ninth grades students was recorded in each category for a Medium Sized Rural School District. The study also examined the pre-algebra curriculum for a Medium Sized Rural School District to see if alignment was present with the algebra curriculum. Embedded skills needed for algebra success were also recorded to develop an in-depth look at the curriculum alignment. The embedded skills are skills that should be mastered before students are placed in the pre-algebra course.

The algebra state standards were compared with the Medium Sized Rural School District local algebra standards. From the local standards, 95 algebra coded skills were established as pertinent for mastery of algebra content. The 95 algebra coded skills were used in the constant comparison document analysis to find content omissions in the algebra curriculum, the pre-algebra curriculum, and the algebra textbook. The 95 algebra coded skills were also examined individually to record embedded skills needed for mastery of each skill. An additional study was performed on the amount of time given to the mastery of the 95 algebra coded skills or performance tasks.

The following results were found in this research for curriculum alignment. In a Medium Size Rural School District, the algebra curriculum and algebra textbook were analyzed for the presence of 95 essential performance tasks in search for missing content. The algebra curriculum and algebra textbook were both found to be aligned with the algebra state standards. These findings allow educators to look at other factors that may contribute to low performance on the Algebra End-of-Course exam. Content omissions were found in the pre-algebra curriculum that show a lack of alignment with the algebra course. Also, 77 embedded skills were recorded as prerequisites to algebra mastery. Last, the amount of material to be mastered in a ninth grade algebra course may be too numerous for ninth grade algebra students to master the material.

I would like to dedicate this research paper to my husband, John Lipscomb. He has stood by me through the entire doctoral process while taking a back seat to many hours of study, stacks of papers and books throughout the house, and my focused attention on research. He is truly the love of my life.

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CHAPTER 1: INTRODUCTION

Florida educators are in the midst of aligning their new standards with Common Core standards. Common Core standards have been adopted by many other states. Florida's version of the Common Core Mathematics Standards are referred to as Florida Mathematic Standards (O'Connor, 2016, para. 7). The purpose of the Florida Mathematic Standards is to increase rigor in the classroom, standardize course curriculum, and prepare students for college and/or a career (Council of Chief State, 2016a, para. 6).

Although the Florida Standards are an attempt to address the achievement of all students, an achievement gap between White students and minority students persists. Particularly, this achievement gap can be seen across many states in mathematics. According to the National Assessment of Educational Progress (NAEP), White students outperform minority students in both reading and mathematics (Vanneman, Hamilton, Anderson, & Rahman, 2009, p. iv). The achievement gap has stayed consistent between Black and White students. White eighth grade students scored 40 points higher in mathematics testing for years but saw a decrease of the gap to 31 points in 2007 (Vanneman et al., 2009, p. 7). The gap between White students and Hispanic students also can be seen in the NAEP report (Hemphill, Vanneman, & Rahman, 2011). The NAEP report shows that there is a continual achievement gap between the two groups in mathematics. Fourth graders have a 19-26 point difference between Hispanic and White students regardless of gender while eighth graders showed a 24-31 point difference (Hemphill et al., 2011, pp. 11-13).

There is a growing focus in the nation for an increase in mathematical ability causing an emphasis on educational reform in American science, technology, engineering, and mathematics (STEM) instruction (You, 2013, p. 64). A U.S. Government report stated that STEM majors are "crucial to national innovation, competitiveness, and well-being and in which not enough students' complete degrees" (as cited in Shapiro & Sax, 2011, p. 5). Even with the emphasis on STEM courses, many students do not pursue majors in STEM fields (Shapiro & Sax, 2011, p. 5). In 2009, only 24% of college freshmen were interested in STEM fields of study and 50% of STEM majors eventually switched to other degree programs (Shapiro & Sax, 2011, p. 5). There is a major concern that American schools are not adequately preparing students to enter college and the global market in STEM careers. Gallagher, Goodyear, Brewer, and Rueda, (2012) note,

> In addition, the dynamic effects of global developments in science and technology are changing the way we work. They call for new and different skills than were required of workers a few years ago. Each of these concerns, and many others, have serious and predictable consequences for our urban communities and the schools, higher education institutions, service providers, and businesses within them. (p. 86)

There are many benefits for students to take rigorous and advanced mathematics and science courses. Higher level thinking skills are associated with STEM courses. According to Hattie (2009), "[new science] programs typically emphasized analytical and process skills, integrated laboratory activities as an integral part of class routine, and higher cognitive skills and appreciation of science" (p. 147). Students who take more rigorous mathematics courses increase college admission and college academic success (You, 2013, p. 65). To close the achievement gap, minority students need to be exposed to higher level STEM courses. For students to advance to higher mathematic courses, they must be successful in Algebra 1 before tenth grade (You, 2013, p. 79). If Algebra 1 is critical, then one area of concern is the number of students who cannot pass the Algebra End of Course exam in ninth grade.

The importance of algebra to a student's future success explains why algebra curriculum alignment is necessary. Anderson (2002) gives four reasons for advocating for curriculum alignment. The author states that curriculum alignment leads to equity in the educational experience, helps educators understand the results of schooling on student outcomes, improves instruction, and requires accountability (Anderson, 2002, p. 259).

If curriculum alignment is important, it is necessary to understand what aligning curriculum means. Leitzel and Vogler (1994) explain that "curriculum alignment is the conscious congruence of three educational elements: curriculum, instruction, and assessment" (p. 1). They continue to say that test questions on a summative assessment should match the instruction material when curriculum alignment is present (Leitzel & Vogler, 1994, p. 1). Anderson (2002) adds that there must be a strong relationship among lesson objectives, instructional practices, and test items (p. 257). Lesson objectives and test items will be examined in this study through analysis of the state algebra standards.

Problem Statement

Because the Florida algebra curriculum standards were new in the 2014-15 school year, this researcher found limited research concerning algebra curriculum alignment relating to the new content standards. The problem to be studied was content omissions in the school district algebra curriculum which may have led to knowledge voids in mathematics for some students. Algebra content omissions may have been either directly missing or embedded skills that were not fully developed in the curriculum alignment. Algebra knowledge gaps could negatively impact a student's future since students are required to pass an Algebra End of Course exam (EOC), in order to graduate from a public high school in Florida. The state's pass rate for the Algebra EOC, for first time test takers in the ninth grade, was 52% under the old standards (FLDOE, 2014). The Algebra EOC is a high stakes test that has vast consequences for students who are unable to pass the exam or an equivalent exam. This researcher wanted to examine if missing algebra content contributed to the 48% of ninth grade students statewide who were unable to pass the Algebra EOC.

Purpose Statement

The purpose of this study was to analyze school district curriculum alignment with state and national standards to find content omissions that may contribute to low Algebra End of Course (EOC) exam scores in ninth grade. The ninth grade algebra curriculum, eighth grade pre-algebra curriculum, and algebra textbook for a Medium Size Rural School District will be examined for missing content that may lead to knowledge voids affecting mastery of the algebra course. If there were content omissions in the curriculum, the necessary skills could be added to the curriculum to increase student performance.

The Significance

The significance of this study was exposure to areas of concern regarding components of the school district algebra curriculum which may lead to knowledge voids and diminished achievement for ninth grade algebra students. These knowledge voids may ultimately effect Algebra EOC outcomes. If knowledge voids were recognized in the curriculum content, they could be addressed through the scope and sequence of the curriculum for algebra and pre-algebra classes. Also, if the embedded skills or pre-requisite skills were known, those skills could be addressed in early mathematics or in the pre-algebra course. Furthermore, once low performing algebra domains were identified, school-wide initiatives and teacher pedagogy could be examined in the future to further address those content and student performance voids. With students and teachers being held accountable, through high stakes testing, it makes sense that curriculum should be aligned with the standards on which the high stakes testing is based.

Definition of Terms

For this study, educational terms will be defined to give clarity to the research questions and study design. These definitions are accepted as education language relating to educational curriculum.

Algebra: The first mathematics course required for high school graduation in the state of Florida (Florida Statutes, 2015). The course is strictly algebra based and no substitution courses are allowed. Successfully completing Algebra 1 in or before ninth grade is critical for reaching other higher mathematic courses (You, 2013, p. 79).

Chunking of material/curriculum: The breakdown of a lesson into small amounts of information so students can learn at their own ability level (LeMire, Melby, Haskins, & Williams, 2012, p. 67).

Codes. Codes are based on the deconstructed local algebra standards for a Medium Size Rural School District (2015b). The local standards will be coded into subthemes, also known as “metacoding” (Bernard & Ryan, 2010, p. 66), according to the skill students are expected to perform. The codes represent the difference performance skills that algebra students should be able to perform once they master the concept in the algebra course.

Table 1

Codes for Local Algebra Standards

Code	Definition
ANA-DATA	Analyze data and statistics
ANA-FUNC	Analyze functions-linear and nonlinear
APP-OPER	Apply operations to polynomials and functions
CAL-DATA	Calculate statistics including frequencies
CC-DATA	Compare or contrast data and statistics
CC-FUNC	Compare and contrast functions including transformed functions and characteristics of functions
CC-PARTS	Compare or contrast parts of a functions such as domain and range
CHO-METH	Choose method for solving or for analyzing statistical data
CLA-EXPR	Classify expressions
COB-FUNC	Combine functions
COM-FUNC	Compose functions
CON-ARGU	Construct an argument
CRE-EQUA	Create equations-linear and nonlinear
CRE-EQUA-2	Create a system of equations
CRE-FUNC	Create functions including real world situations
CRE-INEQ	Create inequalities
DEF-CLOS	Define closure
DEF-DATA	Define characteristics of statistical data
DEF-FUNC	Define functions
DEF-GRAP	Define key features of graphs
DEF-PART	Define or determine parts of an expression, equations, or functions
DEF-QUAN	Define are explain quantities
DEF-RECU	Define the recursive process
DER-FORM	Derive a formula
DES-DATA	Describe data including outliers
DES-RELA	Describe/determine the relationship
DET-EQUA	Determine when to use an equation
DET-FUNC	Determine if relation is a function
DET-INEQ	Determine when to use an inequality
DET-SOLU	Determine solutions of an equation
DET-STEP	Determine steps for problem solving
EVA-FUNC	Evaluate functions-linear and nonlinear
EXP-FUNC	Explain or describe functions and characteristics of functions. Apply explanation to linear and nonlinear functions
EXP-QUAD	Explain parts and forms of quadratic expressions
EXP-PROP-E	Explain properties of quantities in exponential expressions
EXP-PROP-Q	Explain properties of quantities in quadratic expressions
EXP-SOLU	Explain solutions including complex solutions
EXP-STEP	Explain steps in problem solving
FAC-EQUA	Factor a quadratic equation or quadratic expression

Code	Definition
FAC-POLY	Factor polynomials and/or functions
FOR-TABL	Form and interpret tables including coordinate and frequency tables
GRA-COOR	Graph or recognize coordinates
GRA-EQUA	Graph equations
GRA-FUNC	Graph a functions or polynomials. Apply to linear and nonlinear functions
GRA-INEQ	Graph inequalities including systems
GRO-DECA	Classify and solve growth and decay problems
IDE-FORM	Identify equivalent forms of functions
IDE-FUNC	Identify types of functions
IDE-OPER	Identify operations
IDE-PART	Identify parts of functions including domain and range and parts of graphs. Apply to linear and nonlinear functions.
IDE-PROP	Identify properties of equality, exponents, and/or polynomials
IDE-QUAN	Identify, define, or determine quantities
IDE-SOLU-I	Identify graphical and numerical solutions to inequalities. Identify characteristics of the graphs and number lines
IDE-STRU	Identify structures of an expression
IDE-ZERO	Identify zeros of a polynomial
INT-DATA	Interpret data sets
INT-EXPR	Interpret expressions in terms of a context
INT-FUNC	Interpret functions including real world situations
INT-GRAP	Interpret graphs and key characteristics of graphs or tables
INT-PART	Interpret parts of an expression, an equation, or a function
INT-SLOP	Interpret slope and key characteristics of slope
INT-SOLU	Interpret solutions
JUS-METH	Justify method
JUS-QUAN	Justify quantities
JUS-SOLU	Justify solutions
JUS-STEP	Justify steps or process
LAB-GRAP	Label graphs
MOD-DATA	Model data
MOD-FUNC	Model functions
MOD-RELA	Model relationship including real world situations.
PRO-EXPR-E	Produce equivalent forms of exponential expressions
PRO-EXPR-Q	Produce equivalent forms of quadratic expressions
PRV-FUNC	Prove characteristics of functions
REA-EQUA	Rearrange equations or formulas
REC-CONS	Recognize constraints
REC-DATA	Recognize statistical data including frequencies
REC-EXPR-	Recognize forms of an expression
REC-FUNC	Recognize all types of functions and function notation
REC-GRAP	Recognize graphical representations and key features
REC-PART	Recognize parts of an expression, equation, or function
REC-SEQU	Recognize that sequences are functions
REC-SLOP	Recognize slope
REP-CONS	Represent constraints by equations and inequalities

Code	Definition
REP-DATA	Represent data
REW-EXPR	Rewrite expressions
SOL-EQUA	Solve equations including systems of equations. Apply to linear and nonlinear equations. Applies to any method of solving equations.
SOL-FUNC	Solve functions. Apply to linear and nonlinear functions.
SOL-INEQ	Solve linear inequalities or system of inequalities
SOL-SLOP	Solve problems with slope
SUM-DATA	Summarize statistical data
TRA-EXPR-E	Transform exponential functions
TRA-FUNC	Transform a function,-symbolic or graphical. Include recognizing shifts. Apply to linear and nonlinear functions
USE-PROP	Use properties of equality
USE-TECH	Use technology
WRI-FUNC	Write functions. Includes function notation. Apply to linear and nonlinear functions.

Content analysis: The examination of algebra material to identify missing items (Leedy & Ormrod, 2005, p. 142).

Curriculum: The chosen content and lessons that will be covered in a course. Curriculum will be selected by the school district based on Florida state standards (FSU, 2015a). Curriculum and standards guide the development of programs which outline what material should be taught in the classroom (Cordeiro & Cunningham, 2013, p. 300).

Curriculum Alignment: Alignment is the layering or sequence of content within a course (Goodlad & Su, 1992, p.. 330). Alignment is also the layering of content from course to course so that students leave a prerequisite course ready for the next course offering (Case & Zucker, 2008, p. 4). For alignment to be present, there must be a strong relationship between lesson objectives, instructional practices, and test items (Anderson, 2002, p. 257).

Curriculum Map/Blueprint: Posner (1992) describes the written curriculum as "scope and sequence charts, syllabi, curriculum guides, course outlines, and lists of objectives" (p. 10). Curriculum maps should be updated often as they contain the layout of curriculum by school district leaders to guide instructors on the content, scope, and sequence of a course (Palandra, 2010, p. 227).

Embedded Skills: Knowledge that is expected to be known from previous courses and used in a current course. These are pre-requisite skills that are needed to be successful in the course. According to Hale and Dunlap Jr. (2010), the progression of curriculum must be planned with consideration of the skills that have been taught in the earlier years leading to that course (p.5).

End of Course (EOC) exams: For this study an EOC exam refers to a state exam given at the end of a course to measure mastery of content. The Florida Algebra EOC exam is currently prepared by the American Institute of Research, also known as AIR. The Algebra EOC exam is one of the Florida Standards Assessments, also known as FSA, that students are required to complete (Florida Standards Assessment, 2016). Ninth grade data for the Algebra EOC exam will be used in this research and compared with the eighth grade scores for a Medium Sized Rural School District.

Horizontal Alignment: The order that the content should be presented to maximize learning in a course (Goodlad & Su, 1992, p.. 330).

Knowledge Voids: Deficiencies in skills that causes difficulty in new course content. When students are missing important concepts from the required standards, curriculum alignment can help schools recognize the need for remediation and allocate resources more effectively (Squire, 2009, p.7).

Local Standards. Local standards or power standards are skills identified by educators as the most critical to the course (Crawford, 2012, p. 13). In this study the local standards are the skills that the Medium Sized Rural School District has determined critical for the algebra course. The researcher will see if the local algebra standards match the state algebra standards, the pre-algebra state standards, and the adopted algebra textbook.

Medium Size Rural School District: A Florida School District with approximately 41,000 students and eight high schools (2015d)

Pedagogy: The teaching methods and best practices used to teach content to students. According to Hattie (2009), effective teachers use effective strategies, have high expectations, and positive relationships in the classroom (p. 126).

Scaffolding: The layering of new knowledge so it builds on previous concepts. According to Culatta (2015b), "Curriculum should be organized in a spiral manner so that the student continually builds upon what they have already learned" (para 2).

Scope. The depth of the course curriculum including the transfer of knowledge to diverse situations. Many schools require teachers to write measureable objectives and leaning goals based on the scope of the content (Case & Zucker, 2008). Hattie (2009) says that goals inform students of learning expectations so that students can self-evaluate (p. 164).

Sequence: The order that content should be presented to the students to increase student achievement (Crawford, 2012, p. 34).

Standards: State approved curriculum that explicates the knowledge that should be gained through a course. For the 2014-15 school year, Florida adopted new Florida Mathematic Standards which align with Common Core (Florida State, 2015a).

Vertical Alignment: The sequence of the content of course based on previous course content so that the new material builds on prior material (Posner, 1992, p. 127).

Research Questions

This study addressed the algebra Common Core standards for the state of Florida, referred to as the Florida Mathematics Standards. The research questions were:

1. Which algebra domains have the lowest student performance based on the ninth grade Algebra EOC exam (2015)?
2. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district algebra curriculum that may contribute to the low scores on those standards?
3. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district pre-algebra curriculum that should align with those algebra standards?
4. Based on document analysis and expert opinion, what are the knowledge skills embedded in the algebra curriculum that if missing, will contribute to below proficiency on the Florida algebra state standards?
5. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the missing content standards and skills, if any, in the adopted text book that should align with the district curriculum, state standards, and expert opinion?

Table 2

Research Questions and Data Sources

Number	Research Question	Data Source
1	Which algebra domains have the lowest student performance based on the ninth grade Algebra EOC exam?	Medium Sized Rural School District (2015e)
2	Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the algebra content omissions, if any, in the school district algebra curriculum that may contribute to the low scores on those standards?	Algebra Curriculum Blueprint (Medium Size Rural School District, 2015b)
3	Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district pre-algebra curriculum that should align with those algebra standards?	Pre-Algebra Curriculum Blueprint (Medium Size Rural School District, 2015c)
4	Based on document analysis and expert opinion, what are the knowledge skills embedded in the algebra curriculum that if missing, will contribute to below proficiency on the Florida algebra state standards?	Algebra Curriculum Blueprint and expert opinion (Medium Size Rural School District, 2015a)
5	Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the missing content standards and skills, if any, in the adopted text book that should align with the district curriculum, state standards, and expert opinion?	Algebra Curriculum Blueprint (Medium Size Rural School District, 2015b)

Assumptions

This research assumes the following:

1. The presence of content omissions in the curriculum for both pre-algebra and algebra courses will lead to lower scores on the Algebra EOC exam.
2. There are items in the curriculum that students are expected to know but have not had enough time to develop.
3. Low performing schools are missing key elements school-wide, in textbooks, and in classrooms that adds to low achievement.
4. Advanced students usually take algebra before ninth grade.

Limitations

The study has the following limitations:

1. This is the first year for the FSA Algebra EOC exam which means student scores were not available. Since the Algebra EOC scores were not available, a comparison between eighth and ninth grades performance in three separate domains must be used for research.
2. School districts change textbooks and instructional material through the textbook adoption process and therefore materials can change frequently. However, textbook content examination can assist with future textbook adoption expectations.
3. The textbook being examined was adopted before the New Florida Mathematic Standards were accepted for mathematical instruction. Even

though the content of the textbook is being assessed, the algebra textbook may not ask questions in the same style as assessed on the Florida Algebra EOC exam.

4. The academic background and experience of the teacher may limit the effect of implementation of the curriculum.
5. Students' attitudes towards mathematics will not be examined in this study even though their attitudes may contribute to low achievement.

Delimitations

The delimitations employed in this study were selected based on the desire to find reasons that some students perform at a lower ability on the algebra EOC than others. Therefore, the following delimitations were used:

1. In order to find curriculum based content omissions that contribute to lower algebra test scores, the researcher did not examine economic, behavioral, or other factors that can effect learning outcomes.
2. The researcher examined the algebra text books used by the Medium Sized Rural School District for 2015-2016.
3. Only algebra standards from reported categories were examined in the study even though there may be language arts standards tested on the Algebra EOC. Additionally, the Mathematical Practice Standards were not examined (Appendix D).

Conceptual Framework

Studying curriculum alignment and standards-based education requires a look at the background of learning theories and standards-based education. Focusing on learning theories shows the importance and common sense of aligning curriculum to state and national standards, if students are to perform well on state and national assessments that are based on those standards. The researcher introduced a brief synopsis of learning theories that have contributed to the scaffolding and chunking of material in education. Many learning theories have contributed to the post-modern alignment of educational curriculum in public schools. According to Bolles (1992), "the 1930s and 1940s are sometimes called the golden age of learning theory, that was when learning was the heart and soul of psychology" (p. 345).

In the early 1900s, the Russian psychologist, Lev Vygotsky, developed the theory called the "Zone of Proximal Development (ZPD)" making him one of the first contributors to Constructivism (Hannum, 2015c, para. 3). According to Hannum, the ZPD consists of a lower boundary where a student can work independently and an upper boundary where a student cannot perform a task, even with assistance (2015d, para. 7). Vygotsky believed that learning requires social outlets for children to develop concepts (Hannum, 2015d, para. 10). Students learn more when they work within their ZPD and have guidance from peers or an instructor before they start to process information individually (Culatta, 2015d; Hannum, 2015d; McLeod, 2014). According to McLeod (2014), ZPD is a precursor to learning independently because a child learns first with guidance then develops greater mental capabilities to learn on their own (para. 4).

Scaffolding of curriculum starts with guidance for new concepts until a student can perform skills independently and eventually transfer that knowledge to other problem sets.

Near the same time frame as Vygotsky, Jean Piaget also contributed to instructional learning theory through his genetic epistemology studies (Culatta, 2015c, para. 2). Piaget found that students organized knowledge into schemata that relate to the world around themselves, and this schemata can be built upon and applied to different situations (McLeod, 2015, para. 2, 6). Culatta (2015c) says that Piaget found that children either assimilate new learning with existing schema or they accommodate information with new schema (para 3). Instructional materials need to be presented to students in a manner that helps them increase the amount and intricacy of schemas (McLeod, 2015, para. 4). Building upon earlier schemas or prior knowledge is foundational in curriculum alignment.

In the middle of the twentieth century, David Ausubel would introduce Subsumption Theory (Culatta, 2015e) in his research about how children learn. Ausubel was interested in how students layered knowledge by building on prior knowledge (Culatta, 2015e, para. 1; Hannum, 2015a, para. 1). According to Hannum (2015a), Ausubel studied the acquisition of new knowledge which includes the integration of new information with older information so it becomes meaningful to the student (para 3). Ausubel also believed that advance organizers can connect new concepts with existing knowledge (Culatta, 2015e, para. 4). Bridging new concepts with prior knowledge is critical in curriculum alignment.

Jerome Bruner, a contemporary of Ausubel, influenced curriculum reform with his Constructive Theory and linked to Piaget's work (Hannum, 2015b, para. 1). Bruner's constructivist theory says that students learn through "enactive, iconic, and symbolic" depictions (Hannum, 2015b, para 2) which instruction should match. Bruner also believed that learning improves when new knowledge is built on prior concepts (Culatta, 2015b, para 1). Bruner was known for "spiral curriculum" which supported the notion that basic instructional ideas should be reexamined often so they can be built upon to increase knowledge (Culatta, 2015b, para 2; Smith, 2002, para 14).

Robert Gagne, a contemporary of Ausubel and Bruner, found that higher level learning was dependent on mastery of lower level skills (Hannum, 2015e, para. 5). Gagne emphasized the sequencing of instruction based on "learning hierarchies" that allow the instructor to identify the prerequisite skills that help the student learn (Culatta, 2015a, para 2; Hannum, 2015e, para. 6). Gagne believed instruction should be designed around events that engage the learner's senses as well as short-term and long-term memory (Hannum, 2015e, para 6). According to Culatta (2015a), the nine events were:

1. Gaining attention (reception),
2. Informing learners of the objective (expectancy),
3. Stimulating recall of prior learning (retrieval),
4. Presenting the stimulus (selective perception),
5. Providing learning guidance (semantic encoding),
6. Eliciting performance (responding),
7. Providing feedback (reinforcement),

8. Assessing performance (retrieval), and
9. Enhancing retention and transfer (generalization). (para. 3)

According to Bolles (1992), even though learning theory became essential to modern psychology, the emphasis has changed from the arguments of the classical learning theorists (p. 345). Even so, learning theorists contributed to curriculum alignment by showing that to gain an increase in knowledge, sequencing of material must build on prior knowledge. Curriculum alignment structures the scaffolding and chunking of material according to the student's grade level and the prior knowledge from previous courses. In 2009, state educational leaders formed the Common Core Standards because most states were autonomously scaffolding curriculum and independently deciding what students should know in each grade (Council of Chief State, 2016a, para. 3). According to the Common Core State Standards Initiative, 42 states were involved in adopting a common core (Council of Chief State, 2016a, para. 2). The standards were to increase the rigor of American schools and align with the rigor that President Obama's *The Race to the Top* (2009) initiative was promoting. Although the *No Child Left Behind Act (*NCLB; 2001) increased accountability and illuminated the need to close the achievement gap, it also was a one size fits all solution. Instead, the President wanted to give more control to the states to develop innovative programs that would increase rigor and close the achievement gap (President Obama, 2009).

One cause of knowledge gaps in student learning is that the expectations for each grade level were different for each state (Council of Chief State, 2015a, para. 3). Common Core addressed the need for uniformity across the states and across each grade level. One purpose of the Common Core Standards was to formalize what students should be able to do at each grade level so students could take new information and add it to prior knowledge from earlier years (Council of Chief State, 2015a, para. 2). Florida, along with other states, adopted new standards that aligned with Common Core to increase rigor, reveal grade-level expectations, and prepare students for college or career (Council of Chief State, 2015a, para. 6).

NCLB (2001) required accountability measures for assessing curriculum standards such as Common Core to prove that students were getting a quality education therefore reducing the achievement gap. The accountability method of NCLB (2001) brought much debate to education. Many educators believed that the mandated assessments hinder educational practices. Ravitch later says about NCLB (2001), "state education departments were drowning in new bureaucratic requirements, procedures, and routines, and that none of the prescribed remedies was making a difference" (2010, p. 99). However, the accountability tied to standards-based instruction caused many educators to use data analysis to focus instruction and track student progress along with focusing on mathematics and reading (Shepard, Hannaway, & Baker, 2009, p. 2).

According to Shepard, Hannaway, and Baker (2009), many people are confused on what standards-based education means for education (p. 1). The authors continued to say "content standards (subject-matter descriptions of what students should know and be able to do) are often confused with performance standards (which are more like passing scores on a test), and very different theories of action are used to explain how standards-based reforms are expected to work" (Shepard et al., 2009, p. 1). Supporters of standards-based education hoped to raise the level of classroom instruction but were not originally advocating for increased testing (Shepard et al., 2009, p. 1).

Understanding the alignment and chunking of curriculum is relevant today. According to the previous learning theories, the alignment of curriculum allows for students to build on prior knowledge and maximize the processing of material. This study will look at curriculum alignment as it relates to algebra content standards to find missing content which may lead to an interruption of the learning process.

Methodology

This study used a qualitative phenomenological design that required a document analysis of school district algebra curriculum documents to search for content omissions (Lunenburg & Irby, 2008, p. 94). A constant comparison methodology was used within the document analysis (Lunenburg & Irby, 2008, p. 94). The algebra curriculum that was analyzed was based on the Algebra EOC (2015) data provided to the Medium Sized Rural School District from the Florida Department of Education (FLDOE). Algebra EOC data allowed the researcher to identify the algebra content domains or standards with the lowest performance. Once those domains or standards were identified, the researcher examined school district curriculum documents that relate to the content standards to find content omissions.

Procedures

This study required a multi-level analysis that addressed the five research questions guiding the study. First, current school district algebra data provided by the FLDOE was examined to detect the domain or cluster of algebra standards in which students performed the lowest. Since the 2015 Algebra EOC scores were not available, students' scores on separate domains of the Algebra EOC exam were utilized. Second, current algebra curriculum documents from a Medium Size Rural School District (2015b) were analyzed using the constant comparison method to examine alignment of curriculum with tested standards for ninth grade algebra students. Third, current pre-algebra or eighth grade curriculum documents from a Medium Size Rural School District (2015c) were analyzed using the constant comparison method to examine alignment with ninth grade algebra curriculum. Fourth, current algebra curriculum documents from a Medium Size Rural School District (2015b) were analyzed using expert opinion to search for embedded skills in which algebra students should be proficient. Last, the Algebra text books adopted by a Medium Size Rural School District (2015b) were evaluated for content omissions based on analyzed algebra standards from the Algebra EOC data.

Organization of Study

This chapter included the purpose, significance, and conceptual framework behind the study of curriculum alignment between school district documents and Florida state standards. Chapter two includes a literature review concerning curriculum alignment and standards-based curriculum. The literature review will also include mathematics curriculum alignment, and more specifically algebra curriculum alignment. The methodology portion of the study is discussed in chapter three and includes an overview of the document analysis process using the constant comparison method. Chapter four includes the finding from the qualitative study of algebra curriculum alignment and chapter five contains a discussion of the findings.

CHAPTER 2: LITERATURE REVIEW

Introduction

Walk into any academic library and there are hundreds of books on curriculum. Many of these sources cover curriculum design, curriculum implementation, curriculum improvement, curriculum evaluation, and more. For the purpose of this study, the literature review will be confined to standards-based curriculum and curriculum alignment. Curriculum alignment includes both vertical and horizontal alignment along with curriculum mapping. Squires (2012) spoke about curriculum alignment in three areas: instruction, assessment, and the written curriculum and said that instruction must match up with the curriculum standards and assessments (p. 129). Because this study was a qualitative document analysis of curriculum documents, the literature review focused on the written curriculum and assessment and did not examine teacher instruction in the classroom. The literature review also discussed curriculum alignment in the subject of mathematics, algebra, and textbooks. The Florida Standards are aligned with Common Core (O'Connor, 2016, para. 7) and the terms are used interchangeably. The new Florida Mathematics Standards were implemented for algebra during the 2014-2015 school year. Because the Florida Mathematics Standards are new, the literature review had limited research in this area.

Standards-based Curriculum

Florida school districts aligned their curriculum with state standards forming the backbone of standards-based curriculum. Teachers, parents, and school district leaders supported state standards because they believed in high expectations for students and that uniformity in the classroom improved the focus of instruction (Goertz, 2010, p. 55). National standards raised several questions:

1. Are the standards rigorous enough?
2. What makes a standard "good?"
3. Who should develop the new standards?
4. Why should states implement the new standards?
5. How can low performing school districts be supported so that all students achieve? (Goertz, 2010, pp. 59-60)

The creation of national standards should not be confused with a national curriculum. Crawford (2012) reminded readers that the United States does not have a national curriculum but instead created Common Core standards or national performance standards to communicate what students should be able to do in a course of study (p. 7). Standards-based curriculum in itself does not address course content or classroom instruction but instead addressed the skills that students should be able to perform (Crawford, 2012, p. 8). The purpose of Common Core standards was to equalize the instruction in different classrooms. Even if equalization was present in the classroom, accountability had to be present also. Crawford (2012) further stated, "Teachers can teach the same content, but if the specific skills to be mastered are not identified and assessed, there is no guarantee of curriculum alignment" (p. 10). The identification of specific skills that students should know has also helped transient students. Students often move around and change schools making it necessary to have a common curriculum that allows different teachers to instruct the same skills (Palandra, 2010, p. 226). Common standards in standards-based education allowed for students to receive the same education regardless of the school they attend.

Schoenfeld (2015) said that the fact that so many states adopted Common Core standards in mathematics with the majority using two specific assessments, PARCC or SBAC, means that the United States is approaching a national curriculum as long as the assessments are used correctly (p. 192). The assessment of standards, once validated, could ensure that students were learning the full scope of a course. The assessments that measured Common Core standards must stay true to the standards that were being measured and not become watered down due to cost or scoring difficulties (Schoenfeld, 2015, p.192). The assessments should be the accountability piece of standards-based education that helps equalize education for all students.

Ten years after standards-based education began, Olson (2006) reported on the progress made by the states between 1992 and 2005 (p. 3). In the ten-year span, mathematic scores had risen while the achievement gap had gotten smaller (Olson, 2006, p. 3). Interestingly, the results were mixed because there was a positive correlation between mathematics and standards-based education, but not in reading (Olson, 2006, p. 3). Fourth grade NAEP scores had risen 18.5 points and up to 27.7 points for minority students which was encouraging for standards-based education (Olson, 2006, p. 4). The NAEP data showed that 41 states improved in fourth grade mathematics, while many improved in eighth grade mathematics as well (Olson, 2006, p. 4). Studies by Carnoy and Loeb (2002), Hanushek and Raymond (2004), and Bishop (2005), found that strong accountability systems that often surround standards-based education contributed to student achievement (as cited in Olson, 2006, p. 6). These findings supported the need for assessments and research on the alignment of those assessments.

School district administrators and their beliefs had an effect on the school districts' path to standard-based education (Vogel, 2010, p. 1). A study conducted by the Spencer Foundation examined the implementation of standards-based education in eight school districts (Vogel, 2010, p. 18). The first stage of standards-based education implementation required curriculum, textbooks, materials, and professional development to be aligned with the state standards. This stage could take two to four years to complete (Vogel, 2010, p. 43). According to Drake (2007),

> An effective standards-based approach adopted the following premises for both disciplinary and interdisciplinary work:
>
> 1. A design-down curriculum planning process is used.
> 2. The focus is on what students will do, not what the teacher will do.
> 3. Standards, teaching strategies, and assessment are aligned.
> 4. It is important to decide what students should know, do, and be.
> 5. The standards are observable and measureable.
> 6. The assessment of standards is embedded in instructional strategies.
> 7. Big Ideas and Big Understandings act as an umbrella for the content. They reappear in the curriculum at different levels and in different subjects (e. B., change, interdependence, conflict, objectivity, and causality).

8. Big Skills (complex performance skills) reappear year after year and across subject areas (e.g., literacy, problem solving, and technological skills).
9. The content is the vehicle to achieving the standards.
10. The teacher is free to teach in any style as long as the standards are met. (pp. 2-3)

After the state standards for a course were established, school leaders were to ensure that the instructional staff were able to communicate those standards. Educators had the important task of breaking down the standards into digestible bites so that all students could learn (Crawford, 2012, p. 12). Often this required the curriculum team to develop a cohesive curriculum that was in alignment with state standards. The state standards were usually broad while the school district curricula were more precise but matched up with the state standards (Squires, 2009, p. 5). The process of matching the curricula to the state standards required time. Crawford (2012) suggested that teams in charge of curriculum alignment should not throw away previous attempts of curriculum writing, but instead build on the alignment with state standards (p. 12). This study will examine current school district algebra curriculum documents for a Medium Size Rural School District (2015b) so educators can build a more complete curriculum if there are content omissions.

Standards and State Assessments

Curriculum Alignment Defined

Standards-based curriculum allowed educators to know which standards needed to be emphasized in a course. Once those standards were identified, the standards were aligned with the school district curriculum. According to English and Steffy (2001), curriculum alignment meant that instruction matched the test items and this often convinced the community that state assessments were an adequate measure of the written curriculum (pp. 14-15). Curriculum alignment happened when the course material and state assessment joined with the course material and curriculum layout (Drake, 2007, p. 4; English, 2000, p. 63; Squires, 2012, p. 129; Squires, 2009, p. 3). When a disconnection between the curriculum and state testing was present, problems occurred. Squires (2009) said that many of the popular curriculum designs did not address curriculum alignment (p. 4). The state assessment may reflect the subject area loosely, and may not match with the school district curriculum (English & Steffy, 2001, p. 15).

When curriculum does not align with state assessments, student achievement can suffer. Curriculum alignment helped to fix this problem by equalizing the playing field so that all students had a curriculum that matched the assessment (English, 2000, p. 6; English & Steffy, 2001, p. 26). Curriculum alignment was necessary for all students, but some populations received greater benefits. Curriculum alignment was essential for low performing students as they were shown to make more learning gains when the curriculum was aligned (Squires, 2012, p. 133). English and Steffy (2001) used a spelling test as an example, illustrating how students would be outraged at the negligence of the teacher if the weekly spelling test did not match the weekly word list (p. 28).

Concerning curriculum alignment, English and Steffy (2001) believed that part of the problem was the lack of a national curriculum (p. 30). The nation wanted to measure schools but had no way to do this when school had been “done” differently state to state.

As a result, norm-referenced, standardized tests were formed to determine how schools were performing with the curriculum that was utilized (English & Steffy, 2001, p. 31). Standardized tests covered “content domain” which meant they assessed items that were most likely to be covered in a course even sometimes with limited attention (English & Steffy, 2001, p. 32, 36). Curriculum writers must be cautious to not only be concerned with the tested content but the complete curriculum. Aligning the written curriculum with the standards and the state assessments assisted teachers in covering critical content in the classroom.

Assessments

Even with curriculum alignment, accountability needed to be present. Educational assessments have increased monumentally due to the need to provide more academic accountability and improve education (McGehee & Griffith, 2001, p. 137). Improved accountability had aimed at improving all parts of the educational system, including curriculum development and alignment. McGehee and Griffith (2001) said that the data collected from assessments were useful for pushing towards reforms in mathematics education, but only if they helped teacher instruction (p. 137). McGehee and Griffith (2001) were involved with aligning testing, curriculum, and instruction in many different states to improve student achievement (p. 137). In their research about assessment, McGehee and Griffith (2001) asked four questions,

1. What type of instruments are used?
2. How does the design of the test inform instructional practice?

3. How does dissemination of test information inform instructional practice?
4. Who is responsible or accountable for the results? (p. 137)

Not only did the researchers discuss the previous questions, but they also involved teachers in the alignment procedures during professional development courses (McGehee & Griffith, 2001, p. 138). State testing data could be valuable tools for mathematic educators if used correctly, especially since many tests were aligned with state standards and allowed teachers to see how well students performed in certain areas of the curriculum (McGehee & Griffith, 2001, p. 138). In support of their research, McGehee and Griffith (2001) said that curriculum alignment that included instruction and testing, test items released, and teacher contribution in the alignment development all had a positive influence on classroom instruction (p. 140). The authors warned that if the test coverage of standards was thin, the test scores would rise, but the quality of mathematics achievement would be lower so a well-constructed assessment was essential (McGehee & Griffith, 2001, p. 140). The assessment piece can be an important tool in the curriculum alignment process when used correctly.

Back Loading

Many times state testing forced the curriculum alignment process. A process for aligning curriculum with state testing is called "back loading" because it requires working backwards when designing curriculum (English, 2000, p. 5, 70). This study used the back loading process in that the tested content standards were examined first to see if current algebra curriculum documents aligned with the state standards for a

Medium-Sized Rural School District (2015b). Back loading could be a problem when state tests do not fully reflect the full course of study (English, 2000, p. 64). Because of the gaps in the actual assessment, the state assessment was not always an adequate measure of students' ability. According to Goertz (2010), "teachers, do not believe that state tests are necessarily a good measure of their students' mastery of content, and many raise concerns about the lack of alignment among standards, curriculum, and assessment" (p. 55). It is important that the curriculum aligns with state assessments, but a course should not be limited by the same assessment.

Data Analysis

English (2000) said that state testing is only useful if it provided data about students that could be connected to classroom instruction (p. 68). One of the purposes of this study was to examine the connection between state assessment and curriculum. It is essential to be able to take test data and link student performance to the curriculum map that was used in the classroom (English, 2000, p. 87). However, the data from the state assessment should have connected to skills beyond what the course assessed. English (2000) said that the test data needed to be used for assessing prior knowledge requirements and to make curriculum corrections for multiple years (p. 89). Being able to make decisions in the alignment of curriculum over multiple years allowed for proper sequencing of concepts (English, 2000, p. 105).

In mathematical education, it was important to have high standards so that students were successful in the next phase of their lives; either continuing their education or entering the workforce (McGehee & Griffith, 2001, p. 139). McGehee and Griffith (2001) mentioned that one problem with a norm-referenced test and the bell curve was the expectation that students should not be able to answer every question, which is problematic when the assessment was to see if the students were meeting the learning goal (p. 139). English (2000) supported McGehee and Griffith by explaining that a normal bell curve only happened when curriculum alignment to state testing was low (p. 72). This means that 50% of the students must be below the average score. He continued to say that if the curriculum and state test aligned or "teaching to the test" occurred, then the curve should be positively skewed into a "J" curve (English, 2000, p. 74, 76). "Teaching to the test" is unavoidable when high stakes are tied to the test. Therefore, teaching must include a high level of tested content which means purposive alignment is essential (English, 2000, p. 78). Curriculum alignment to state assessments is difficult to do when the test questions are secretive, but essential to the alignment process.

Curriculum Alignment

Curriculum Design

Standards-based education and state assessments were only part of the curriculum alignment process. Understanding curriculum alignment required a clear understanding of curriculum and how it related to state standards, assessment, and classroom instruction. Crawford (2012) defined curriculum as,

> A document, readily available to and understandable by the entire educational community, that clearly outlines standards-based learning expectations for the

> year and for the academic terms within that year. It specifically addresses both what must be learned and when it must be learned. These skills will be deliberately scaffolded to maximize student learning, and this curriculum will be the basis for all instruction and assessments within the district. This curriculum addresses the what and the when, but not the how. Nor does it contain resources, suggested activities, or assessments; those documents are contained elsewhere, perhaps in a true curriculum map. (p. 34)

Once the reader had an understanding of the written curriculum, he or she could then see how the documents related to state standards. These documents must be based on the Common Core state standards and then broken down to identify power standards with learning objectives (Crawford, 2012, p. 37). The algebra curriculum documents for a Medium-Sized Rural School District were examined (2015b). These documents combined the curriculum and curriculum map (blueprint) into one cohesive document (Medium Size Rural School District, 2015a). The algebra state standards were unpacked into "local standards or power standards" (Medium-Sized Rural School District, 2015b). These power standards needed to completely express the state standard (Crawford, 2012, p. 37). The researcher examined the algebra curriculum documents to see if the local power standards precisely expressed the algebra state standards.

English (2000) said that there are three types of curriculum: formal, informal, and hidden (p. 7). For the purpose of this study, the formal curriculum was examined. Formal curriculum is "the one that usually appears in curriculum guides, state regulations, or officially sanctioned scope and sequence charts" (English, 2000, p. 7). A curriculum team has the arduous task of writing out the curriculum for each course. Formalizing the curriculum by describing what the written curriculum should contain became a necessary beginning step to aligning the curriculum with standards because no accepted methods existed (Squires, 2012, p. 130). The development of curriculum was often by a team of teachers who agreed on the items that should be taught in accordance with state and district policies (English, 2000, p. 9; Squires, 2009, p. 6). A school district that used only a curriculum development process often produced a curriculum that lacked cohesiveness. The school district curriculum team should have looked at the alignment between the curriculum, state standards, state testing, and text books to see if it was strong or weak and improve the alignment (Squires, 2009, p. 6). When curriculum showed fragmentation, it became hard to decide which topics should be emphasized in a course (English, 2000, p. 10). State testing often became the dictator of curriculum content. In other words, the scope of the curriculum matched to test items (English, 2000, p. 12). Matching curriculum to test items appeared essential because high stakes testing assessed students' comprehension.

Power standards or local Common Core state standards, according to Crawford (2012), did not include all the skills that the student could learn but because of time restraints, they were the skills identified by educators as the most critical to the course and future courses (p. 13). The power standards were arranged in small digestible bites and sequenced in a manner so the critical material was covered in the classroom for maximum student achievement (Crawford, 2012, p. 18). The Medium-Sized Rural School District algebra curriculum blueprints showed the power standards underneath the state standard (2015b). The power standards should align with the state standards. Squires (2009) reminded readers that the results of alignment were mostly operational and allowed a capable school system to remediate students that lacked proficiency in certain standards by reallocating resources more effectively (p. 7).

Vertical Alignment

Curriculum alignment to state standards for a particular course was one level of a multi-layered process. Curriculum must be created with consideration of the material that was taught in previous years. This process was known as either vertical progression (Hale & Dunlap Jr., 2010, p. 5) or vertical alignment (Goodlad & Su, 1992, p. 330; Squires, 2009, p. 59). Posner (1992) saw that for increased achievement to happen, curriculum must be vertically aligned to allow for the scaffolding of material on prior knowledge (p. 127). This building on prior knowledge agreed with the conceptual framework discussed in chapter one; students learned better when material was chunked into digestible bites and layered so to build on earlier concepts. The vertical alignment, scaffolding of material, and mathematical content across different academic years has been debated for over a hundred years (Dingman, 2010, p. 103). Curriculum teams must look at the sequencing of a topic over multiple years to align curriculum. When an assessment assessed a large benchmark, it was important for educators to align and express the curriculum vertically across a band of grades as opposed to working in isolation (McGehee & Griffith, 2001, p. 140). A lack of vertical alignment could cause children to do well in a classroom but not perform well on high stakes testing (McGehee & Griffith, 2001, p. 142).

According to Drake (2007), "Vertical maps are interesting in that they allow a picture of how the content, skills, and standards are connected and build on each other over the years" (p. 12). Vertical mapping was essential from grade level to grade level, but also within a classroom. Vertical curriculum mapping could prevent overlap of standard-based lessons and determine what students should or should not know. (Drake, 2007, p. 21). Posner (1992) called the vertical progression a "linear configuration" which separates a progressing curriculum from isolated material that can be taught alone (p. 129). Educators must determine what curriculum concepts can only be learned with prior exposure to preexisting concepts. Posner (1992) made vertical alignment synonymous with the sequence of a course or courses (p. 127). This study looked at the vertical alignment between pre-algebra and algebra courses.

Horizontal Alignment

Along with the vertical alignment progression of skills, educators were also responsible for horizontal alignment of curriculum. Horizontal alignment was often described as the "breadth" of a course and usually included the sequence of content for the course (Goodlad & Su, 1992, p. 330). Deciding what will be taught during the course is extremely important for curriculum alignment. Using relevant data, a curriculum mapping team has to decide which skills are most important for the year within the scope of the state standards (Hale & Dunlap, 2010, p. 11, Posner, 1992, p. 127).

The scope of the state standard is the range of material to be covered in a class. The organization of skills has been described as the "steel fibers in a concrete tower-not seen but necessary to the tower's strength" (Goodlad & Su, 1992, p. 331). However, it is important to note that horizontal alignment could also refer to the interdisciplinary nature of concepts, across multiple subjects (Goodlad & Su, 1992, p. 336; Posner, 1992, p. 127). For the purposes of this study, horizontal alignment did not include interdisciplinary curriculum, such as the language arts standards, that are embedded in the algebra curriculum. Instead, the horizontal alignment only covered the mathematics standards within the algebra curriculum.

Curriculum Mapping

When considering curriculum alignment, the definition of written curricula can be ambiguous. Posner (1992) identified the written curriculum to include "scope and sequence charts, syllabi, curriculum guides, course outlines, and lists of objectives" (p. 10). According to Posner's definition, curriculum mapping, also known as blueprints or guides, were part of the written curriculum. Whichever curriculum was used, it had to be evaluated for quality, accuracy, and effectiveness by the school or school district (Posner, 1992, p. 21). Consistent with Posner's beliefs, research that evaluated curricula was essential for academic improvement. Posner (1992) would continue to say that curricula is complicated because it usually encompasses the views of a diverse group of educators (p. 35). As such, differing opinions existed when considering the best combination of content to cover in the written curriculum for any subject. The Medium-Sized Rural

School District in this study combined the algebra curriculum and the algebra curriculum map into one document called a blueprint (2015b).

Curriculum mapping has been compared to photography where the overview is the zoomed out picture of the vertical progression of the curriculum and the mapping is the zoomed in picture of what should be happening in the classroom (Hale & Dunlap Jr., 2010, p. 2). It was important that curriculum maps aligned with standards and district curriculum. Palandra (2010) said,

> The curriculum maps were adjusted yearly to continue to align ever evolving curricula, instruction and assessments. They provided the principals with a means to ensure that the major contents and skills were covered in each classroom at a pace appropriate for the educational level of the students. (p. 227)

According to Palandra, a curriculum map should be a continual work in progress. According to Hale and Dunlap (2010), curriculum mapping must be continually revised and implemented at the school and district level to be effective at raising student achievement (p. 2). This researcher looked at algebra curriculum mapping of a Medium Sized Rural School District so that future documents could be revised for effectiveness in student achievement in subsequent school years (2015b).

According to Hale and Dunlap (2010), "mapping first and foremost focuses on horizontal and vertical articulation of the student learning design and then blends in an ongoing focus on best-practice classroom instruction" (p. 3). Willoughby (2010) believed that a good curriculum should allow for a student-centered classroom in which students can search for questions and answers in an enjoyable and skillful manner (p. 79).

Teacher instruction and student attitudes were important components that should be researched in future studies. As previously stated, this study did not focus on classroom instruction, but instead on the written curriculum which included curriculum maps.

Not everyone agreed with how curriculum maps were used. According to Hale and Dunlap (2010), some states misused curriculum maps as a way to expedite the process of increased student achievement on high stake tests (p. 85). Instead, Hale (2015) stated that “maps are designed to provide *authentic evidence* of what has happened or is being planned to happen in a school or throughout a district” (para. 7). The author continued that curriculum maps are never finished but instead a work in progress (Hale, 2015, para. 6). Curriculum maps may be effective if used correctly and edited as needed. Hale (2015) reminded educators that “encouraging frequent individual and collaborative revisiting, reviewing, and renewing of available data (e.g., curriculum maps, student assessments/evaluations, teacher-to-teacher instruction observations, formal testing results) through curricular dialogues and collaborative decision making is at the heart of mapping” (para. 7). If a school’s leadership team found that curriculum mapping was being used incorrectly, most likely the maps would not be revised and edited in an effective manner (Hale & Dunlap, 2010, p. 85).

Crawford (2012) proposed that the curriculum map is the tool that will discuss the best way to reach the learning objectives (p. 40). It is important to note that Crawford (2012) also said curriculum maps were useful for instructional activities and resources (p. 43). Depending on the administrations’ perspective on curriculum mapping, the content of curriculum maps may vary. Hale and Dunlap (2010) stated that curriculum mapping is not concerned with the day to day instruction but instead, the monthly or unit progression (p. 4). This meant that particular approaches and practices were truncated to align with a particular skill (Hale & Dunlap, 2010, p. 9). Regardless of whether a curriculum map was used as a monthly tool or a daily pacing guide, it was still important that the map aligned with state standards and state assessments.

Curriculum Alignment for Mathematics

Curriculum alignment to state standards and state assessments is essential in mathematics. Students with a good foundation in mathematical skills were more adept at building an enhanced understanding of mathematics (LeMire, Melby, Haskins, & Williams, 2012, p. 66, 67). Much of the study in mathematical alignment by LeMire, Melby, Haskins, and Williams (2012), was focused on curriculum alignment and the student's ability level (p. 67). Studies on alignment often reflected teacher pedagogy and student attitudes about mathematics which was beyond the scope of this study. However, teacher pedagogy should reflect a school district curriculum alignment progression across multiple school years. When the alignment of curriculum does not match the ability of the student, the learner could resist learning additional mathematical skills (LeMire et al., 2012, p. 69). Students responded and trusted teachers who taught mathematics in the student's ZPD (LeMire et al., 2012, p. 71). This researcher did not examine pedagogy but instead analyzed the written school district curriculum behind that pedagogy, to lead to increased student achievement in algebra.

Jacobs et al. (2006), looked at past TIMSS studies to consider the debate of standards-based mathematics teaching versus traditional mathematical education. Having a middle school mathematics curriculum that is aligned with standards is only beneficial if the teachers are using the standards correctly. Research has shown that standards are not impacting mathematics education in middle schools (Jacobs et al., 2006, p. 7). To look at the TIMSS video studies, researchers from different countries gave codes to specific mathematical skills, mathematic problems, and teaching techniques to evaluate which areas were most important and captured the purpose of the standards (Jacobs et al., 2006, p. 10). The authors found that students spent the majority of class time on problem solving but the category was too broad to know if the standard was being met (2006, p. 14). However, many of the mathematical problems were of low complexity, not connected to real world, and isolated from other mathematical concepts (Jacobs et al., 2006, p. 17, 26). A positive finding showed that an increase of complex problem solving happened between 1995 and 1999 but results of the study also showed that change is slow (Jacobs et al., 2006, p. 29, 30). Curriculum alignment could help to assure that the mathematics standards are being completely covered.

Bales and Akdere (2014) performed a study of teachers in a graduate program that examined how the alignment of standards and instructional methods affected student achievement. The study promoted continual improvement of instructional methods while aligning mathematics instruction and curriculum with standards and assessments to increase student understanding of concepts (Bales & Adkere, 2014, p. 838). Continual review of instructional practices and curriculum alignment should help improve the students' conceptual understanding of material. By giving teachers the tools to increase instructional quality, gaps in mathematics curriculum and instruction were more apparent (Bales & Adkere, 2014, p. 839). The authors said "this study expands our understanding of disconnects between the teaching and learning vision of mathematics written into the Common Core and this particular system-wide college mathematics placement exam" (Bales & Adkere, 2014, p. 839). If gaps are revealed in both the educational system and the classroom instruction, then students' college preparation can be assessed. Bales and Adkere (2014) believed the course sequencing, instructional gaps, and misalignment of assessments contributed to low-socioeconomic, urban students not being prepared for college coursework (p. 839). In other words, students who did not have a well-aligned curriculum and high-quality teaching, were not always prepared for college level courses. Ultimately, alignment in mathematics could help student achievement and college readiness.

For curriculum alignment in mathematics, a school district must decide how to sequence the course content and performance tasks that are vital to growth in mathematics (Romberg, 1992, p. 749). The National Council of Teachers of Mathematics (NCTM; 1989) defined mathematics curriculum as the "operational plan" that outlines the goals for what students should know and do, how the student will perform the task, and what the teacher can do to help the student reach the goal (as cited in Romberg, 1992, p. 749). School districts that implement creative and aligned mathematics curriculum that stressed higher-order thinking could have higher student achievement on classroom, district, and state assessments (Seeley, 2004, p. 26). This is especially important with the increased demands on students. Over the years, changes in mathematic curriculum have increased the intricacy and amount of mathematical education needed, especially with a technological and data driven society (Romberg, 1992, p. 772; Willoughby, 2010, p. 83). Mathematics can no longer be thought of as numerous ideas and computations that should be mastered or a "transmission of knowledge" (Romberg, 1992, p. 781, 782). Students must not only have computation skills, but must apply mathematics in different contexts. The application of mathematical problem solving is extremely broad and essential to many other fields of study (Romberg, 1992, p. 755). Curriculum alignment with mathematics standards can help to change old instructional practices that only centered on computation and help students learn to problem-solve at a higher level. This is essential if students are going to transfer mathematics knowledge to STEM fields of study.

In one study, the researchers looked at 18 high schools in six states to see the effects of school district policies in curriculum selection for the classroom and its effect on achievement in both mathematics and science (Porter, Kirst, Osthoff, Smithson, & Schneider, 1993, p. 32-33). The timing of the study was during the early 1990s when there was a call for a shift in curriculum from memorization to reasoning (Porter et al., 1993, p. 35). Porter, Kirst, Osthoff, Smithson, and Schneider (1993) recognized that mathematics curriculum analysis is useful for examining school district policies and implementation of curriculum even though their research is geared towards the classroom instruction (p. 32).

A study was performed in eleven states to examine the effects of standard-based education in mathematics and science (Blank, Porter, & Smithson, 2001). One aspect of the study looked at curriculum alignment with state assessment (Blank et al., 2001, p. ii). Although the study was multi-layered, one component also included a mathematics analysis for alignment of assessment to instruction. (Blank et al., 2001, p. 26). Blank, Porter, and Smithson (2001) showed that mathematics instruction was more aligned with the assessment for that state with a correlation of .33 for grade eight and .42 for grade four than with other assessments like the NAEP (p. 29). The results of the study also show that fourth grade mathematics is most aligned to the NAEP assessment showing more alignment to standard-based education than other grade levels (Blank et al., 2001, p. 29). The limitation of the study is that it revealed a method of analysis but does not offer useable data. The authors were careful to say that the data did not reflect the instructional practices of the eleven participating states because it was only a "snapshot" but further analysis would be beneficial (Blank et al., 2001, p. 29-30).

Another important aspect of the study was the alignment of instruction with content standards (Blank et al., 2001, p. 42). The content map analysis looked at areas emphasized in mathematics instruction so that teachers and administrators could get an overview of mathematical content for the curriculum (Blank et al, 2001, p. 42-43). Although the content maps were helpful, the study was performed before Common Core standards for mathematics were implemented in most states. Interestingly, at the time of the study, the findings indicated that elementary teachers only spend 6% of instructional time on algebra concepts (Blank et al., 2001, p. 49, 50). This study supports further research in curriculum alignment for mathematics.

Part of the purpose of curriculum alignment was to help students develop proficiency in mathematics within the context of a situation or problem. The Mathematics Practice Standards were implemented for this reason (see Appendix D), but were not reviewed in this study. Meyer (2009) pointed out that in the Trends in International Mathematics and Science Study or TIMSS report (2008), the study showed that American students were not going deep enough into mathematics and only performing repetitious problems, especially in the middle school grades (p. 1). A partnership was formed between University of Wisconsin Madison and Netherland's University of Utrecht Freudenthal Institute (FI) to collaborate on context-based mathematics curriculum (Meyer, Dekker, & Eade, 2010, p. 147). The pair worked on a mathematics curriculum model for the United States for over six years (Meyer et al., 2010, p. 146). The FI group was concerned with the amount of previous knowledge, relatable context, and number of skills that would be useful for American students. The Wisconsin group was mostly concerned with teaching complex problem solving with limited scaffolding, individual mathematical units, and grade-level alignment (Meyer et al., 2010, p. 146-47). The curriculum approach called Mathematics in Context (MiC) was considered successful and contributed to another curriculum program called Making Sense of Mathematics (MSM) which was initiated in England for the purpose of teaching applied mathematics (Meyer et al., 2010, p. 147). Programs like MiC and MSM tried to address curriculum alignment and high-level mathematical skills to address learning gaps and inspire higher-level reasoning.

One purpose of curriculum alignment is to build a cohesive curriculum that strings together the big pictures from a unit of study so that students use old ideas or prior knowledge in new situations (Johanning, 2010, p. 172; Romberg, 1992, p. 764). Cuoco, Benson, Kerins, Sword, and Waterman (2010), stated that if curriculum developers were going to decide which parts of a mathematic unit are most important, they must not only have a grasp of mathematics but also a knowledge of "mathematical habits of mind" that allow for good habits in mathematics (p.183). Cuoco et al. (2010) formed the CME project to studied high school curriculum over a four year period. The authors found the following areas useful in mathematics curriculum:

> 1. Organizing content around big-picture ideas,
> 2. Finding surprising depth in seemingly simple mathematics problems,
> 3. Reaching into classical mathematics to design tasks, and
> 4. Making use of available technological tools to support students' learning. (p. 182)

School districts that implemented creative and aligned mathematics curriculum that stressed higher-order thinking skills could have higher student achievement on classroom, district, and state assessments (Seeley, 2004, p. 26). No longer should students learn mathematics in the passive, fragmented fashion that was popular in the 1990s (Romberg, 1992, p. 765).

Those in charge of curriculum alignment and development must make sure there is a smooth transition or sequencing of material in mathematic courses. Johanning (2010) reminded educators that mathematics must be aligned “across grades and across content standards” (p. 179). Curriculum alignment in mathematics is essential for students to build new skills that require foundational skills. Johanning (2010) did not believe that concept review was as important as embedding review into the new material in rigorous problem solving (p. 179). This idea not only supports scaffolding of mathematics content, but scaffolding within topic.

Amazingly, mathematics curriculum was considered one of the most organized curricula in schools (Porter et al., 1993, p. 655; Usiskin, 2010, p. 27). Even if that was true, it did not change the fact that many different organizations and individuals had strong beliefs on which mathematical concepts should be taught and when they should be taught. According to Usiskin (2010), mathematic teachers were exhausted from the many different curriculum expectations that come from the school district, the individual school, the textbook, mandated state tests, parents, expert opinion and the teacher’s personal beliefs (p. 27). With so many different ideas, curriculum alignment in mathematics was extremely important so that teachers clearly knew the scope and sequence of the course they taught.

Educators have tried to reform mathematic curriculum and align it with standards for many years. Curriculum alignment with standards is important but will be pointless without teacher knowledge and pedagogy in the classroom (Ball, Hill, & Bass, 2005, p. 14). Ball et al. (2005) developed a 250 item questionnaire, with domains in areas such as algebra and geometry, to find if a teacher's mathematical knowledge had an effect on student achievement (p. 43). The large scale study showed that the mathematical knowledge of a teacher was indeed directly related to student achievement (Ball et al., 2005, p. 45). This finding reminds educators that curriculum alignment is only one part of a multi-tiered process for improving mathematical education.

Curriculum Alignment for Algebra

Although there are numerous studies in mathematics, research about curriculum alignment in algebra is limited. Kennedy High School in Washington initiated an algebra alignment project to improve student achievement (Neher & Plourde, 2012, p. 85). At the end of the project, students' algebra scores were not available to measure achievement but teachers had an algebra curriculum, course maps, learning objectives, and lesson plans that were better aligned with the algebra state standards (Neher & Plourde, 2012, p. 94). Although statistics were not available, the project allowed for a more detailed formal curriculum in algebra.

A strong, cohesive, and aligned algebra curriculum is important but the vertical progression of mathematical skills is also necessary. Middle school students who had built learning on the embedded skills learned in previous years and understood proportionality, were better equipped to handle algebra and functions (Seeley, 2004, p. 22). When curriculum documents were examined, more research was needed in the area of vertical progression to make sure students were prepared for algebra. With the desire to have students ready for algebra, there has been an increase interest in introducing algebra reasoning skills as early as prekindergarten (Hollenbeck, Wray, & Fey, 2010, p. 270). Vertical alignment in algebra became increasingly important as middle and high schools dutifully tried to develop algebra reasoning skills in the areas of equations and expressions which can often be enhanced with technology (Hollenbeck et al., 2010, p. 271).

Research may be limited in algebra because the content that is taught has been changed considerably. Porter et al. (1993) studied the amount of time different topics received in algebra instruction. Porter et al. (1993) found that algebra topics were taught using traditional approaches with emphasis on equations even though the NCTM standards (1989) promoted modeling and graphs (p. 454). These findings supported the need for reform in the algebra content standards which can be seen in the adoption of Common Core. Even more, algebra curriculum alignment was essential if application and reasoning of mathematics were to be emphasized. This is especially important when courses like Algebra 1 spend over “50 percent or more of instructional time on computation” (Porter et al., 1993, p. 458). Even with standards and accountability, many local school districts leave room for their own interpretation of what should be emphasized in a class (Porter et al., 1993, p. 652). Teachers also can use their own discretion when deciding what to accentuate in a classroom (Porter, 1993, p. 652). Porter et al. (1993) admitted that the timing of their study was a weakness because it was at the beginning of reform in mathematics instruction in many states (p. 652). Even within the subject itself, there were differing opinions on which areas should receive the most attention in algebra. Those who were given the task of developing algebra curriculum had to decide the degrees of importance given to equations, arithmetic, or functions, and everyone may not agree which category should win (Groth, 2010, p. 157). Groth (2010) cautioned curriculum writers to emphasize higher rigor and statistical approaches, both mathematical and nonmathematical in curriculum (p. 168). Algebra curriculum writers must align with the rigor of the state standard.

Porter et al. (1993) warned that pre-algebra courses such as “Math A” should not be a “catch all” math class for students who have nowhere to go, but instead a serious preparatory class for algebra which is critical for college entrance (p. 663). Pre-algebra classes need variety but strong content as well (Porter et al., 1993, p. 664). The research suggested that preparatory classes like Math A should have investigation and active learning (Porter et al., 1993, p. 664). Porter et al. (1993) said,

> The goals of Math A are (1) to develop a spirit of inquiry and excitement about learning mathematics, (2) to generate in students a sense of responsibility for developing the skills they will need, and (3) to provide students with powerful mathematics content that will enable them to deal with new situations. (p. 665)

Students who take algebra in ninth grade are often the struggling mathematics students. Many of the students that take algebra in the eighth grade are already on the honors program track (Spielhagen, 2006, p. 42). If this is the case, it is even more important that the curriculum be aligned for the students who take algebra in ninth grade. Spielhagen (2006) researched the benefits of providing algebra before ninth grade. She mentioned that students who take algebra in ninth grade were unable to take calculus in high school unless they double up on mathematic courses (Spielhagen, 2006, p. 39). Spielhagen

(2006) stated that the high school graduation requirement was only two mathematic courses including algebra (p. 48), which differs from the graduation requirement of four mathematic courses for the Medium-Sized Rural School District in this paper (Florida Statutes, 2015). This rigorous graduation requirement can be detrimental to students who are not successful in algebra in the ninth grade because there is not much room for doubling mathematic courses. Spielhagen (2006) said that her study [of eighth grade algebra benefits] was limited because no data were provided concerning curriculum and alignment even though the school district did provide a pacing and sequencing guide (p. 54). To really understand the algebra needs of students, curriculum alignment must first be in place before analyzing other areas of algebra instruction.

Curriculum Alignment and Textbooks

One cannot consider algebra curriculum alignment without looking at the adopted textbook. Teachers have often used the textbook as their curriculum as oppose to the curriculum map which is detrimental if the textbook does not align with the curriculum (English, 2000, p. 3). Dingman (2010) said that there was little supporting evidence that showed selected textbooks aligned with mathematic state standards (p. 105). In a study that examined the covered material in textbooks for fourth grade mathematics, the results showed that textbooks varied in content for instruction (Freeman et al., 1983, p. 510). Many times the textbooks had too many topics for instruction and often only part of those topics were tested on standardized testing (Freeman et al., 1983, p. 510). Even more so, since teachers often rely on textbooks, textbook changes from year to year could interrupt a student's achievement (Freeman et al., 1983, p. 510). Improved mathematics textbooks are needed if mathematical education is going to improve, but many textbook publishers make minimal changes and try to keep the textbooks familiar as opposed to making sure they are aligned (Willoughby, 2010, p. 79-81). An important question to ask is if the textbook and ancillary material support the performance standards in mathematics (Dingman, 2010, p. 104)?

Porter et al. (1993) found that mathematics instruction was influenced by textbooks and assessments (p. 654). Because Florida allowed school districts to choose from a list of textbooks for a course, Porter et al. (1993) found Florida's text book adoption policies weaker than California's (p. 654). Even more, the textbooks were not found to keep up with expected curriculum reforms for higher thinking skills or not available in some schools (Porter et al., 1993, p. 655). Textbook alignment to state standards is critical when teachers depend on them for instruction. Since textbooks are important, textbook adoption often becomes the focus for school district officials rather than curriculum design (English, 2000, p. 16). Van Steenbrugge, Valcke, and Desoete, (2013) conducted a large scale study that looked at the teacher's view of the textbooks for mathematics courses. Veteran teachers did not find the textbook as crucial to student learning as novice teachers did (Van Steenbrugge, Valcke, & Desoete, 2013, p. 339). Teachers' views about textbooks can differ tremendously depending on grade, experience, textbook content, and teacher support (Van Steenbrugge et al., 2013, p. 345). The chosen textbook series did not impact student scores and the authors agreed that it is hard to judge the effectiveness of textbooks as they vary greatly (Van Steenbrugge et al., 2013, p. 345, 346).

Even if it was hard to evaluate textbooks, the textbook adoption process was critical, especially if it was used as the primary source of instruction. Bhatt, Koedel, and Lehmann (2013) suggested that a one-size-fits-all mathematic curriculum could attain high scores in one tested area and low scores in another (p. 108). In the study by Bhatt et al. (2013), curriculum was synonymous with text book adoption for over 1200 Florida schools that used a single traditional curriculum (p. 109). Many studies on curriculum [textbook] adoption only looked at overall achievement because states other than Florida did not keep text book adoption data (Bhatt, Koedel, & Lehmann, 2013, p. 118). Bhatt et al. (2013) looked at how the textbooks were used when instructing Florida elementary students in the five tested areas of elementary mathematics. The uniform curriculum used in different schools showed achievement in two categories of mathematical study but not in the other three categories causing the researchers to believe that school leaders should be more selective using non-uniform curriculum that best meets the needs of students for different areas of study (Bhatt et al., 2013, p. 118). The researchers admitted that further study is necessary but the topic of text book curriculum is relevant to algebra alignment as well (Bhatt et al., 2013, p. 118).

Textbook choices for mathematics became an important topic especially when considering accountability and alignment with state standards. According to a study by Mark, Spencer, Zeringue, and Schwinden (2010), not only were textbooks chosen by school district personnel but stricter policies were being implemented to make sure teachers followed those textbooks (p. 201). Teachers were no longer allowed to have the flexibility of curriculum choices. Many school districts used a common textbook per subject matter in order to create fluidity and alignment with standards among all schools (Mark, Spencer, Zeringue, & Schwinden, 2010, p. 201). Many school district educators were concerned about textbook alignment with state standards, but relied on the state's adoption approval for confirmation of alignment (Mark et al., 2010, p. 202). However, just because the state approves a textbook, does not necessarily mean the textbook is of highest quality. Mark et al., (2010) suggested that school district leaders who make textbook decisions have more information about the value and efficacy of a textbook before adopting (p. 208).

Conclusion

Curriculum alignment in algebra has many layers. Alignment includes state standards, state assessments, curriculum documents, and classroom instruction. If student achievement is going to improve, alignment must be present. However, curriculum alignment does not solve the problem of low performing schools alone. The classroom instruction must also align with the written curriculum. Curriculum should not take the teacher's freedom of delivery away but instead give common learning goals (English, 2000, p. 17). Crawford (2012) would agree that teachers should have creative freedom and curriculum should not prescribe specific activities (p. 42). The lack of prescribed activities in no way means a "free-for-all" mindset in the classroom. School districts cannot let teachers go without accountability and this can make curriculum development challenging (Crawford, 2012, p. 25; English, 2000, p. 17). Even when a school district has put together a well aligned curriculum, teachers can ignore school district curriculum and teach what they want in their classrooms (English, 2000, p. 1). English said that often the curriculum is just an icon of what should be taught but does not reflect what is taught in the classroom (2000, p. 2).

Squires (2009) found that the school district must pay careful attention to alignment with the state standards and testing otherwise student achievement can be negatively affected (p. 187). However, school districts can productively put together a curriculum that is effective for student achievement outcomes. School districts could control their outcomes by planning a well aligned curriculum and examine models that have worked (Squires, 2009, p. 187). This study will examine the written algebra curriculum documents for a Medium-Sized Rural School District to look for the presence of alignment within the algebra course, the pre-algebra course, and the assigned textbook (2015b).

Organization of Study

This chapter examined the research in curriculum alignment to support the need for further research in algebra curriculum alignment. The methodology for this research study is found in chapter three. Chapter four will contain the data for this algebra curriculum alignment research. Chapter five will contain the research results, implications of the study, and suggestions for further research.

CHAPTER 3: METHODOLOGY

Introduction

This study incorporated a phenomenological research design for a qualitative analysis of school district algebra curriculum documents to search for content omissions in the school district curriculum documents. According to Lunenburg and Irby (2008), a phenomenological design is appropriate when performing a descriptive analysis to explain a phenomenon (p. 90). In this study, algebra curriculum will be analyzed to describe how it may, or may not, contribute to student achievement on the Algebra EOC. To wit, how algebra students interact with the algebra curriculum. This researcher did not use the data to explain the phenomenon, "cause and effect", but to describe the phenomenon in detail through common themes (Groenewald, 2004, p. 18). Moustakas (1994) states that "the whole process of reducing toward what is texturally meaningful and essential in its phenomenal and experiential components depends on competent and clear reflectiveness, on an ability to attend, recognize, and describe with clarity" (p. 93). The researcher will establish themes to study the phenomenon. All major and minor themes that are established relate to the phenomenon (Scott, 2004, p. 120). In the study, the researcher analyzed the curriculum documents for the algebra course, developed related themes, and described with clarity the alignment process to identify content omissions that contributed to the phenomenon of how the students interact with the algebra curriculum. Ultimately, this phenomenon could have an effect on the students' Algebra EOC scores.

Algebra EOC data allowed the researcher to identify the algebra domains with the lowest performance by ninth grade students. School districts were given test performance datum for individual students in three algebra domains. The Medium Sized Rural School District used this individual datum to determine the eighth and ninth grade students' performance on the Algebra EOC exam. Since the Algebra EOC scale scores were not available, the ninth grade performance in the three algebra domains were compared with the eighth graders. The eighth grade students are typically the advanced learners and performed higher than the ninth grade students. Once the problematic domains for ninth grades students were identified, the researcher was able to examine school district curriculum documents that relate to the content standards in those domains to look for content omissions. A second component of the study was to analyze the documents for curriculum alignment between the pre-algebra course and the algebra course. Based on the algebra document analyses, embedded skills that should be learned in previous school years were documented because of their necessity in algebra success. Last, the textbook was analyzed for alignment with the scope and sequence of the curriculum.

The methodology and procedures are explained in this chapter and organized into eight parts. The chapter begins with a statement of the purpose of the study and the research questions. Next, the researcher discusses the population utilized in the study along with the procedures for conducting the research. Instrumentation, data sources, and data analysis are also discussed. The data analysis section includes validity using triangulation. The chapter ends with a summary for methodology and the organization of the study.

Purpose Statement

The purpose of this study was to analyze school district curriculum alignment with state and national standards to find content omissions that may contribute to low Algebra End of Course (EOC) exam scores in ninth grade. The ninth grade pre-algebra and algebra curriculum for a Medium Size Rural School District (2015b, 2015c) were examined for missing content that may lead to knowledge gaps in the content of the course. If there are content omissions in the curriculum, they can be added to the curriculum to increase student performance.

Research Questions

This study addressed the algebra Common Core standards for the state of Florida, referred to as the Mathematics Florida Standards. The research questions were:

1. Which algebra domains have the lowest student performance based on the ninth grade Algebra EOC exam (2015)?
2. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district algebra curriculum that may contribute to the low scores on those standards?
3. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district pre-algebra curriculum that should align with those algebra standards?
4. Based on document analysis and expert opinions, what are the knowledge skills embedded in the algebra curriculum that if missing, will contribute to below proficiency on the Florida algebra state standards?
5. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the missing content standards and skills, if any, in the adopted text book that should align with the district curriculum, state standards, and expert opinion?

Population

The population for this qualitative document analysis were the ninth grade algebra students in a Medium Size Rural School District during the 2014-15 school year (2015d). The school district had eight public high schools that host ninth grade algebra classes. The Algebra EOC exam scores of the entire population of 1707 ninth grade students were analyzed to determine which tested algebra domains received the lowest student performance so those algebra standards could be reviewed for curriculum alignment. The data from the 1707 ninth grade students were compared with similar data for 1405 eighth grade students from the same school district. Since the Algebra EOC scale scores were not available, the individual student's datum from the three tested domains was utilized. The sample examined was a purposive group of eighth and ninth grade algebra students to determine the algebra standards that needed review for omissions in the school district curriculum. According to Lunenburg and Irby (2008), "this is keeping with qualitative research's emphasis on in-depth description of participants' perspective and context" (p.177). The researcher is interested in describing the algebra content omissions in the school district curriculum that impact ninth grades students' EOC preparation. A ninth grade population was selected because they have a significantly lower pass rate on the Algebra EOC exam than their eighth grade counterparts who are typically high performing students. Under the old mathematic standards, Florida's pass rate for first time Algebra EOC test takers in the ninth grade was 52% (FLDOE, 2014).

Instrumentation and Sources of Data

The numerical data in the study was from the individual student's Algebra EOC exam scores from three domains collected from the FLDOE for the 2014-2015 school year. These domain scores will be the result of the Florida Standards Assessment (FSA) created by the American Institute of Research (FLDOE Press Office, 2014, para. 8). The individual scores were calculated into a group percentage for comparison purposes. Because a scale score from the FSA was not given due to the pilot year release, the ninth grade students' Algebra EOC domain scores were compared with eighth grade domain scores to determine low performing standards. Those domains included Algebra, Functions, and Statistics, which are themes under the current algebra standards. The Algebra EOC domain scores determined which standards needed review for curriculum alignment.

The qualitative portion of this study employed a constant comparison technique for examining curriculum documents in this phenomenological study (Lunenburg & Irby, 2008, p. 94). A phenomenological study was used to describe the effect of curriculum alignment on student achievement on the Algebra EOC exam. According to Lunenburg and Irby (2008), a phenomenological design is appropriate when performing a descriptive analysis to explain a phenomenon (p. 90). In this study, algebra curriculum will be analyzed to describe the phenomenon of how students interact with it and how the curriculum may or may not contribute to student achievement on the Algebra EOC. The curriculum documents are referred to as "blueprints" for the Medium Size Rural School District (2015a). The researcher examined curriculum blueprints along with the supporting textbook that related to specific algebra standards. The curriculum documents were analyzed for both algebra and pre-algebra for the 2015-2016 school year. The embedded skills that students should know from previous classes were determined through the algebra document analysis, the researcher's mathematical knowledge, and educators' expert opinion. The constant comparison method was used to find themes which were used for coding the curriculum text for qualitative analysis (Bernard & Ryan, 2010, p. 56). This methodology is explained in depth in the next section.

Procedures

Research Question One

This study required a multi-level analysis that addressed the five research questions guiding the study. First, current data provided by the FLDOE to the Medium Sized Rural School District were examined to detect the domains or clusters of algebra standards in which ninth grade students performed the lowest. At the time of this study, the FLDOE did not provide students' scale score for the Algebra EOC exam since it was a pilot testing year. Instead, individual datum was provided to school districts in three domains. The three domains of interest were Algebra and Modeling, Functions and Modeling, and Statistics and the Number System. For brevity, these three domains were referred to as Algebra, Functions, and Statistics. The testing and evaluation department used the individual Algebra EOC datum to determine the percentage of students who answered 50% of questions correctly in each domain (Medium Sized Rural School District, 2015e). In this study, the testing and evaluation department applied the arbitrary number of 50% to compare eighth and ninth grade algebra students (Medium Sized Rural School District, 2015e). The ninth grade exam data were compared with the eighth grade data in the three domains and the results were reported in percentages to reflect the number of students who were considered proficient in the particular domain being assessed. Standards in these three domains were identified to determine which areas of district curriculum the researcher must focus analyses. Based on ninth grade student data, the mathematics standards with the lowest performance as compared to eighth grade students were used for the document analysis for the remaining research questions. Only algebra content standards from the domains with a low percentage of proficiency were examined for curriculum alignment in this study.

Research Question Two

A phenomenological study was conducted using a document analysis method for research (Lunenburg & Irby, 2008, p. 94). Groenewald (2004) reminded the reader that a phenomenological study does not try to explain the cause of the phenomenon, but instead tries to give a complete picture of the phenomenon (p. 18). As mentioned earlier, the phenomenon being studied was how ninth grade students interact with the algebra curriculum which may cause low performance on the Algebra EOC exam.

To study this phenomenon, the algebra curriculum for a Medium Sized Rural School District was analyzed for content omissions. The primary source of data was the Florida Mathematics' State Standards for the algebra course and the Medium Rural School District algebra curriculum plans (2015b). According to Bernard and Ryan

(2010), the research data were produced by disaggregating the artifacts into "recordable units" (p. 5). Using the three domains from research questions one, themes or categories were established that related to the phenomenon being studied (Bernard & Ryan, 2010, p. 55). In other words, the themes related to what students should have known to be successful on the Algebra EOC exam.

The themes or categories were predetermined from the algebra content standards found in the Florida Standards for Mathematics (see Appendix A, B, & C for tested algebra standards). Based on each of the state standards for the algebra course, the researcher used the deconstructed local standards, also known as power standards for a Medium Sized Rural School District. These local standards were found in the algebra curriculum documents from the Medium Size Rural School District (2015b). Due to the amount of deconstructed local standards for the algebra course, the local standards were coded into subthemes, also known as "metacoding" (Bernard & Ryan, 2010, p. 66), according to the skills students were expected to perform. The local standards were coded based on their appearance and repetition in the curriculum documents (Bernard & Ryan, 2010, p. 57). There were 95 coded local algebra standards categories or skills. The codes were reported in Table 3.

Table 3

Codes for Local Algebra Standards

Code	Definition
ANA-DATA	Analyze data and statistics
ANA-FUNC	Analyze functions-linear and nonlinear
APP-OPER	Apply operations to polynomials and functions
CAL-DATA	Calculate statistics including frequencies
CC-DATA	Compare or contrast data and statistics
CC-FUNC	Compare and contrast functions including transformed functions and characteristics of functions
CC-PARTS	Compare or contrast parts of a functions such as domain and range
CHO-METH	Choose method for solving or for analyzing statistical data
CLA-EXPR	Classify expressions
COB-FUNC	Combine functions
COM-FUNC	Compose functions
CON-ARGU	Construct an argument
CRE-EQUA	Create equations-linear and nonlinear
CRE-EQUA-2	Create a system of equations
CRE-FUNC	Create functions including real world situations
CRE-INEQ	Create inequalities
DEF-CLOS	Define closure
DEF-DATA	Define characteristics of statistical data
DEF-FUNC	Define functions
DEF-GRAP	Define key features of graphs
DEF-PART	Define or determine parts of an expression, equations, or functions
DEF-QUAN	Define are explain quantities
DEF-RECU	Define the recursive process
DER-FORM	Derive a formula
DES-DATA	Describe data including outliers
DES-RELA	Describe/determine the relationship
DET-EQUA	Determine when to use an equation
DET-FUNC	Determine if relation is a function
DET-INEQ	Determine when to use an inequality
DET-SOLU	Determine solutions of an equation
DET-STEP	Determine steps for problem solving
EVA-FUNC	Evaluate functions-linear and nonlinear
EXP-FUNC	Explain or describe functions and characteristics of functions. Apply explanation to linear and nonlinear functions
EXP-QUAD	Explain parts and forms of quadratic expressions
EXP-PROP-E	Explain properties of quantities in exponential expressions
EXP-PROP-Q	Explain properties of quantities in quadratic expressions
EXP-SOLU	Explain solutions including complex solutions

Code	Definition
EXP-STEP	Explain steps in problem solving
FAC-EQUA	Factor a quadratic equation or quadratic expression
FAC-POLY	Factor polynomials and/or functions
FOR-TABL	Form and interpret tables including coordinate and frequency tables
GRA-COOR	Graph or recognize coordinates
GRA-EQUA	Graph equations
GRA-FUNC	Graph a functions or polynomials. Apply to linear and nonlinear functions
GRA-INEQ	Graph inequalities including systems
GRO-DECA	Classify and solve growth and decay problems
IDE-FORM	Identify equivalent forms of functions
IDE-FUNC	Identify types of functions
IDE-OPER	Identify operations
IDE-PART	Identify parts of functions including domain and range and parts of graphs. Apply to linear and nonlinear functions.
IDE-PROP	Identify properties of equality, exponents, and/or polynomials
IDE-QUAN	Identify, define, or determine quantities
IDE-SOLU-I	Identify graphical and numerical solutions to inequalities. Identify characteristics of the graphs and number lines
IDE-STRU	Identify structures of an expression
IDE-ZERO	Identify zeros of a polynomial
INT-DATA	Interpret data sets
INT-EXPR	Interpret expressions in terms of a context
INT-FUNC	Interpret functions including real world situations
INT-GRAP	Interpret graphs and key characteristics of graphs or tables
INT-PART	Interpret parts of an expression, an equation, or a function
INT-SLOP	Interpret slope and key characteristics of slope
INT-SOLU	Interpret solutions
JUS-METH	Justify method
JUS-QUAN	Justify quantities
JUS-SOLU	Justify solutions
JUS-STEP	Justify steps or process
LAB-GRAP	Label graphs
MOD-DATA	Model data
MOD-FUNC	Model functions
MOD-RELA	Model relationship including real world situations.
PRO-EXPR-E	Produce equivalent forms of exponential expressions
PRO-EXPR-Q	Produce equivalent forms of quadratic expressions
PRV-FUNC	Prove characteristics of functions
REA-EQUA	Rearrange equations or formulas
REC-CONS	Recognize constraints
REC-DATA	Recognize statistical data including frequencies
REC-EXPR-	Recognize forms of an expression

Code	Definition
REC-FUNC	Recognize all types of functions and function notation
REC-GRAP	Recognize graphical representations and key features
REC-PART	Recognize parts of an expression, equation, or function
REC-SEQU	Recognize that sequences are functions
REC-SLOP	Recognize slope
REP-CONS	Represent constraints by equations and inequalities
REP-DATA	Represent data
REW-EXPR	Rewrite expressions
SOL-EQUA	Solve equations including systems of equations. Apply to linear and nonlinear equations. Applies to any method of solving equations.
SOL-FUNC	Solve functions. Apply to linear and nonlinear functions.
SOL-INEQ	Solve linear inequalities or system of inequalities
SOL-SLOP	Solve problems with slope
SUM-DATA	Summarize statistical data
TRA-EXPR-E	Transform exponential functions
TRA-FUNC	Transform a function,-symbolic or graphical. Include recognizing shifts. Apply to linear and nonlinear functions
USE-PROP	Use properties of equality
USE-TECH	Use technology
WRI-FUNC	Write functions. Include function notation. Apply to linear and nonlinear functions.

The curriculum documents were separated using the cut and sort method (Bernard & Ryan, 2010, p. 63) to sort for common words and skills between the local algebra standard and the state standards for algebra. The researcher utilized the constant comparison method (Lunenburg & Irby, 2008, p.94) to compare the curriculum documents with the algebra state standards based on the occurrences of the established codes (Bernard & Ryan, 2010, p. 76). According to O'Connor et al. (2008), "Simply put, constant comparison assures that all data are systematically compared to all other data in the data set. This assures that all data produced will be analyzed rather than potentially disregarded on thematic grounds" (as cited in Fram, 2013, p. 2). Fram (2013) encouraged the use of the constant comparison analysis method to identify similarities and links in the data as well as an organizational tool for putting large amounts of data in more manageable themes (p.20).

Using the constant comparison method, the researcher matched the codes from the local algebra standards to the algebra state standards to determine the skills that were expected to be mastered. Once the algebra skills were identified, the scope and sequence of the school district documents were examined to see if they fully covered the selected algebra standards or if there were content omissions within the established themes (Bernard & Ryan, 2010, p. 62). The results were systematized using a coding process to make the data more manageable and meaningful (Bernard & Ryan, 2010, p. 75, 86) and recorded in tables. The collected information was documented categorically for the algebra standards that were analyzed.

Research Question Three

The eighth grade pre-algebra curriculum documents were analyzed from a Medium Size Rural School District (2015c) to examine alignment with the ninth grade algebra curriculum. A constant comparison methodology was used when analyzing school district curriculum documents (Lunenburg & Irby, 2008, p. 94). As mentioned earlier, this method according to O'Conner et al. (2008), "…assures that all data are systematically compared to all other data in the data set. This assures that all data produced will be analyzed rather than potentially disregarded on thematic grounds" (as cited in Fram, 2013, p. 2). The constant comparison analysis method allowed the phenomenon to be described in detail by "[helping] novice researchers to develop an ability to systematically organize and reduce data" (Fram, 2013, p. 20).

The phenomenon being studied examined how ninth grade students interacted with the algebra curriculum. To study this phenomenon, the three domains, Algebra, Functions, and Statistics, from the Florida Standards for Mathematics were used for the analysis. The eighth grade pre-algebra state standards were matched with the algebra state standards based on the relationship of skills. Geometry standards that were included in the eighth grade pre-algebra curriculum were not used in the analysis. Again, the deconstructed local algebra standards were coded and used for research question three. The pre-algebra curriculum documents were separated using the cut and sort method (Bernard & Ryan, 2010, p. 63) to find common words and skills between the coded local algebra standards and the eighth grade pre-algebra state standards listed in the curriculum. The researcher utilized the constant comparison method (Lunenburg & Irby, 2008, p.94) to analyze the curriculum documents to determine the pre-algebra skills that aligned with the coded algebra skills. After matching the codes from the algebra curriculum document to the prerequisite skills found in the eighth grade pre-algebra state standards, the researcher determined which skills were introduced, repeated, or omitted. The scope and sequence of the pre-algebra school district documents were examined to see if they prepared algebra students for the selected algebra standards or if there were content omissions within the established themes (Bernard & Ryan, 2010, p. 62). The results were systematized using a coding process to make the data more manageable and meaningful (Bernard & Ryan, 2010, p. 75, 86) and recorded in tables. The collected information was documented categorically for the algebra standards that were analyzed.

Research Question Four

Current algebra curriculum documents were analyzed from a Medium Size Rural School District (2015b) to search for skills in which algebra students should be proficient. Embedded skills that students should know in order to be successful on the coded algebra standards were determined by experience algebra teachers. The embedded skills were organized based on the alignment with the themes and codes that were established previously from the algebra content standards and Algebra EOC data. This process of recognizing embedded skills and aligning them with coded standards relied on the researcher's mathematic background and the knowledge of other experienced algebra teachers. These embedded skills should be developed from previous mathematics classes in elementary and middle school. The embedded skills were reported categorically for each coded local algebra standard to determine which skills students should know before entering the algebra course so that the phenomenon being studied can be better understood.

Research Question Five

Last, the adopted text book for a Medium Size Rural School District (2015b) was evaluated for content omissions based on the coded local algebra standards from the Algebra EOC data and the school district blueprint. Again, a constant comparison methodology was used to find text book themes as they related to coded skills from the content standards (Lunenburg & Irby, 2008, p. 94). This method according to O'Conner et al. (2008), "…assures that all data are systematically compared to all other data in the data set. This assures that all data produced will be analyzed rather than potentially disregarded on thematic grounds" (as cited in Fram, 2013, p. 2).

The curriculum documents were separated using the cut and sort method (Bernard & Ryan, 2010, p. 63) to sort for common words and skills between the coded local algebra standards and the text book. The researcher utilized the constant comparison method (Lunenburg & Irby, 2008, p.94) to analyze the text book based on the occurrences or omissions of the established codes (Bernard & Ryan, 2010, p. 76). The researcher matched the coded local algebra skills from the algebra curriculum document to the material in the adopted text book for a Medium Sized Rural School District. In other words, the text book topics were compared to the coded local algebra content standards that were selected from the question one to find content omissions.

The purpose of the comparison between the coded local algebra standards and the adopted textbook was to see if the textbook fully covered the coded local algebra standards or if there were content omissions within the established themes (Bernard & Ryan, 2010, p. 62). The results were systematized using a coding process to make the data more manageable and meaningful (Bernard & Ryan, 2010, p. 75, 86) and recorded in tables. The collected information was documented categorically for the algebra standards that were analyzed.

The researcher recognizes that textbooks are adopted frequently and that analyses must look for generalizations to report as they relate to the other research questions and the algebra curriculum documents. Because the textbook was adopted under the old mathematic standards, it is possible for the textbook to contain the coded local algebra skills but still lack the questioning style of the current Algebra EOC exam. The Medium-Sized Rural School District also utilized a resource call *High School Flip Book: Common Core Standards for Mathematics* (Hart, 2012) which was not analyzed in this research. The *Flip Book* was not analyzed because the purpose of research question five was to see if the adopted textbook aligned with the curriculum document and state standards, not the supporting material.

Data Analysis

The FSA (2015) data from research question one were analyzed to determine the domain or cluster of state standards for algebra that have the lowest performance of ninth grade students. This was the only portion of the study that had quantifiable data using Algebra EOC scores in three domains for ninth graders. These data were reported in percentages and compared with eighth grade scores.

Research question two focused on the scope and sequence of the algebra curriculum documents for a Medium Size Rural School District (2015b) to see if the document entirely covered the algebra state standards or if there were content omissions. Only selected algebra state standards were used based on the Algebra EOC data from research question one. Each algebra state standard was matched with the similar coded local algebra standard to look for content omissions. The results were reported in tables based on the algebra themes.

Research question three focused on the scope and sequence of the pre-algebra curriculum documents for a Medium Size Rural School District (2015c), to see if the pre-algebra standards aligned with the algebra curriculum. Only selected algebra state standards were used based on the Algebra EOC data from research question one. Each pre-algebra state standard was matched with the similar coded local algebra standard to look for content omissions. Because the pre-algebra course was vertically aligned with the algebra course, the researcher looked for standards that related to the coded local algebra standards. If a skill was not introduced partially in the pre-algebra course, the skill was marked as omitted. The results were reported in tables based on the algebra themes.

Research question four focused on the analysis of the algebra curriculum blueprints from a Medium Size Rural School District (2015b), to find the embedded skills required for algebra success. Embedded skills were examined for selected algebra state standards that were based on the Algebra EOC data from research question one. Each coded local algebra standard was matched with skills that algebra teachers found essential for mastery. The embedded or pre-requisite skills were determined by a panel of experienced algebra teachers and reported in a table.

Research question five focused on the analysis of the algebra textbook to look for alignment with the Medium Size Rural School District (2015b) algebra curriculum. Only selected algebra state standards were used based on the Algebra EOC data from research question one. Textbook topics were matched with the similar coded local algebra standard to look for content omissions. The results were reported in tables based on the algebra themes. The results were reported in tables based on the algebra themes.

Triangulation

To ensure the qualitative research in this study was meaningful and dependable, the researcher used data triangulation (Lunenberg & Irby, 2008, p. 10). Triangulation allowed for the researcher to use multiple data sources to strengthen the validity of the research and reduce bias (Mathison, 1988, p. 13). This triangulation included the Florida Standards for algebra (Florida State, 2015a), Medium Size Rural School District algebra curriculum documents (2015b), and the Florida Standard Algebra EOC data (FLDOE, 2015). All three of the data sources were written and approved by experts in education (FLDOE, 2015, Florida State, 2015a; Council of Chief, 2016a). The purpose of triangulation in this study was not to only see where the standards, curriculum, exam data meet or separate, but to bring it together under "a more comprehensive explanatory framework" (Howe, 2012, p. 90). The triangulation allowed for a complete understanding of the phenomenon being studied, that is, how the students interacted with the algebra curriculum based on the school district curriculum and the Algebra EOC exam. The interaction with the curriculum could negatively affect Algebra EOC outcomes if course content were missing. According to Mathison (1988),

> In practice, triangulation as a strategy provides a rich and complex picture of some social phenomenon being studied, but rarely does it provide a clear path to a singular view of what is the case. I suggest that triangulation as a strategy provides evidence for the researcher to make sense of some social phenomenon, but that the triangulation strategy does not, in and of itself, do this. (p. 15)

This researcher used the triangulation of data to provide a complete view of the curriculum alignment to better understand the difficulties students had in certain areas of algebra.

Table 4

Research Questions, Data Source, and Method

Number	Research Questions	Data Sources	Method
1	Which algebra domains have the lowest student performance based on the ninth grade Algebra EOC exam (2015)?	Florida Department of Education (2015b) statewide data on Algebra Florida Standards Assessment or Medium Size Rural School District benchmark test data	Determine percentage of lowest performance standards (FLDOE, 2015a)
2	Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the algebra content omissions, if any, in the school district algebra curriculum that may contribute to the low scores on those standards?	Algebra Curriculum Blueprint (Medium Size Rural School District, 2015b)	Document analysis using constant comparison method to search for content omissions (Lunenburg & Irby, 2008, p. 94)
3	Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district pre-algebra curriculum that should align with those algebra standards?	Pre-Algebra Curriculum Blueprint (Medium Size Rural School District, 2015d)	Document analysis using constant comparison method to search for content omissions (Lunenburg & Irby, 2008, p. 94).
4	Based on document analysis and expert opinion, what are the knowledge skills embedded in the algebra curriculum that if missing, will contribute to below proficiency on the Florida algebra state standards?	Algebra Curriculum Blueprint (Medium Size Rural School District, 2015a)	Document analysis using constant comparison method and expert opinion to search for embedded skills (Lunenburg & Irby, 2008, p. 94)
5	Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the missing content standards and skills, if any, in the adopted text book that should align with the district curriculum, state standards, and expert opinion?	Text book examination for adopted text book in the school district. (Medium Size Rural School District, 2015b)	Text book analysis using constant comparison method to search for content omissions (Lunenburg & Irby, 2008, p. 94).

Summary

The qualitative document analysis of algebra curriculum for a Medium Size Rural School District (2015b), offered several advantages. First, the analysis allowed ninth grade algebra student data to be connected to the school district curriculum. Second, algebra curriculum analysis looked for content omissions to address the knowledge voids of some students. Ultimately, using this strategy, curriculum can be improved to help close the achievement gap for students who fall behind. Third, algebra curriculum can be aligned with other courses so embedded skills needed for algebra can be addressed at earlier grade levels. Last, textbook alignment with algebra state standards can be assessed to see if the text books are meeting the algebra needs of students.

Organization of Study

This chapter contained a description of the methodology used for this phenomenological study. In chapter four, algebra exam data were examined to determine low performing areas on mathematic standards to answer the research questions. A constant comparison method was used to determine alignment of curriculum with algebra content standards and to find content omissions in the algebra curriculum. Chapter four also contains the data for this algebra curriculum alignment research. Chapter five contains the research results, implications of the study, and suggestions for further research.

CHAPTER 4: PRESENTATION AND ANALYSIS OF DATA

Introduction

This qualitative study intended to analyze district curriculum alignment documents to find content omissions that may contribute to low Algebra End of Course exam (EOC) scores. The ninth grade algebra curriculum, the algebra textbook, and the eighth grade pre-algebra curriculum for a Medium Size Rural School District (2015c) were examined for missing content that may lead to knowledge voids in the content of the algebra course. Another aspect of this study was to examine the embedded skills needed from previous classwork to be successful in an algebra class. If there were content omissions in the curriculum, they can be added to the curriculum to increase student performance.

The researcher examined each research question individually to look for alignment within the school district algebra curriculum. The researcher analyzed Algebra FSA data for a Medium Sized Rural School District to find the low performing domains in the algebra curriculum. Next, the researcher analyzed algebra curriculum documents for the Medium Sized Rural School District in search of content omissions. Third, the researcher compared the algebra curriculum documents with the pre-algebra curriculum documents for the Medium Sized Rural School District to compare for alignment. Fourth, the researcher analyzed the algebra curriculum to determine embedded skills needed for success the in algebra course. Last, the textbook for the Medium Sized Rural School District was analyzed for alignment with the algebra curriculum documents.

Research Questions

This study addressed the algebra Common Core standards for the state of Florida, referred to as the Mathematics Florida Standards. The research questions were:

1. Which algebra domains have the lowest student performance based on the ninth grade Algebra EOC exam (2015)?
2. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district algebra curriculum that may contribute to the low scores on those standards?
3. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district pre-algebra curriculum that should align with those algebra standards?
4. Based on document analysis and expert opinions, what are the knowledge skills embedded in the algebra curriculum that if missing, will contribute to below proficiency on the Florida algebra state standards?
5. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the missing content standards and skills, if any, in the adopted text book that should align with the district curriculum, state standards, and expert opinion?

Testing the Research Questions

Research Question One

Which algebra domains have the lowest student performance based on the ninth grade Algebra EOC exam (2015)?

Data were collected through Florida Standards Assessment Algebra EOC data (2015) provided to the Medium Sized Rural School District by the Florida Department of Education. These documents were not available online and were given to the testing department of the Medium Sized Rural School District (2015e) by the FLDOE. Because 2015 was a pilot year for the FSA Algebra EOC, pass and fail scores were not reported in time for this study. The reported data showed student achievement in three domains: Algebra, Functions, and Statistics. The data only showed student performance in each domain and did not break down the students' performance for individual state standards.

The researcher requested that the Medium Sized Rural School District Testing Department break down the data in percentages for each category for ninth grade students. The percentages were based on ninth grade students correctly answering 50% of the questions in the corresponding domain for the 2015 spring FSA Algebra EOC. It is important to note that the 50% mark for each category was an arbitrary number and in no way expressed a passing or failing score on the Algebra EOC exam. There were 22 questions in the Algebra domain, 22 questions in the Function domain, and eight questions in the Statistics domain of the 2015 Algebra EOC exam (Medium Sized Rural School District, 2015e). Both the eighth grade and ninth grade percentages were reported for comparison purposes.

The eighth grade algebra students were most likely on an honors tracking system in mathematics. Of the 1405 eighth grade students who completed the 2015 spring Algebra EOC, 424 students (30.18%) answered 50% of the questions in the Algebra domain correctly. Of the 1707 ninth grade students who completed the 2015 spring Algebra EOC, 36 students (2.11%) answered 50% of the questions in the Algebra domain correctly. The results were provided by the Medium Sized Rural School District (2015e) and reported in Table 5.

Table 5

Percent of Students who Correctly Answered 50% in the Algebra Domain

Grade	Number Of Students	Number Of Students With 50% Correct	Percentage Of Students With 50% Correct
8	1405	424	30.18
9	1707	36	2.11

Of the 1405 eighth grade students who completed the 2015 spring Algebra EOC, 356 students (25.34%) answered 50% of the questions in the Functions domain correctly. Of the 1707 ninth grade students who completed the 2015 spring Algebra EOC, 22 students (1.29%) answered 50% of the questions in the Functions domain correctly. The results were provided by the Medium Sized Rural School District (2015e) and reported in Table 6.

Table 6

Percentage of Students who Correctly Answered 50% in the Function Domain

Grade	Number Of Students	Number Of Students With 50% Correct	Percentage Of Students With 50% Correct
8	1405	356	25.34
9	1707	22	1.29

Of the 1405 eighth grade students who completed the 2015 spring Algebra EOC, 773 students (55.02%) answered 50% of the questions in the Statistics domain correctly. Of the 1707 ninth grade students who completed the 2015 spring Algebra EOC, 382 students (22.38%) answered 50% of the questions in the Statistics domain correctly. The results were provided by the Medium Sized Rural School District (2015e) and reported in Table 7.

Table 7

Percentage of Students who Correctly Answered 50% in the Statistics Domain

Grade	Number Of Students	Number Of Students With 50% Correct	Percentage Of Students With 50% Correct
8	1405	773	55.02
9	1707	382	22.38

Research Question Two

Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district algebra curriculum that may contribute to the low scores on those standards?

Algebra curriculum documents were analyzed for the Medium Sized Rural School District (2015b). The documents were available to the public through the online website for the Medium Sized School District. First, the researcher analyzed each algebra unit in the algebra curriculum document to see which state standards were being taught and if there were any omitted state standards in the documents. Second, the algebra state standards were organized according to their domain found in the Florida Standards for Mathematics. Next, the algebra state standards were matched with the test specifications for the Florida Standard Assessment Algebra EOC (see Appendix A for algebra tested standards). The cut and sort method (Bernard & Ryan, 2010, p. 63) was used to organize the tested state standards. If a standard was not tested then it was dropped from the analysis. The mathematics state standards for the domain called Number Quantities was eliminated from the analysis because it was not a reported category for the Algebra EOC exam. After the algebra state standards were determined to be the essential tested standards, the school district (local) version of the state standards were coded. Those coded local standards or skills were analyzed to see if they completely covered the state mathematics' standards. The analysis was performed by matching the coded local algebra skill categories with the algebra state standards to examine for breadth of coverage. It is important to note that each coded local algebra standards can have multiple skills within the category itself.

<u>Content Omission for Algebra: Polynomials and Rational Expressions</u>

A document analysis was performed for the domain, *Algebra: Polynomials and Rational Expressions* (see Appendix A for tested algebra standards). There were only two algebra state standards for this domain and both were found in the algebra curriculum document (Medium Sized Rural School District, 2015b; 2015k; 2015m). The curriculum document was analyzed for algebra content omissions and of the six local standard coded skill categories, one omitted skill was found. The algebra state standard MAFS.912.A-APR.2.3 asked students to be able to "Identify zeros of polynomials" (Florida Standards, 2015a, p. 44) and "use the zeros to construct a rough graph" (Florida Standards, 2015a, p. 44). However, the curriculum document only stated in the local power standard to "factor polynomials using any method [and] use the x-intercepts of a polynomial function and the x-y table to construct a rough graph of the function" (Medium Size Rural School District, 2015m, p. 1). The results were recorded in Table 8.

Table 8

Content Omissions for Algebra: Polynomials and Rational Expressions (*n* = 2)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.A-APR.1.1	3	APP-OPER	I	6
		DEF-CLOS	I	6
		IDE-OPER	I	6
MAFS.912.A-APR.2.3	3	FAC-POLY	I	8
		GRA-FUNC	I	8
		IDE-ZERO	O	8

Note. O = Omitted, I = Included

<u>Content Omissions for Algebra: Creating Equations</u>

A document analysis was performed for the domain, *Algebra: Creating Equations* (see Appendix A for tested algebra standards). There were four algebra state standards for the domain, all of which were found in the algebra curriculum document (Medium Sized Rural School District, 2015b; 2015f; 2015h, 2015i, 2015l). The curriculum document was analyzed for algebra content omissions and no omitted skills were found. The analysis showed that all 23 local standard coded skill categories were covered in the algebra curriculum document. The results were reported in Table 9.

Table 9

Content Omissions for Algebra: Creating Equations ($n = 4$)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.A-CED.1.1	6	APP-OPER	I	1
		CRE-EQUA	I	1, 7
		CRE-INEQ	I	1
		DES-RELA	I	1
		SOL-EQUA	I	1, 7
		SOL-INEQ-	I	1
MAFS.912.A-CED.1.2	9	CRE-EQUA	I	3, 4
		CRE-EQUA-2	I	3, 4
		DES-RELA	I	3, 4
		GRA-EQUA	I	3, 4
		IDE OPER	I	3, 4
		IDE-QUAN	I	3, 4
		JUS-QUAN	I	3, 4
		LAB-GRAP	I	3, 4
		MOD-RELA	I	3, 4
MAFS.912.A-CED.1.3	5	DET-EQUA	I	1, 4
		DET-INEQ	I	1, 4
		INT-SOLU	I	1, 4
		REC-CONS	I	1, 4
		REP-CONS	I	1, 4
MAFS.912.A-CED.1.4	3	DEF-QUAN	I	1
		IDE-QUAN	I	1
		REA-EQUA	I	1

Note. O = Omitted, I = Included

Content Omissions for Algebra: Seeing Structure in Expressions

A document analysis was performed for the domain, *Algebra: Seeing Structure in Expressions* (see Appendix A for tested algebra standards). There were three algebra state standards for the domain, all of which were found in the algebra curriculum document (Medium Sized Rural School District, 2015b; 2015f; 2015j; 2015k; 2015l; 2015m). The curriculum document was analyzed for algebra content omissions and no omitted skills were found. The analysis showed that all 23 local standard coded skill categories were covered in the algebra curriculum document. The results were reported in Table 10.

Table 10

Content Omissions for Algebra: Seeing Structure in Expressions (*n* = 3)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.A-SSE.1.1	7	CRE-EQUA	I	1
		CRE-INEQ	I	1
		DEF-PART	I	6
		INT-EXPR	I	6
		INT-PART	I	6
		MOD-RELA	I	1
		REC-PART	I	1
MAFS.912.A-SSE.1.2	3	CLA-EXPR	I	6
		IDE-STRU	I	6
		REW-EXPR	I	6
MAFS.912.A-SSE.2.3	13	EXP-PROP-E	I	5, 8
		EXP-PROP-Q	I	6, 7
		EXP-QUAD	I	6, 7
		FAC-EQUA	I	6, 7, 8
		FAC-POLY	I	6, 7, 8
		FOR-TABL	I	7, 8
		GRA-FUNC	I	7. 8
		IDE ZERO	I	7, 8
		IDE-PROP	I	6, 7
		PRO-EXPR-E	I	5, 8
		PRO-EXPR-Q	I	6, 7
		REC-EXPR	I	5, 6, 7, 8
		TRA-EXPR-E	I	8

Note. O = Omitted, I = Included

Content Omissions for Algebra: Reasoning with Equations and Inequalities

A document analysis was performed for the domain, *Algebra: Reasoning with Equations and Inequalities* (see Appendix A for tested algebra standards). There were four algebra state standards for the domain, all of which were found in the algebra curriculum document (Medium Sized Rural School District, 2015b; 2015f; 2015h; 2015i; 2015l; 2015m). The curriculum document was analyzed for algebra content omissions and no omitted skills were found. The analysis showed that all 43 local standard coded skill categories were covered in the algebra curriculum document. The results were reported in Table 11.

Table 11

Content Omissions for Algebra: Reasoning with Equations and Inequalities (*n* = 8)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.A-REI.1.1	9	CHO-METH	I	1
		CON-ARGU	I	1
		DET-SOLU	I	1
		EXP-STEP	I	1
		IDE-PROP	I	1
		JUS-METH	I	1
		JUS-SOLU	I	1
		SOL-EQUA	I	1
		USE-PROP	I	1
MAFS.912.A-REI.2.3	5	DEF-PART	I	1
		IDE-PROP	I	1
		INT-PART	I	1
		SOL-EQUA	I	1
		SOL-INEQ	I	1
MAFS.912.A-REI.2.4	5	DER-FORM	I	7
		DET-STEP	I	7
		EXP-SOLU	I	7
		FAC-EQUA	I	7
		SOL-EQUA	I	7
MAFS.912.A- REI.3.5	4	EXP-PROP	I	4
		JUS-STEP	I	4
		SOL-EQUA	I	4
		USE-PROP	I	4
MAFS.912.A-REI.3.6	3	CHO-METH	I	4, 7
		JUS-METH	I	4, 7
		SOL-EQUA	I	4, 7
MAFS.912.A-REI.4.10	3	EXP-SOLU	I	3
		GRA-EQUA	I	3
		REC-GRAP	I	3

Note. O = Omitted, I = Included

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.A-REI.4.11	9	CHO-METH	I	4, 8
		EXP-SOLU	I	4, 8
		FOR-TABL	I	4, 8
		GRA-COOR	I	4, 8
		GRA-FUNC	I	4, 8
		INT-GRAP	I	4, 8
		REC-FUNC-	I	4, 8
		USE-TECH	I	4, 8
		WRI-FUNC	I	4, 8
MAFS.912.A-REI.4.12	5	EXP-SOL	I	4
		GRA-INEQ	I	4
		IDE-SOLU-I	I	4
		INT-GRAP	I	4
		SOL-INEQ	I	4

Note. O = Omitted, I = Included

Content Omissions for Functions: Interpreting Functions

A document analysis was performed for the domain, *Functions: Interpreting Functions* (see Appendix B for tested algebra standards). There were nine algebra state standards for the domain, all of which were found in the algebra curriculum document (Medium Sized Rural School District, 2015b; 2015g; 2015h; 2015j; 2015l; 2015m). The curriculum document was analyzed for algebra content omissions and no omitted skills were found. The analysis showed that all 63 local standard coded skill categories were covered in the algebra curriculum document. The results were reported in Table 12.

Table 12

Content Omissions for Functions: Interpreting Functions (n = 9)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.F-IF.1.1	4	DET-FUNC	I	2
		EVA-FUNC	I	2
		IDE-PART	I	2
		SOL-FUNC	I	2
MAFS.912.F-IF.1.2	6	DEF-FUNC	I	2
		DET-FUNC	I	2
		DET-PART	I	2
		EVA-FUNC	I	2
		INT-FUNC	I	2
		WRI-FUNC	I	2
MAFS.912.F-IF.1.3	3	IDE-PART	I	3
		REC-FUNC-	I	3
		REC-SEQU	I	3
MAFS.912.F-IF.2.4	7	DEF-GRAP	I	2
		GRA-FUNC	I	2
		IDE-QUAN	I	2
		INT-FUNC	I	2
		INT-GRAP	I	2
		MOD-RELA	I	2
		REC-GRAP	I	2
MAFS.912.F-IF.2.5	5	DES-RELA	I	2
		EXP-FUNC	I	2
		IDE-PART	I	2
		INT-GRAP	I	2
		REC-GRAP	I	2
MAFS.912.F-IF.2.6	3	INT-SLOP	I	3
		REC-SLOP	I	3
		SOL-SLOP	I	3

Note. O = Omitted, I = Included

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.F-IF.3.7	15	ANA FUNC	I	8
(a, b, c, e)		CC-FUNC	I	3, 8
		CC-PART-	I	8
		DES-RELA	I	8
		EXP-FUNC	I	3, 8
		FAC-POLY	I	8
		GRA-FUNC	I	3, 8
		IDE-FORM	I	8
		IDE-FUNC	I	8
		IDE-PART	I	8
		IDE-ZERO	I	8
		INT-GRAP	I	8
		LAB-GRAP	I	3, 8
		MOD-FUNC	I	8
		USE-TECH	I	3, 8
MAFS.912.F-IF.3.8	15	CLA-EXPR	I	5
		EXP-QUAD	I	7
		FAC-POLY	I	7
		GRO-DECA	I	5
		IDE-FORM	I	5, 7
		IDE-PART	I	5, 7
		IDE-PROP	I	5
		IDE-ZERO	I	7
		INT-EXPR	I	5
		INT-FUNC	I	5, 7
		INT-GRAP	I	5, 7
		REC-EXPR-Q	I	7
		REC-GRAP	I	7
		USE-PROP	I	5
		WRI-FUNC	I	5, 7
MAFS.912.F-IF.3.9	5	CC-FUNC	I	2, 8
		CC-PART	I	2, 8
		IDE-FUNC	I	2, 8
		IDE-PART	I	2, 8
		INT GRAP	I	2, 8

Note. O = Omitted, I = Included

Content Omissions for Functions: Building Functions

A document analysis was performed for the domain, *Functions: Building Functions* (see Appendix B for tested algebra standards). There were four algebra state standards for the domain, all of which were found in the algebra curriculum document (Medium Sized Rural School District, 2015b; 2015h; 2015k; 2015l; 2015m). The curriculum document was analyzed for algebra content omissions and no omitted skills were found. The analysis showed that all 22 of the local standard coded skill categories were covered in the algebra curriculum document. The results were reported in Table 13.

Table 13

Content Omissions for Functions: Building Functions (n = 2)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.F-BF.1.1	14	APP-OPER	I	3, 7
		COB-FUNC	I	3, 6, 7
		COM-FUNC	I	6
		CRE-FUNC	I	3, 6, 7
		DEF-FUNC	I	3
		DEF-RECU	I	3
		DES-RELA	I	3, 7
		EVA-FUNC	I	3, 7
		EXP-FUNC	I	3, 7
		IDE-PART	I	3, 7
		IDE-QUAN	I	3, 7
		MOD-FUNC	I	6
		MOD-RELA	I	6
		WRI-FUNC	I	3
MAFS.912.F-BF.2.3	8	CC-FUNC	I	3, 8
		EVA-FUNC	I	3, 8
		EXP-FUNC	I	3, 8
		GRA-FUNC	I	3, 8
		IDE-PART	I	3, 8
		INT-GRAP	I	3, 8
		TRA-FUNC	I	3, 8
		USE-TECH	I	3, 8

Note. O = Omitted, I = Included

Content Omissions for Functions: Linear, Quadratic, and Exponential Models

A document analysis was performed for the domain, *Functions: Linear, Quadratic, and Exponential Models* (see Appendix B for tested algebra standards). There were four algebra state standards for the domain, all of which were found in the algebra curriculum document (Medium Sized Rural School District, 2015b; 2015h; 2015j; 2015m). The curriculum document was analyzed for algebra content omissions and no omitted skills were found. The analysis showed that all 27 local standard coded skill categories were covered in the algebra curriculum document. The results were reported in Table 14.

Table 14

Content Omissions for Functions: Linear, Quadratic, and Exponential Models (*n* = 4)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.F-LE.1.1	10	CC-FUNC	I	3, 5
		DES-RELA	I	3, 5
		GRO-DECA	I	5
		IDE-FUNC	I	3, 5
		IDE-PART	I	3, 5
		IDE-QUAN	I	3, 5
		MOD-FUNC	I	3, 5
		PRV-FUNC	I	3, 5
		REC-FUNC	I	3, 5
		SOL-FUNC	I	3, 5
MAFS.912.F-LE.1.2	6	CRE-FUNC	I	3, 5
		DES-RELA	I	3, 5
		INT-GRAP	I	3, 5’
		REC-FUNC	I	3, 5
		REC-SEQU	I	3, 5
		SOL-FUNC	I	3, 5
MAFS.912.F-LE.1.3:	5	CC-FUNC	I	5, 8
		CC-PARTs	I	5, 8
		IDE-QUAN	I	5, 8
		INT-GRAP	I	5, 8
		SOL-FUNC	I	5, 8
MAFS.912.F-LE.2.5:	6	IDE-PART	I	3, 5
		INT-FUNC	I	3, 5
		INT-GRAP	I	3, 5
		REC-FUNC	I	3, 5
		REC-SLOP	I	3, 5
		TRA-FUNC	I	3, 5

Note. O = Omitted, I = Included

Content Omissions for Statistics and Probability: Interpreting Data

A document analysis was performed for the domain, *Statistics and Probability: Interpreting Data* (see Appendix C for tested algebra standards). There were eight algebra state standards for the domain, all of which were found in the algebra curriculum document (Medium Sized Rural School District, 2015b; 2015h; 2015n). The curriculum document was analyzed for algebra content omissions and no omitted skills were found. The analysis showed that all 36 local standard coded skill categories were covered in the algebra curriculum document. The results were reported in Table 15.

Table 15

Content Omissions for Statistics and Probability: Interpreting Data ($n = 8$)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Coverage	Unit of study
MAFS.912.S-ID.1.1	2	ANA-DATA	I	9
		REP-DATA	I	9
MAFS.912.S-ID.1.2	3	ANA-DATA	I	9
		CC-DATA	I	9
		CHO-METH	I	9
MAFS.912.S-ID.1.3	3	ANA-DATA	I	9
		DES-DATA	I	9
		INT-DATA	I	9
MAFS.912.S-ID.2.5	7	ANA-DATA	I	9
		CAL-DATA	I	9
		CC-DATA	I	9
		FOR-TABL	I	9
		INT-DATA	I	9
		REC-DATA	I	9
		SUM-DATA	I	9
MAFS.912.S-ID.2.6	9	ANA-DATA	I	9
		DES-DATA	I	9
		EXP-FUNC	I	9
		GRA-COOR	I	9
		GRA-FUNC	I	9
		IDE-QUAN	I	9
		MOD-FUNC	I	9
		REP-DATA	I	9
		SOL-FUNC	I	9
MAFS.912.S-ID.3.7	3	INT-DATA	I	3, 9
		INT-SLOP	I	3, 9
		MOD-DATA	I	9
MAFS.912.S-ID.3.8	6	ANA-DATA	I	9
		DEF-DATA	I	9
		DES-RELA	I	9
		INT-DATA	I	9
		MOD-DATA	I	9
		USE-TECH	I	9
MAFS.912.S-ID.3.9	3	CC-DATA	I	9
		DEF-DATA	I	9
		INT-DATA	I	9

Note. O = Omitted, I = Included

Research Question Three

Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district pre-algebra curriculum that should align with those algebra standards?

Curriculum documents were analyzed for a Medium Sized Rural School District (2015b; 2015c). The documents were available to the public online. The researcher used the same categorical domains for the algebra state standards that were used in research question two. The researcher analyzed each pre-algebra unit in the pre-algebra curriculum document (Medium Sized Rural School District, 2015c) to see which standards were being taught. Next, the pre-algebra state standards in the eighth grade pre-algebra curriculum (Medium Sized Rural School District, 2015c) were matched with the algebra state standard used in research question two. Pre-algebra state standards that did not relate to the algebra curriculum and tested algebra standards were dropped from the analyses. For example, if the pre-algebra standard was related to a geometry standard, it was not used in this research. Once the pre-algebra state standards were determined to be essential for success in the algebra course and the Algebra EOC exam, they were compared with the coded local algebra standards. The results were recorded in a table as either included or omitted. It is important to recognize that some concepts may be taught in earlier grade levels but only the eighth grade material was used to answer the research question pertaining to alignment between the algebra and pre-algebra courses.

Pre-Algebra Omissions for Algebra: Polynomials and Rational Expressions

A document analysis was performed for the domain, *Algebra: Polynomials and Rational Expressions* (see Appendix A for tested algebra standards). The domain contained two algebra state standards. Next, the pre-algebra curriculum documents were analyzed and matched with the algebra state standards to see if there were omitted prerequisite skills in the pre-algebra curriculum. The analysis showed that two of the six local standard coded skill categories were introduced in the pre-algebra curriculum document (Medium Sized Rural School District, 2015b; 2015c). The results were reported in Table 16.

Table 16

Pre-Algebra Omissions for Algebra: Polynomial and Rational Expressions ($n = 2$)

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage
MAFS.912.A-APR.1.1	MAFS.8.EE.1.1	APP-OPER	I
		DEF-CLOS	O
		IDE-OPER	I
MAFS.912.A-APR.2.3		FAC-POLY	O
		GRA-FUNC	O
		IDE-ZERO	O

Note. O = Omitted, I = Included

Pre-Algebra Omissions for Algebra: Creating Equations

A document analysis was performed for the domain, *Algebra: Creating Equations* (see Appendix A for tested algebra standards). Next, the pre-algebra curriculum documents were analyzed and matched with the four algebra state standards to see if there were omitted prerequisite skills in the pre-algebra curriculum. The analysis showed that 17 of the 23 local standard coded skill categories were introduced in the pre-algebra curriculum document (Medium Sized Rural School District, 2015b; 2015c). The results were reported in Table 17.

Table 17

Pre-Algebra Omissions for Algebra: Creating Equations (n = 4)

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage	Limitation
MAFS.912.A-CED.1.1	MAFS.8.EE.3.7	APP-OPER	I	Linear
		CRE-EQUA	O	
		CRE-INEQ	O	
		DES-RELA	I	
		SOL-EQUA	I	
		SOL-INEQ-	I	
MAFS.912.A-CED.1.2	MAFS.8.EE.1.1	CRE-EQUA	O	
	MAFS.8.EE.3.7	CRE-EQUA-2	O	
	MAFS.8.F.2.4	DES-RELA	I	
	MAFS.8.F.2.5	GRA-EQUA	I	
		IDE OPER	I	
		IDE-QUAN	I	
		JUS-QUAN	I	
		LAB-GRAP	I	
		MOD-RELA	I	
MAFS.912.A-CED.1.3	MAFS.8.EE.3.7	DET-EQUA	I	
	MAFS.8.F.1.1	DET-INEQ	O	
		INT-SOLU	I	
		REC-CONS	I	
		REP-CONS	O	
MAFS.912.A-CED.1.4	MAFS.8.EE.3.7	DEF-QUAN	I	
		IDE-QUAN	I	
		REA-EQUA	I	

Note. O = Omitted, I = Included

Pre-Algebra Omissions for Algebra: Seeing Structure in Expressions

A document analysis was performed for the domain, *Algebra: Seeing Structure in Expressions* (see Appendix A for tested algebra standard). Next, the pre-algebra curriculum documents were analyzed and matched with the three algebra state standards to see if there were omitted prerequisite skills in the pre-algebra curriculum. The analysis showed that 13 of the 23 local standard coded skill categories were introduced in the pre-algebra curriculum document (Medium Sized Rural School District, 2015b; 2015c). The results were reported in a Table 18.

Table 18

Pre-Algebra Omissions for Algebra: Seeing Structure in Expressions (*n* = 3)

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage	Limitation
MAFS.912.A-SSE.1.1	MAFS.8.EE.2.5	CRE-EQUA	I	
	MAFS.8.F.2.4	CRE-INEQ	O	
	MAFS.8.F.2.5	DEF-PART	O	
		INT-EXPR	I	
		INT-PART	O	
		MOD-RELA	I	
		REC-PART	O	
MAFS.912.A-SSE.1.2	MAFS.8.EE.1.1	CLA-EXPR	I	
	MAFS.8.EE.3.7	IDE-STRU	I	
		REW-EXPR	I	
MAFS.912.A-SSE.2.3	MAFS.8.EE.1.1	EXP-PROP-E	O	Linear
	MAFS.8.EE.1.2	EXP-PROP-Q	O	
	MAFS.8.F.2.5	EXP-QUAD	I	
	MAFS.8.F.2.6	FAC-EQUA	I	
	MAFS.8.NS.1.2	FAC-POLY	O	
		FOR-TABL	I	
		GRA-FUNC	I	
		IDE ZERO	I	
		IDE-PROP	I	
		PRO-EXPR-E	O	
		PRO-EXPR-Q	O	
		REC-EXPR	I	
		TRA-EXPR-E	O	

Note. O = Omitted, I = Included

Pre-Algebra Omissions for Algebra: Reasoning with Equations and Inequalities

A document analysis was performed for the domain, *Algebra: Reasoning with Equations and Inequalities* (see Appendix A for tested algebra standards). Next, the pre-algebra curriculum documents were analyzed and matched with the eight algebra state standards to see if there were omitted prerequisite skills in the pre-algebra curriculum. The analysis showed that 26 of the 43 local standard coded skill categories were introduced in the pre-algebra curriculum document (Medium Sized Rural School District, 2015b; 2015c). The results were reported in Table 19.

Table 19

Pre-Algebra Omissions for Algebra: Reasoning with Equations and Inequalities (*n* = 8)

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage	Limitation
MAFS.912.A-REI.1.1	MAFS.8.EE.1.1	CHO-METH	I	
	MAFS.8.EE.3.7	CON-ARGU	O	
		DET-SOLU	I	
		EXP-STEP	I	
		IDE-PROP	I	
		JUS-METH	O	
		JUS-SOLU	I	
		SOL-EQUA	I	
		USE-PROP	I	
MAFS.912.A-REI.2.3	MAFS.8.EE.3.7	DEF-PART	I	
		IDE-PROP	I	
		INT-PART	I	
		SOL-EQUA	I	
		SOL-INEQ	O	
MAFS.912.A-REI.2.4	MAFS.8.EE.1.2	DER-FORM	O	Exponents
	MAFS.8.NS.1.2	DET-STEP	O	and square
		EXP-SOLU	O	roots
		FAC-EQUA	O	
		SOL-EQUA	I	
MAFS.912.A-REI.3.5	MAFS.8.EE.1.1	EXP-PROP	O	Linear
	MAFS.8.EE.3.7	JUS-STEP	O	
	MAFS.8.EE.3.8	SOL-EQUA	I	
		USE-PROP	I	
MAFS.912.A-REI.3.6	MAFS.8.F.2.5	CHO-METH	I	Linear
	MAFS.8.EE.3.7	JUS-METH	O	
	MAFS.8.EE.3.8	SOL-EQUA	I	
MAFS.912.A-REI.4.10	MAFS.8.EE.2.5	EXP-SOLU	I	
	MAFS.8.F.2.5	GRA-EQUA	I	
	MAFS.8.F.2.6	REC-GRAP	I	
MAFS.912.A-REI.4.11	MAFS.8.EE.3.8	CHO-METH	O	Linear
	MAFS.8.F.2.4	EXP-SOLU	O	
	MAFS.8.F.2.5	FOR-TABL	I	
	MAFS.8.F.2.6	GRA-COOR	I	
		GRA-FUNC	I	
		INT-GRAP	I	
		REC-FUNC-	I	
		USE-TECH	O	
		WRI-FUNC	I	

Note. O = Omitted, I = Included

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage	Limitation
MAFS.912.A-REI.4.12	MAFS.8.EE.2.5 MAFS.8.F.2.5	EXP-SOL	O	Equations
		GRA-INEQ	I	
		IDE-SOLU-I	O	
		INT-GRAP	O	
		SOL-INEQ	O	

Note. O = Omitted, I = Included

Pre-Algebra Omissions for Functions: Interpreting Functions

A document analysis was performed for the domain, *Functions: Interpreting Functions* (see Appendix B for tested algebra standards). Next, the pre-algebra curriculum documents were analyzed and matched with the nine algebra state standards to see if there were omitted prerequisite skills in the pre-algebra curriculum. The analysis showed that 43 of the 63 local standard coded skill categories were introduced in the pre-algebra curriculum document (Medium Sized Rural School District, 2015b; 2015c). The results were reported in Table 20.

Table 20

Pre-Algebra Omissions for Functions: Interpreting Functions (n = 9)

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage	Limitation
MAFS.912.F-IF.1.1	MAFS.8.EE.3.7	DET-FUNC	I	
	MAFS.8.F.1.1	EVA-FUNC	O	
		IDE-PART	I	
		SOL-FUNC	I	
MAFS.912.F-IF.1.2	MAFS.8.F.1.1	DEF-FUNC	I	
	MAFS.8.F.1.3	DET-FUNC	I	
	MAFS.8.F.2.4	DET-PART	I	
	MAFS.8.F.2.5	EVA-FUNC	O	
		INT-FUNC	I	
		WRI-FUNC	I	
MAFS.912.F-IF.1.3	MAFS.8.F.1,1	IDE-PART	I	
		REC-FUNC-	O	
		REC-SEQU	O	
MAFS.912.F-IF.2.4	MAFS.8.EE.2.5	DEF-GRAP	I	
	MAFS.8.F.1.2	GRA-FUNC	I	
	MAFS.8.F.1.3	IDE-QUAN	I	
	MAFS.8.F.2.4	INT-FUNC	I	
	MAFS.8.F.2.5	INT-GRAP	I	
		MOD-RELA	I	
		REC-GRAP	I	
MAFS.912.F-IF.2.5	MAFS.8.EE.2.5	DES-RELA	I	
	MAFS.8.F.1.1	EXP-FUNC	O	
	MAFS.8.F.1.2	IDE-PART	I	
	MAFS.8.F.2.5	INT-GRAP	I	
		REC-GRAP	I	
MAFS.912.F-IF.2.6	MAFS.8.EE.2.5	INT-SLOP	I	
	MAFS.8.EE.2.6	REC-SLOP	I	
	MAFS.8.F.1.1	SOL-SLOP	I	
	MAFS.8.F.1.2			
	MAFS.8.F.1.3			
	MAFS.8.F.2.4			
	MAFS.8.F.2.5			
	MAFS.8.F.2.6			

Note. O = Omitted, I = Included

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage	Limitation
MAFS.912.F-IF.3.7	MAFS.8.F.1.2	ANA FUNC	I	Graph
(a, b, c, e)	MAFS.8.EE.2.5	CC-FUNC	I	Linear,
	MAFS.8.F.1.1	CC-PART-	O	Interpret
	MAFS.8.F.1.2	DES-RELA	I	both linear
	MAFS.8.F.1.3	EXP-FUNC	I	and
	MAFS.8.F.2.4	FAC-POLY	O	nonlinear
	MAFS.8.F.2.5	GRA-FUNC	I	
	MAFS.8.F.2.6	IDE-FORM	I	
		IDE-FUNC	I	
		IDE-PART	O	
		IDE-ZERO	O	
		INT-GRAP	I	
		LAB-GRAP	I	
		MOD-FUNC	I	
		USE-TECH	O	
MAFS.912.F-IF.3.8	MAFS.8.EE.1.1	CLA-EXPR	O	Graph
	MAFS.8.EE.1.2	EXP-QUAD	O	Linear,
	MAFS.8.EE.3.7	FAC-POLY	O	Interpret
	MAFS.8.F.1.2	GRO-DECA	O	both linear
	MAFS.8.F.1.3	IDE-FORM	O	and
	MAFS.8.F.2.5	IDE-PART	O	nonlinear
		IDE-PROP	O	
		IDE-ZERO	O	
		INT-EXPR	O	
		INT-FUNC	O	
		INT-GRAP	I	
		REC-EXPR-Q	I	
		REC-GRAP	I	
		USE-PROP	I	
		WRI-FUNC	I	
MAFS.912.F-IF.3.9	MAFS.8.EE.3.7	CC-FUNC	I	
	MAFS.8.EE.3.8	CC-PART	I	
	MAFS.8.F.1.1	IDE-FUNC	I	
	MAFS.8.F.1.2	IDE-PART	I	
	MAFS.8.F.1.3	INT GRAP	I	
	MAFS.8.F.2.4			
	MAFS.8.F.2.5			

Note. O = Omitted, I = Included

Pre-Algebra Omissions for Functions: Building Functions

A document analysis was performed for the domain, *Functions: Building Functions* (see Appendix B for tested algebra standards). Next, the pre-algebra curriculum documents were analyzed and matched with the two algebra state standards to see if there were omitted prerequisite skills in the pre-algebra curriculum. The analysis showed that 16 of the 22 local standard coded skill categories were introduced in the pre-algebra curriculum document (Medium Sized Rural School District, 2015b; 2015c). The results were reported in Table 21.

Table 21

Pre-Algebra Omissions for Functions: Building Functions (*n* = 2)

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage	Limitation
MAFS.912.F-BF.1.1	MAFS.8.EE.3.7	APP-OPER	I	Create Linear, Interpret both linear and nonlinear
	MAFS.8.EE.3.8	COB-FUNC	I	
	MAFS.8.F.1.1	COM-FUNC	I	
	MAFS.8.F.1.2	CRE-FUNC	I	
	MAFS.8.F.1.3	DEF-FUNC	I	
	MAFS.8.F.2.4	DEF-RECU	O	
	MAFS.8.F.2.5	DES-RELA	I	
		EVA-FUNC	O	
		EXP-FUNC	I	
		IDE-PART	I	
		IDE-QUAN	I	
		MOD-FUNC	I	
		MOD-RELA	I	
		WRI-FUNC	I	
MAFS.912.F-BF.2.3	MAFS.8.EE.2.5	CC-FUNC	I	
	MAFS.8.EE.3.7	EVA-FUNC	O	
	MAFS.8.F.1.2	EXP-FUNC	O	
	MAFS.8.F.2.5	GRA-FUNC	I	
		IDE-PART	I	
		INT-GRAP	I	
		TRA-FUNC	O	
		USE-TECH	O	

Note. O = Omitted, I = Included

Pre-Algebra Omissions for Functions: Linear, Quadratic, and Exponential Models

A document analysis was performed for the domain, *Functions: Linear, Quadratic, and Exponential Models* (see Appendix B for tested algebra standards). Next, the pre-algebra curriculum documents were analyzed and matched with the four algebra state standards to see if there were omitted prerequisite skills in the pre-algebra curriculum. The analysis showed that 24 of the 27 local standard coded skill categories were introduced in the pre-algebra curriculum document (Medium Sized Rural School District, 2015b; 2015c). The results were reported in a Table 22.

Table 22

Pre-Algebra Omissions for Functions: Linear, Quadratic, and Exponential Models (n = 4)

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage
MAFS.912.F-LE.1.1	MAFS.8.EE.1.1	CC-FUNC	I
	MAFS.8.F.1.2	DES-RELA	I
	MAFS.8.F.1.3	GRO-DECA	O
	MAFS.8.F.2.4	IDE-FUNC	I
	MAFS.8.F.2.5	IDE-PART	I
		IDE-QUAN	I
		MOD-FUNC	I
		PRV-FUNC	O
		REC-FUNC	I
		SOL-FUNC	I
MAFS.912.F-LE.1.2	MAFS.8.EE.2.5	CRE-FUNC	I
	MAFS.8.F.1.1	DES-RELA	I
	MAFS.8.F.2.4	INT-GRAP	I
	MAFS.8.F.2.5	REC-FUNC	I
		REC-SEQU	O
		SOL-FUNC	I
MAFS.912.F-LE.1.3:	MAFS.8.EE.1.2	CC-FUNC	I
	MAFS.8.NS.1.2	CC-PARTs	I
	MAFS.8.F.1.2	IDE-QUAN	I
	MAFS.8.F.1.3	INT-GRAP	I
		SOL-FUNC	I
MAFS.912.F-LE.2.5:	MAFS.8.F.1.3	IDE-PART	I
	MAFS.8.F.2.4	INT-FUNC	I
	MAFS.8.F.2.5	INT-GRAP	I
	MAFS.8.SP.1.3	REC-FUNC	I
		REC-SLOP	I
		TRA-FUNC	I

Note. O = Omitted, I = Included

Pre-Algebra Omissions for Statistics and Probability: Interpreting Data

A document analysis was performed for the domain, *Statistics and Probability: Interpreting Data* (see Appendix C for tested algebra standards). Next, the pre-algebra curriculum documents were analyzed and matched with the eight algebra state standards to see if there were omitted prerequisite skills in the pre-algebra curriculum. The analysis showed that 25 of the 36 local standard coded skill categories were introduced in the pre-algebra curriculum document (Medium Sized Rural School District, 2015b; 2015c). The results were reported in Table 23.

Table 23

Pre-Algebra Omissions for Statistics and Probability: Interpreting Data (*n* = 8)

Algebra State Standards	Pre-Algebra State Standards	Local Standard Coded Skill	Coverage	Limitation
MAFS.912.S-ID.1.1	MAFS.8.NS.1.2	ANA-DATA	O	Number
		REP-DATA	I	Line
MAFS.912.S-ID.1.2		ANA-DATA	O	
		CC-DATA	O	
		CHO-METH	O	
MAFS.912.S-ID.1.3	MAFS.8.SP.1.1	ANA-DATA	O	Outliers
		DES-DATA	I	Scatter plots
		INT-DATA	I	
MAFS.912.S-ID.2.5	MAFS.8.SP.1.4	ANA-DATA	I	
		CAL-DATA	I	
		CC-DATA	I	
		FOR-TABL	I	
		INT-DATA	I	
		REC-DATA	I	
		SUM-DATA	I	
MAFS.912.S-ID.2.6	MAFS.8.EE.3.7	ANA-DATA	I	
	MAFS.8.SP.1.1	DES-DATA	I	
	MAFS.8.SP.1.2	EXP-FUNC	I	
		GRA-COOR	I	
		GRA-FUNC	I	
		IDE-QUAN	I	
		MOD-FUNC	I	
		REP-DATA	I	
		SOL-FUNC	I	
MAFS.912.S-ID.3.7	MAFS.8.EE.2.5	INT-DATA	I	
	MAFS.8.F.2.4	INT-SLOP	I	
	MAFS.8.F.2.5	MOD-DATA	I	
	MAFS.8.F.2.6			
	MAFS.8.SP.1.3			
MAFS.912.S-ID.3.8	MAFS.8.SP.1.1	ANA-DATA	O	Patterns and
		DEF-DATA	I	Linear
		DES-RELA	I	Associations
		INT-DATA	O	
		MOD-DATA	O	
		USE-TECH	O	
MAFS.912.S-ID.3.9	MAFS.8.SP.1.1	CC-DATA	I	Patterns and
		DEF-DATA	O	Linear
		INT-DATA	O	Associations

Note. O = Omitted, I = Included

Research Question Four

Based on document analysis and expert opinions, what are the knowledge skills embedded in the algebra curriculum that if missing, will contribute to below proficiency on the Florida algebra state standards?

Curriculum documents were analyzed for a Medium Sized Rural School District (2015a). The documents were available to the public online. The researcher used the same categorical domains for the algebra state standards that were used in research questions two and three. First, the researcher analyzed each algebra unit in the Medium Sized Rural School District algebra curriculum document (2015b) to see which standards were being taught. Next, the embedded skills needed for each algebra state standard in the algebra curriculum were matched with the algebra state standard. These embedded skills were chosen by expert opinion which consisted of current or former algebra public school teachers. The embedded skills were recorded in Table 24.

Table 24

Embedded Skills Required for Mastery of Local Standard Coded Skills

Code	Embedded Prerequisite Skills
ANA-DATA	Understand measures of central tendencies, slope, graphs, tables, charts, and trends.
ANA-FUNC	Understand vocabulary, quantities, measurements, coefficients, variables, linear and nonlinear graphs.
APP-OPER	Understanding place value, ratios, order of operations, distributive property, arithmetic properties, factoring, like terms, and properties of exponents.
CAL-DATA	Use operations, measures of central tendencies, percentages, tables, charts, and graphs.
CC-DATA	Understand measures of central tendencies, slope, graphs, tables, charts, and trends.
CC-FUNC	Understand fractions, coefficients, laws of exponents, linear and nonlinear graphs.
CC-PARTS	Understand domain, range, coordinates, input/output, variables, and sets.
CHO-METH	Determine when to use measures of central tendencies, slope, graphs, tables, operations, graphing, and factoring
CLA-EXPR	Understand like terms, exponents, degree, and variables.
COB-FUNC	Understand order of operations, substitution, distributive property, like terms, and function notation
COM-FUNC	Use properties of equality, substitution, variables, distributive property, like terms, and order of operations.
CON-ARGU	Use vocabulary and understand word problems, quantities, coefficients, and variables.
CRE-EQUA	Understand vocabulary, order of operations, variables, quantities, measurements, properties of equality, exponents, coefficients, and integers.
CRE-EQUA-2	Use vocabulary, operations, variables, quantities, measurements, equalities, exponents, coefficients, like terms, and integers.
CRE-FUNC	Understand vocabulary, operations, variables, quantities, measurements, properties of equality, exponents, coefficients, function notation, and integers
CRE-INEQ	Understand vocabulary, order of operations, variables, quantities, measurements, properties of equality, exponents, coefficients, "greater/less than", and integers.
DEF-CLOS	Understand sets, set notation, and intervals.
DEF-DATA	Using measures of central tendencies, variability of data, and multiple data points.
DEF-FUNC	Understand bivariate data, quantities, measurements, domain, range, variables, input/output and coordinates.
DEF-GRAP	Understand coordinate planes, ordered pairs, plotting points, slopes, intercepts, radicals, and exponents.
DEF-PART	Understand algebraic expressions, coefficients, variables, base numbers, exponents, degree, slope, intercepts and constants.
DEF-QUAN	Explain algebraic expressions, variables, and substitution into equations.

Code	Embedded Prerequisite Skills
DEF-RECU	Using patterns, sequences, terms, common differences, and order of operations
DER-FORM	Understand quantities, measurements, exponents, and order of operations
DES-DATA	Explain data using measures of central tendencies, data points, percentages, graphs, slope, outliers, and trends.
DES-RELA	Understand bivariate data, quantities, measurements, domain, range, variables, and coordinates.
DET-EQUA	Understand relationships, variables, equalities, quantities, measurements, and integers.
DET-FUNC	Understand function rule, tables, quantities, measurements, domain, range, variables, input/output, vertical line test, and coordinates.
DET-INEQ	Understand vocabulary, equality, and greater/less than.
DET-SOLU	Understand quantities, variables, polynomials, vocabulary, and number sense.
DET-STEP	Understand order of operations, like terms, variables, exponents, GCF, factoring, integers, and equality.
EVA-FUNC	Use order of operations, integers, distributive property, laws of exponents, properties of equality, like terms, variables, and substitution.
EXP-FUNC	Understand vocabulary, properties of equality, laws of exponents, input/output, equivalence, graphs, and substitution.
EXP-QUAD	Understand, exponents, nonlinear graphs, degree, factoring, and coefficients
EXP-PROP-E	Understand fractions, nonlinear graphs, exponents, variables, and coefficients.
EXP-PROP-Q	Understand fractions, nonlinear graphs, exponents, variables, and coefficients.
EXP-SOLU	Understand vocabulary, measurements, quantities, graphs, and variables
EXP-STEP	Understand quantities, variables, order of operations, properties of equality, integers, and substitution.
FAC-EQUA	Use exponents, like terms, operations, integers, greatest common factors, factoring, and variables.
FAC-POLY	Use exponents, like terms, operations, integers, greatest common factors, factoring, and variables
FOR-TABL	Understand and use bivariate data, tally marks, and tables.
GRA-COOR	Know coordinate planes, axes, variables, domain, and range.
GRA-EQUA	Know and use coordinates, intercepts, slope, bivariate data, tables, substitution, and variables.
GRA-FUNC	Know and use coordinates, intercepts, slope, bivariate data, tables, variables, domain, and range.
GRA-INEQ	Know and use coordinates, intercepts, slope, bivariate data, variables, sets, intervals, and "greater/less than"
GRO-DECA	Use percentages, intervals, graphs, increasing, decreasing, exponents, nonlinear graphs, and rate of change.
IDE-FORM	Know properties of equality, distributive property, substitution, graphs, and variables.
IDE-FUNC	Know graphs, exponents, radicals, and the difference between linear and nonlinear.
IDE-OPER	Understanding place value, ratios, order of operations, distributive property, and arithmetic properties.
IDE-PART	Know coefficients, variables, terms, slope, fractions, and intercepts.
IDE-PROP	Know properties of equality, laws of exponents, and like terms.
IDE-QUAN	Understand variables, algebraic expressions, substitutions, conversions, and measurements.

Code	Embedded Prerequisite Skills
IDE-SOLU-I	Understand vocabulary, operations, variables, quantities, measurements, properties of equality, exponents, coefficients, "greater/less than", graphs, number lines, sets, intervals, and integers
IDE-STRU	Understand coefficients, variables, base, exponents, degree, and constants
IDE-ZERO	Know intercepts, isolating variables, substitution, and graphs.
INT-DATA	Understand measures of central tendencies, slope, graphs, tables, charts, and trends.
INT-EXPR	Understand vocabulary, word problems, coefficients, and variables
INT-FUNC	Understand graphs, word problems, coefficients, and variables
INT-GRAP	Understand ordered pairs, domain, range, slopes, intercepts, radicals, and exponents
INT-PART	Understand algebraic expressions, vocabulary, fractions, variables, quantities, measurements, and integers.
INT-SLOP	Understand rate of change, integers, and graphs.
INT-SOLU	Use reasoning skills, variables, graphs, quantities, measurements, and vocabulary.
JUS-METH	Reasoning skills, vocabulary, properties of equality, and writing skills.
JUS-QUAN	Reasoning skills, vocabulary, coefficients, variables, and writing skills.
JUS-SOLU	Reasoning skills, vocabulary, variables, interpreting answers, and writing skills.
JUS-STEP	Reasoning skills, order of operations, properties of equality, like terms, distributive property, and writing skills.
LAB-GRAP	Understand intervals, dependent and independent variables.
MOD-DATA	Create and interpret tables, frequency tables, line plots, stem and leaf plots, histograms, bar graphs, circle graphs, scatterplots, box and whisker plots, and Venn diagrams.
MOD-FUNC	Reasoning skills, graphs, domain, range, coefficients, variables, slope, and intercepts
MOD-RELA	Reasoning skills, graphs, domain, range, bivariate data, coefficients, and variables.
PRO-EXPR-E	Use distributive property, law of exponents, order of operations, integers, fractions, and factoring
PRO-EXPR-Q	Use distributive property, law of exponents, order of operations, integers, fractions, and factoring
PRV-FUNC	Reasoning skills, graphs, domain, range, coefficients, variables, slope, intercepts, and writing skills.
REA-EQUA	Use properties of equality, isolating variables, order of operations, like terms, and integers.
REC-CONS	Know domain, range, sets, and graphs; use reasoning skills.
REC-DATA	Using measures of central tendency, variability of data, and multiple data points
REC-EXPR-	Understand like terms, laws of exponents, order of operations, and factoring
REC-FUNC	Understand properties of equality, variables, coefficients, linear and nonlinear graphs.
REC-GRAP	Understand coordinate planes, ordered pairs, plotting points, slopes, intercepts, radicals, and exponents
REC-PART	Understand terms, coefficients, variables, exponents, quantities, measurements, slope, and intercepts
REC-SEQU	Understand patterns, domain, range, variables, coefficients, slope, exponents, and sets.
REC-SLOP	Understand rate of change, graphs, trends, fractions, and substitution.
REP-CONS	Understand intervals, boundaries, sets, domain, range, graphs, and substitution

Code	Embedded Prerequisite Skills
REP-DATA	Create and interpret tables, frequency tables, line plots, stem and leaf plots, histograms, bar graphs, circle graphs, scatterplots, box and whisker plots, and Venn diagrams.
REW-EXPR	Use order of operations, integers, distributive property, laws of exponents, and factoring.
SOL-EQUA	Use order of operations, integers, distributive property, laws of exponents, properties of equality, GCF, like terms, variables, and factoring
SOL-FUNC	Use order of operations, integers, distributive property, properties of exponents, properties of equality, GCF, like terms, variables, and factoring
SOL-INEQ	Use order of operations, integers, distributive property, properties of exponents, properties of equality and inequalities, GCF, like terms, variables, “greater/less than”, number lines, intervals, and factoring
SOL-SLOP	Use operations, coordinates, integers, fractions, intercepts, and graphs.
SUM-DATA	Understand measures of central tendencies, slope, graphs, tables, charts, and trends.
TRA-EXPR-E	Understand laws of exponents, coefficients, variables and graphs.
TRA-FUNC	Understand coefficients, variables, fractions, distributive property, and graphs.
USE-PROP	Understand vocabulary, equality, substitution, operations, integers, and like terms.
USE-TECH	Use a calculator, computer, Microsoft programs, and cell phone applications to solve problems and graph.
WRI-FUNC	Reasoning skills, coefficients, variables, measurements, bivariate data, and writing skills.

Research Question Five

Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the missing content standards and skills, if any, in the adopted text book that should align with the district curriculum, state standards, and expert opinion?

Curriculum documents were analyzed for a Medium Sized Rural School District (2015b). The documents were available to the public online. First, the researcher analyzed each algebra unit in the algebra curriculum document to see which standards were being taught. Second, the algebra state standards in the algebra curriculum were categorized by the same mathematical domains used in research questions two, three, and four. Once the algebra state standards were determined to be essential for passing the Algebra EOC exam, the local version of the algebra standards were coded and used in the analysis. Next, the coded local algebra standard or skills were matched with the designated textbook section in the curriculum document to look for content omissions. The letter "M" signifies that the concept is found in numerous other chapters in addition to the ones listed. The "M" is used for brevity when the chapters are too numerous to list. The results were reported in tables based on the algebra themes.

Textbook and Algebra: Polynomials and Rational Expressions

A document analysis was performed for the domain, *Algebra: Polynomials and Rational Expressions* (see Appendix A for tested algebra standards). The two algebra state standards for the domain were compared with the adopted algebra textbook

(*Springboard mathematics: Algebra 1*, 2014) to see which topics were covered or omitted. Five of the six local standard coded skills were covered in the adopted textbook (Medium Sized Rural School District, 2015b; 2015k; 2015m*; Springboard mathematics: Algebra 1*, 2014). The algebra state standard, MAFS.912.A-APR.1.1, asked students to be able to "Define Closure" (Medium Sized Rural School District, 2015k, p. 1). This skill is missing from the textbook. The results were recorded in Table 25.

Table 25

Text Book and Algebra: Arithmetic with Polynomials and Rational Expressions

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.A-APR.1.1	APP-OPER	Chap 24, 25
	DEF-CLOS	O
	IDE-OPER	Chap 24, 25
MAFS.912.A-APR.2.3	FAC-POLY	Chap 26
	GRA-FUNC	Chap 31
	IDE-ZERO	Chap 31

Note. O = Omitted

Textbook and Algebra: Creating Equations

A document analysis was performed for the domain, *Algebra: Creating Equations* (see Appendix A for tested algebra standards). The four algebra state standards for the domain were compared with the adopted textbook for algebra (*Springboard mathematics: Algebra 1*, 2014) to see which topics were covered or omitted. All 23 algebra skills were covered in the adopted textbook (Medium Sized Rural School District, 2015b; 2015f; 2015h, 2015i, 2015l; *Springboard mathematics: Algebra 1*, 2014). The results were recorded in Table 26.

Table 26

Text Book and Algebra: Creating Equations

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.A-CED.1.1	APP-OPER	Chap 2, 3
	CRE-EQUA	Chap 2
	CRE-INEQ	Chap 3
	DES-RELA	Chap 2, 3
	SOL-EQUA	Chap 2
	SOL-INEQ-	Chap 3
MAFS.912.A-CED.1.2	CRE-EQUA	Chap 2
	CRE-EQUA-2	M, (14-2)
	DES-RELA	M, (7-1)
	GRA-EQUA	M (Chap 6, 7)
	IDE OPER	M, (14-2)
	IDE-QUAN	M, (14-2)
	JUS-QUAN	M, (6-1)
	LAB-GRAP	M, (6-1)
	MOD-RELA	M, (6-1)
MAFS.912.A-CED.1.3	DET-EQUA	Chap 2,
	DET-INEQ	Chap 3
	INT-SOLU	Chap 2, 3
	REC-CONS	Chap 2, 3
	REP-CONS	Chap 2, 3
MAFS.912.A-CED.1.4	DEF-QUAN	Chap 2, 3,
	IDE-QUAN	Chap 2, 3,
	REA-EQUA	Chap2-5

Note. M = Embedded in Multiple Chapters throughout Textbook

Textbook and Algebra: Seeing Structure in Expressions

A document analysis was performed for the domain, *Algebra: Seeing Structure in Expressions* (see Appendix A for tested algebra standards). The three algebra state standards for the domain were compared with the adopted textbook for algebra (*Springboard mathematics: Algebra 1*, 2014) to see which topics were covered or omitted. All 23 algebra skills were covered in the adopted textbook (Medium Sized Rural School District, 2015b; 2015f; 2015j; 2015k; 2015l; 2015m; *Springboard mathematics: Algebra 1*, 2014). The results were recorded in Table 27.

Table 27

Textbook and Algebra: Seeing Structure in Expressions

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.A-SSE.1.1	CRE-EQUA	Chap 2
	CRE-INEQ	Chap 3
	DEF-PART	(24-1)
	INT-EXPR	Chap 24
	INT-PART	Chap 24
	MOD-RELA	Chap 2, 3, 24
	REC-PART	(24-1)
MAFS.912.A-SSE.1.2	CLA-EXPR	Chap 24-27
	IDE-STRU	(26-1), (27-2)
	REW-EXPR	(26-1)
MAFS.912.A-SSE.2.3	EXP-PROP-E	Chap 22
	EXP-PROP-Q	Chap 29-32
	EXP-QUAD	Chap 29-32
	FAC-EQUA	Chap 27, 31, 32
	FAC-POLY	Chap 26, 27, 31, 32
	FOR-TABL	Chap 22, 29, 30
	GRA-FUNC	Chap 22, 29-32
	IDE ZERO	Chap 31, 32
	IDE-PROP	Chap 25-27, 29-32
	PRO-EXPR-E	Chap 19, 23
	PRO-EXPR-Q	Chap 25-27, 31, 32
	REC-EXPR	Chap 25-27, 31, 32
	TRA-EXPR-E	Chap 8, 22

Textbook and Algebra: Reasoning with Equations and Inequalities

A document analysis was performed for the domain, *Algebra: Reasoning with Equations and Inequalities* (see Appendix A for tested algebra standards). The eight algebra state standards for the domain were compared with the adopted textbook for algebra (*Springboard mathematics: Algebra 1*, 2014) to see which topics were covered or omitted. All 43 algebra skills were covered in the adopted textbook (Medium Sized Rural School District, 2015b; 2015f; 2015h; 2015i; 2015l; 2015m*; Springboard mathematics: Algebra 1*, 2014). However, for standard MAFS.912.A-REI.4.11 there was limited coverage for graphing functions because rational functions and logarithmic functions were not included in the textbook (Medium Sized Rural School District, 2015i, p. 2). The results were recorded in Table 28.

Table 28

Textbook and Algebra: Reasoning with Equations and Inequalities

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.A-REI.1.1	CHO-METH	Chap 2
	CON-ARGU	(2-3), (2-4)
	DET-SOLU	Chap 2
	EXP-STEP	Chap 2
	IDE-PROP	Chap 2
	JUS-METH	Chap 2
	JUS-SOLU	Chap 2
	SOL-EQUA	Chap 2
	USE-PROP	Chap 2
MAFS.912.A-REI.2.3	DEF-PART	(3-2), (3-3)
	IDE-PROP	Chap 2
	INT-PART	Chap 2
	SOL-EQUA	Chap 2
	SOL-INEQ	Chap 2, 3
MAFS.912.A-REI.2.4	DER-FORM	(32-2), (32-3)
	DET-STEP	Chap 29-32
	EXP-SOLU	Chap 31, 32
	FAC-EQUA	Chap 31, 32
	SOL-EQUA	Chap 31, 32
MAFS.912.A- REI.3.5	EXP-PROP	Chap 17
	JUS-STEP	Chap 17
	SOL-EQUA	Chap 17
	USE-PROP	Chap 17
MAFS.912.A-REI.3.6	CHO-METH	Chap 17
	JUS-METH	Chap 17
	SOL-EQUA	Chap 17
MAFS.912.A-REI.4.10	EXP-SOLU	M, (Chap 6, 7, 17)
	GRA-EQUA	M, (Chap 6, 7, 17)
	REC-GRAP	M, (Chap 6, 7, 17)
MAFS.912.A-REI.4.11	CHO-METH	Chap 17
	EXP-SOLU	Chap 17
	FOR-TABL	Chap 17
	GRA-COOR	Chap 17
	GRA-FUNC	Chap 17 (limited)
	INT-GRAP	Chap 17
	REC-FUNC-	M, (Chap 5)
	USE-TECH	M, (Chap 17, 23)
	WRI-FUNC	M, (Chap 5, 17)

Note. M = Embedded in Multiple Chapters of the Textbook

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.A-REI.4.12	EXP-SOL	Chap 3, 16, 18
	GRA-INEQ	Chap 16, 18
	IDE-SOLU-I	Chap 3, 16, 18
	INT-GRAP	Chap 16, 18
	SOL-INEQ	Chap 3, 16, 18

Note. O = Omitted, M = Embedded in Multiple Chapters of the Textbook

Textbook and Functions: Interpreting Functions

A document analysis was performed for the domain, *Functions: Interpreting Functions* (see Appendix B for tested algebra standards). The nine algebra state standards for the domain were compared with the adopted textbook for algebra (*Springboard mathematics: Algebra 1*, 2014) to see which topics were covered or omitted. All 63 algebra skills were covered in the adopted textbook (Medium Sized Rural School District, 2015b; 2015g; 2015h; 2015j; 2015l; 2015m; *Springboard mathematics: Algebra 1*, 2014). However, for standard MAFS.912.F-IF.3.7 there was limited coverage for graphing functions, interpreting graphs, and using technology. The reason for this limitation was because trigonometric functions and logarithmic functions were not included in the textbook (Medium Size Rural School District, 2015m, p. 3). The results were recorded in Table 29.

Table 29

Textbook and Functions: Interpreting Functions

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.F-IF.1.1	DET-FUNC	Chap 5, 14
	EVA-FUNC	Chap 5, 14
	IDE-PART	Chap 5, 14
	SOL-FUNC	Chap 5, 14
MAFS.912.F-IF.1.2	DEF-FUNC	Chap 5, 14
	DET-FUNC	Chap 5, 14
	DET-PART	Chap 5, 14
	EVA-FUNC	Chap 5, 14
	INT-FUNC	M, Chap 5, 6, 14
	WRI-FUNC	M, Chap 5, 14
MAFS.912.F-IF.1.3	IDE-PART	Chap 11, 21
	REC-FUNC-	Chap 11, 21
	REC-SEQU	Chap 11, 21
MAFS.912.F-IF.2.4	DEF-GRAP	Chap 6, 22
	GRA-FUNC	Chap 6, 22
	IDE-QUAN	Chap 6, 22
	INT-FUNC	Chap 6, 22
	INT-GRAP	Chap 6, 22
	MOD-RELA	Chap 6, 22
	REC-GRAP	Chap 6, 22
MAFS.912.F-IF.2.5	DES-RELA	Chap 6
	EXP-FUNC	Chap 6
	IDE-PART	Chap 6
	INT-GRAP	Chap 6
	REC-GRAP	Chap 6
MAFS.912.F-IF.2.6	INT-SLOP	Chap 9, 14
	REC-SLOP	Chap 9
	SOL-SLOP	Chap 9

Note. M = Embedded in Multiple Chapters of the Textbook

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.F-IF.3.7	ANA FUNC	Chap 6, 8,14, 22, 31
(a, b, c, e)	CC-FUNC	Chap 6, 8,14, 22, 31
	CC-PART-	Chap 6, 8,14, 22, 31
	DES-RELA	Chap 6, 8,14, 22, 31
	EXP-FUNC	Chap 6, 8,14, 22, 31
	FAC-POLY	Chap 31
	GRA-FUNC	Chap 6, 8,14, 22, 31 (limited)
	IDE-FORM	Chap 6, 8,14, 22, 31
	IDE-FUNC	Chap 6, 8,14, 22, 31
	IDE-PART	Chap 6, 8,14, 22, 31
	IDE-ZERO	Chap 31
	INT-GRAP	Chap 6, 8,14, 22, 31 (limited)
	LAB-GRAP	Chap 6, 8,14, 22, 31
	MOD-FUNC	Chap 6, 8,14, 22, 31
	USE-TECH	Chap 8,14, 22, 31 (limited)
MAFS.912.F-IF.3.8	CLA-EXPR	Chap 22, 23, 30-33
	EXP-QUAD	Chap 30-33
	FAC-POLY	Chap 31-33
	GRO-DECA	Chap 22
	IDE-FORM	Chap 22, 23, 30-33
	IDE-PART	Chap 22, 23, 30-33
	IDE-PROP	Chap 22, 23, 30-33
	IDE-ZERO	Chap 31-33
	INT-EXPR	Chap 22, 23, 30-33
	INT-FUNC	Chap 22, 23, 30-33
	INT-GRAP	Chap 22, 23, 30-33
	REC-EXPR-Q	Chap 30-33
	REC-GRAP	Chap 22, 23, 30-33
	USE-PROP	Chap 22, 23, 30-33
	WRI-FUNC	Chap 22, 23, 31, 32,
MAFS.912.F-IF.3.9	CC-FUNC	Chap 35
	CC-PART	Chap 35
	IDE-FUNC	M (Chap 5, 6, 8, 14, 22, 23, 31, 32)
	IDE-PART	M (Chap 5, 6, 8, 14, 22, 23, 31, 32
	INT GRAP	M (Chap 5, 6, 8, 14, 22, 23, 31, 32

Note. O = Omitted, M = Embedded in Multiple Chapters of the Textbook

Textbook and Functions: Building Functions

A document analysis was performed for the domain, *Functions: Building Functions* (see Appendix B for tested algebra standards). The two algebra state standards for the domain were compared with the adopted textbook for algebra (*Springboard mathematics: Algebra 1*, 2014) to see which topics were covered or omitted. There were 21 out of 22 coded algebra skills covered in the adopted textbook (Medium Sized Rural School District, 2015b; 2015h; 2015k; 2015l; 2015m; *Springboard mathematics: Algebra 1*, 2014). State standard MAFS.912.F-BF.1.1., composing functions, was not found in the textbook. The results were recorded in Table 30.

Table 30

Textbook and Functions: Building Functions

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.F-BF.1.1	APP-OPER	Chap 24, 25
	COB-FUNC	Chap 24, 25
	COM-FUNC	O
	CRE-FUNC	Chap 17
	DEF-FUNC	Chap 11
	DEF-RECU	Chap 11
	DES-RELA	Chap 5
	EVA-FUNC	Chap 5, 17
	EXP-FUNC	Chap 5, 17
	IDE-PART	Chap 5, 17
	IDE-QUAN	Chap 5, 17
	MOD-FUNC	Chap 5, 17
	MOD-RELA	Chap 17
	WRI-FUNC	Chap 11, 17
MAFS.912.F-BF.2.3	CC-FUNC	Chap 8, 30
	EVA-FUNC	Chap 8, 30
	EXP-FUNC	Chap 8, 30
	GRA-FUNC	Chap 8, 30
	IDE-PART	Chap 8, 30
	INT-GRAP	Chap 8, 30
	TRA-FUNC	Chap 8, 30
	USE-TECH	Chap 8, 30

Note. O = Omitted, M = Embedded in Multiple Chapters in Textbook

Textbook and Functions: Linear, Quadratic, and Exponential Models

A document analysis was performed for the domain, *Functions: Linear, Quadratic, and Exponential Models* (see Appendix B for tested algebra standards). The four algebra state standards for the domain were compared with the adopted textbook for algebra (*Springboard mathematics: Algebra 1*, 2014) to see which topics were covered or omitted. For this domain, 26 of the 27 algebra skills were covered in the adopted textbook (*Springboard mathematics: Algebra 1*, 2014). However, for standard MAFS.912.F-LE.1.1, there was no coverage for proving the growth of functions (Medium Sized Rural School District, 2015h, p. 3). Although the textbook covers the growth of linear and exponential functions, it did not ask students to prove how linear and exponential functions grow. The results were recorded in Table 31.

Table 31

Textbook and Functions: Linear, Quadratic, and Exponential Models

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.F-LE.1.1	CC-FUNC	Chap 35
	DES-RELA	Chap 5-11, 21-23
	GRO-DECA	Chap 22
	IDE-FUNC	Chap 5-11, 21-23
	IDE-PART	Chap 5-11, 21-23
	IDE-QUAN	Chap 5-11, 21-23
	MOD-FUNC	Chap 5-11, 21-23
	PRV-FUNC	O
	REC-FUNC	Chap 11, 21
	SOL-FUNC	Chap 5-11, 21-23
MAFS.912.F-LE.1.2	CRE-FUNC	Chap 11, 21
	DES-RELA	Chap 11, 21
	INT-GRAP	Chap 11, 21
	REC-FUNC	Chap 11, 21
	REC-SEQU	Chap 11, 21
	SOL-FUNC	Chap 11, 21
MAFS.912.F-LE.1.3:	CC-FUNC	Chap 34
	CC-PARTs	Chap 34
	IDE-QUAN	Chap 34
	INT-GRAP	Chap 34
	SOL-FUNC	Chap 22, 23, 33, 34
MAFS.912.F-LE.2.5:	IDE-PART	Chap 8
	INT-FUNC	Chap 8, 12, 22, 23
	INT-GRAP	Chap 8, 12, 22, 23
	REC-FUNC	Chap 8
	REC-SLOP	Chap 9, 12
	TRA-FUNC	Chap 8

Note. O = Omitted, M = Embedded in Multiple Chapters in Textbook

Textbook and Statistics and Probability: Interpreting Data

A document analysis was performed for the domain, *Statistics and Probability: Interpreting Categorical and Quantitative Data* (see Appendix C for tested algebra standards). The eight algebra state standards for the domain were compared with the adopted textbook for algebra (*Springboard mathematics: Algebra 1*, 2014) to see which topics were covered or omitted. All 36 algebra skills were covered in the adopted textbook (Medium Sized Rural School District, 2015n). However, state standard MAFS.912.S-ID.1.1 included histograms in the data analysis. There were no histogram analyses in the textbook so the standard was marked as limited coverage. The results were recorded in Table 32.

Table 32

Textbook and Statistics and Probability: Interpreting Categorical and Quantitative Data

Algebra State Standards	Local Standard Coded Skill	Textbook Coverage
MAFS.912.S-ID.1.1	ANA-DATA	(37-1), (37-2) limited
	REP-DATA	(37-1), (37-2) limited
MAFS.912.S-ID.1.2	ANA-DATA	(36-1), (36-2), (37-3)
	CC-DATA	(36-1), (37-3)
	CHO-METH	M
MAFS.912.S-ID.1.3	ANA-DATA	(37-3)
	DES-DATA	(37-2)
	INT-DATA	(37-3)
MAFS.912.S-ID.2.5	ANA-DATA	(40-1), (40-2)
	CAL-DATA	(40-1)
	CC-DATA	(40-1)
	FOR-TABL	(40-2)
	INT-DATA	(40-2)
	REC-DATA	(40-1), (40-2)
	SUM-DATA	(40-1), (40-2)
MAFS.912.S-ID.2.6	ANA-DATA	Chap 38, 39
	DES-DATA	(38-1), (38-2)
	EXP-FUNC	(39-3), (39-4)
	GRA-COOR	Chap 38, 39
	GRA-FUNC	(39-4)
	IDE-QUAN	(38-1)
	MOD-FUNC	Chap 38, 39
	REP-DATA	Chap 38, 39
	SOL-FUNC	(39-3)
MAFS.912.S-ID.3.7	INT-DATA	(39-3)
	INT-SLOP	(39-3)
	MOD-DATA	Chap 39
MAFS.912.S-ID.3.8	ANA-DATA	(38-1), (38-2)
	DEF-DATA	(38-1), (38-2)
	DES-RELA	(38-1), (38-2)
	INT-DATA	(38-1), (38-2)
	MOD-DATA	(38-1), (38-2)
	USE-TECH	(39-2)
MAFS.912.S-ID.3.9	CC-DATA	(38-2)
	DEF-DATA	(38-1), (38-2)
	INT-DATA	Chap 38, 39

Note. O = Omitted, M = Embedded in Multiple Chapters in Textbook

Additional Analysis

An additional study was performed by analyzing the algebra curriculum documents for the Medium Sized Rural School District to compare the amount of time given to a unit of study with the amount of local standard coded skills required. This analysis was not originally proposed in the research questions and data analysis. Once the number of algebra skills were found to be numerous, the researcher became concerned that there would not be adequate time devoted for mastery of the material, including review and remediation. There were nine units in the algebra curriculum document (Medium Sized Rural School District, 2015b) that were analyzed by comparing tasks with time allowances.

Time Allowance for Skills in Unit One

Unit One: Representing Relationships Mathematically, of the algebra curriculum for the Medium Sized Rural School District (2015b), included eight state mathematics standards. Only the six standards from the algebra domain were analyzed. There were 15 days allotted for mastery of the 32 local standard coded skills for this unit (Medium Sized Rural School District, 2015f, p. 1-3). The results were reported in Table 33.

Table 33

Time Allowance for Unit One (*n* = 6)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.A- SSE.1.1a	4	CRE-EQUA	15 days
		CRE-INEQ	
		MOD-RELA	
		REC-PART	
MAFS.912.A- CED.1.1	6	APP-OPER	
		CRE-EQUA	
		CRE-INEQ	
		DES-RELA	
		SOL-EQUA	
		SOL-INEQ-	
MAFS.912.A- CED.1.3	5	DET-EQUA	
		DET-INEQ	
		INT-SOLU	
		REC-CONS	
		REP-CONS	
MAFS.912.A- CED.1.4	3	DEF-QUAN	
		IDE-QUAN	
		REA-EQUA	
MAFS.912.A-REI.1.1	9	CHO-METH	
		CON-ARGU	
		DET-SOLU	
		EXP-STEP	
		IDE-PROP	
		JUS-METH	
		JUS-SOLU	
		SOL-EQUA	
		USE-PROP	
MAFS.912.A-REI.2.3	5	DEF-PART	
		IDE-PROP	
		INT-PART	
		SOL-EQUA	
		SOL-INEQ	

Time Allowance for Skills in Unit Two

Unit Two: Understanding Functions, of the algebra curriculum for the Medium Sized Rural School District (2015b), included six state mathematics standards. One standard came from the algebra domain and the other five were from the functions domain. There were 10 days allotted for mastery of the 27 local standard coded skills for this unit (Medium Sized Rural School District, 2015g, p. 1-3). The results were reported in Table 34.

Table 34

Time Allowance for Unit Two ($n = 6$)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.F-IF.1.1	4	DET-FUNC	10 days
		EVA-FUNC	
		IDE-PART	
		SOL-FUNC	
MAFS.912.F-IF.1.2	6	DEF-FUNC	
		DET-FUNC	
		DET-PART	
		EVA-FUNC	
		INT-FUNC	
		WRI-FUNC	
MAFS.912.F-IF.2.4	7	DEF-GRAP	
		GRA-FUNC	
		IDE-QUAN	
		INT-FUNC	
		INT-GRAP	
		MOD-RELA	
		REC-GRAP	
MAFS.912.F-IF.2.5	5	DES-RELA	
		EXP-FUNC	
		IDE-PART	
		INT-GRAP	
		REC-GRAP	
MAFS.912.F-IF.3.9	5	CC-FUNC	
		CC-PART	
		IDE-FUNC	
		IDE-PART	
		INT GRAP	

Time Allowance for Skills in Unit Three

Unit Three: Linear Functions, of the algebra curriculum for the Medium Sized Rural School District (2015b), included 11 state mathematics standards. Two standards were from the algebra domain, eight standards were from the functions domain and one came from the statistics domain. There were 25 days allotted for mastery of the 66 local standard coded skills (Medium Sized Rural School District, 2015h, p. 1-4). The results were reported in Table 35.

Table 35

Time Allowance for Unit Three (*n* = 6)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.A-CED.1.2	9	CRE-EQUA	25 days
		CRE-EQUA-2	
		DES-RELA	
		GRA-EQUA	
		IDE OPER	
		IDE-QUAN	
		JUS-QUAN	
		LAB-GRAP	
		MOD-RELA	
MAFS.912.A-REI.4.10	3	EXP-SOLU	
		GRA-EQUA	
		REC-GRAP	
MAFS.912.F-BF.1.1.a,b	11	APP-OPER	
		COB-FUNC	
		CRE-FUNC	
		DEF-FUNC	
		DEF-RECU	
		DES-RELA	
		EVA-FUNC	
		EXP-FUNC	
		IDE-PART	
		IDE-QUAN	
		WRI-FUNC	
MAFS.912.F-BF.2.3	8	CC-FUNC	
		EVA-FUNC	
		EXP-FUNC	
		GRA-FUNC	
		IDE-PART	
		INT-GRAP	
		TRA-FUNC	
		USE-TECH	
MAFS.912.F-IF.1.3	3	IDE-PART	
		REC-FUNC-	
		REC-SEQU	
MAFS.912.F-IF.2.6	3	INT-SLOP	
		REC-SLOP	
		SOL-SLOP	

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.F-IF.3.7.a	5	CC-FUNC	
		EXP-FUNC	
		GRA-FUNC	
		LAB-GRAP	
		USE-TECH	
MAFS.912.F-LE.1.1	9	CC-FUNC	
		DES-RELA	
		IDE-FUNC	
		IDE-PART	
		IDE-QUAN	
		MOD-FUNC	
		PRV-FUNC	
		REC-FUNC	
		SOL-FUNC	
MAFS.912.F-LE.1.2	6	CRE-FUNC	
		DES-RELA	
		INT-GRAP	
		REC-FUNC	
		REC-SEQU	
		SOL-FUNC	
MAFS.912.F-LE.2.5	6	IDE-PART	
		INT-FUNC	
		INT-GRAP	
		REC-FUNC	
		REC-SLOP	
		TRA-FUNC	
MAFS.912.S-ID.3.7	3	INT-DATA	
		INT-SLOP	
		MOD-DATA	

Time Allowance for Skills in Unit Four

Unit Four: Systems of Linear Equations and Inequalities, of the algebra curriculum for the Medium Sized Rural School District (2015b) included six state mathematics standards. All six standards were from the algebra domain. There were 10 days allotted for mastery of the 35 local standard coded skills in this unit (Medium Sized Rural School District, 2015i, p. 1-3). The results were recorded in Table 36.

Table 36

Time Allowance for Unit Four (*n* = 6)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.A-CED.1.2	9	CRE-EQUA	10 days
		CRE-EQUA-2	
		DES-RELA	
		GRA-EQUA	
		IDE OPER	
		IDE-QUAN	
		JUS-QUAN	
		LAB-GRAP	
		MOD-RELA	
MAFS.912.A-CED.1.3	5	DET-EQUA	
		DET-INEQ	
		INT-SOLU	
		REC-CONS	
		REP-CONS	
MAFS.912.A-REI.3.5	4	EXP-PROP	
		JUS-STEP	
		SOL-EQUA	
		USE-PROP	
MAFS.912.A-REI.3.6	3	CHO-METH	
		JUS-METH	
		SOL-EQUA	
MAFS.912.A-REI.4.11	9	CHO-METH	
		EXP-SOLU	
		FOR-TABL	
		GRA-COOR	
		GRA-FUNC	
		INT-GRAP	
		REC-FUNC-	
		USE-TECH	
		WRI-FUNC	
MAFS.912.A-REI.4.12	5	EXP-SOL	
		GRA-INEQ	
		IDE-SOLU-I	
		INT-GRAP	
		SOL-INEQ	

Time Allowance for Skills in Unit Five

Unit Five: Exponential Functions and Equations, of the algebra curriculum for a Medium Sized Rural School District (2015b) included ten state mathematics standards. One state standard came from the algebra domain and five were from the functions domain. There were 15 days allotted for mastery of the 40 local standard coded skills in this unit (Medium Sized Rural School District, 2015j, p. 1-4). The results were reported in Table 37.

Table 37

Time Allowance for Unit Five ($n = 6$)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.A-SSE.2.3.c	3	EXP-PROP-E	15 days
		PRO-EXPR-E	
		REC-EXPR	
MAFS.912.F-IF.3.8.b	10	CLA-EXPR	
		GRO-DECA	
		IDE-FORM	
		IDE-PART	
		IDE-PROP	
		INT-EXPR	
		INT-FUNC	
		INT-GRAP	
		USE-PROP	
		WRI-FUNC	
MAFS.912.F-LE.1.1	10	CC-FUNC	
		DES-RELA	
		GRO-DECA	
		IDE-FUNC	
		IDE-PART	
		IDE-QUAN	
		MOD-FUNC	
		PRV-FUNC	
		REC-FUNC	
		SOL-FUNC	
MAFS.912.F-LE.1.2	6	CRE-FUNC	
		DES-RELA	
		INT-GRAP	
		REC-FUNC	
		REC-SEQU	
		SOL-FUNC	
MAFS.912.F-LE.1.3	5	CC-FUNC	
		CC-PARTs	
		IDE-QUAN	
		INT-GRAP	
		SOL-FUNC	
MAFS.912.F-LE.2.5	6	IDE-PART	
		INT-FUNC	
		INT-GRAP	
		REC-FUNC	
		REC-SLOP	
		TRA-FUNC	

Time Allowance for Skills in Unit Six

Unit Six: Polynomial Expressions and Functions, of the algebra curriculum for the Medium Sized Rural School District (2015b) included five state mathematics standards. Four state standard were from the algebra domain and one came from the function domain. There were 15 days allotted for mastery of the 21 local standard coded skills in the unit (Medium Sized Rural School District, 2015k, p. 1-2). The results were reported in Table 38.

Table 38

Time Allowance for Unit Six (n = 5)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.A-APR.1.1	3	APP-OPER	15 days
		DEF-CLOS	
		IDE-OPER	
MAFS.912.A-SSE.1.1.b	3	DEF-PART	
		INT-EXPR	
		INT-PART	
MAFS.912.A-SSE.1.2	3	CLA-EXPR	
		IDE-STRU	
		REW-EXPR	
MAFS.912.A-SSE.2.3.a	7	EXP-PROP-Q	
		EXP-QUAD	
		FAC-EQUA	
		FAC-POLY	
		IDE-PROP	
		PRO-EXPR-Q	
		REC-EXPR	
MAFS.912.F.-BF.1.1.c	5	COB-FUNC	
		COM-FUNC	
		CRE-FUNC	
		MOD-FUNC	
		MOD-RELA	

Time Allowance for Skills in Unit Seven

Unit Seven: Quadratic Equations and Functions, of the algebra curriculum for the Medium Sized Rural School District (2015b) included six state mathematics standards. Four of the state standards were from the algebra domain and two were from the function domain. There were 15 days allotted for mastery of the 41 local standard coded skills in the unit (Medium Sized Rural School District, 2015l, p. 1-3). The results were reported in Table 39.

Table 39

Time Allowance for Unit Seven (*n* = 5)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.A-CED.1.1	6	APP-OPER	15 days
		CRE-EQUA	
		CRE-INEQ	
		DES-RELA	
		SOL-EQUA	
		SOL-INEQ	
MAFS.912.A-REI.2.4	5	DER-FORM	
		DET-STEP	
		EXP-SOLU	
		FAC-EQUA	
		SOL-EQUA	
MAFS.912.A-REI.3.6	3	CHO-METH	
		JUS-METH	
		SOL-EQUA	
MAFS.912.A-SSE.2.3.b	10	EXP-PROP-Q	
		EXP-QUAD	
		FAC-EQUA	
		FAC-POLY	
		FOR-TABL	
		GRA-FUNC	
		IDE ZERO	
		IDE-PROP	
		PRO-EXPR-Q	
		REC-EXPR	
MAFS.912.F-BF.1.1.b	8	APP-OPER	
		COB-FUNC	
		CRE-FUNC	
		DES-RELA	
		EVA-FUNC	
		EXP-FUNC	
		IDE-PART	
		IDE-QUAN	
	9	EXP-QUAD	
		FAC-POLY	
		IDE-FORM	
		IDE-PART	
		IDE-ZERO	
		INT-FUNC	
		INT-GRAP	
		REC-EXPR-Q	
		REC-GRAP	

Time Allowance for Skills in Unit Eight

Unit Eight: Relationships that are not Linear, of the algebra curriculum for the Medium Sized Rural School District (2015b) included seven state mathematics standards. Two of the state standards were from the algebra domain and the other five were from the functions domain. There were 20 days allotted for mastery of the 52 local standard coded skills in the unit (Medium Sized Rural School District, 2015m, p. 1-4). The results were reported in Table 40.

Table 40

Time Allowance for Unit Eight (*n* = 7)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.A-APR.2.3	3	FAC-POLY	20 days
		GRA-FUNC	
		IDE-ZERO	
MAFS.912.A-REI.4.11	9	CHO-METH	
		EXP-SOLU	
		FOR-TABL	
		GRA-COOR	
		GRA-FUNC	
		INT-GRAP	
		REC-FUNC-	
		USE-TECH	
		WRI-FUNC	
MAFS.912.F-BF.2.3	8	CC-FUNC	
		EVA-FUNC	
		EXP-FUNC	
		GRA-FUNC	
		IDE-PART	
		INT-GRAP	
		TRA-FUNC	
		USE-TECH	
MAFS.912.F-IF.2.4	7	DEF-GRAP	
		GRA-FUNC	
		IDE-QUAN	
		INT-FUNC	
		INT-GRAP	
		MOD-RELA	
		REC-GRAP	

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.F-IF.3.7.b, c, e	15	ANA FUNC	
		CC-FUNC	
		CC-PART-	
		DES-RELA	
		EXP-FUNC	
		FAC-POLY	
		GRA-FUNC	
		IDE-FORM	
		IDE-FUNC	
		IDE-PART	
		IDE-ZERO	
		INT-GRAP	
		LAB-GRAP	
		MOD-FUNC	
		USE-TECH	
MAFS.912.F-IF.3.9	5	CC-FUNC	
		CC-PART	
		IDE-FUNC	
		IDE-PART	
		INT GRAP	
MAFS.912F-LE.1.3	5	CC-FUNC	
		CC-PARTS	
		IDE-QUAN	
		INT-GRAP	
		SOL-FUNC	

Time Allowance for Skills in Unit Nine

Unit Nine: Statistical Models of the algebra curriculum for the Medium Sized Rural School District (2015b) included seven state mathematics standards. All seven state standards were from the statistics domain. There were 15 days allotted for mastery of the 33 local standard coded skills in the unit (Medium Sized Rural School District, 2015n, pp. 1-3). The results were reported in Table 41.

Table 41

Time Allowance for Statistics and Probability: Interpreting Data (n = 7)

State Standards	Number of Skill Categories	Local Standard Coded Skill	Time Allowance
MAFS.912.S-ID.1.1	2	ANA-DATA	15 days
		REP-DATA	
MAFS.912.S-ID.1.2	3	ANA-DATA	
		CC-DATA	
		CHO-METH	
MAFS.912.S-ID.1.3	3	ANA-DATA	
		DES-DATA	
		INT-DATA	
MAFS.912.S-ID.2.5	7	ANA-DATA	
		CAL-DATA	
		CC-DATA	
		FOR-TABL	
		INT-DATA	
		REC-DATA	
		SUM-DATA	
MAFS.912.S-ID.2.6.a, b, c	9	ANA-DATA	
		DES-DATA	
		EXP-FUNC	
		GRA-COOR	
		GRA-FUNC	
		IDE-QUAN	
		MOD-FUNC	
		REP-DATA	
		SOL-FUNC	
MAFS.912.S-ID.3.8	6	ANA-DATA	
		DEF-DATA	
		DES-RELA	
		INT-DATA	
		MOD-DATA	
		USE-TECH	
MAFS.912.S-ID.3.9	3	CC-DATA	
		DEF-DATA	
		INT-DATA	

Summary

The purpose of this study was to analyze district curriculum alignment to determine the existence of content omissions that may impact Algebra EOC exam scores in ninth grade. The analysis was performed based on the results of the FSA Algebra EOC exam. In a Medium Size Rural School District, the algebra curriculum and algebra textbook were analyzed for the presence of 95 essential performance tasks in search for missing content. The pre-algebra curriculum was also examined to see if it aligned with the algebra curriculum. Embedded skills needed in the algebra course were recorded because they add to a student's ability to be proficient in algebra. An additional analysis was performed to examine the amount of time devoted to mastery of the algebra curriculum.

Organization of Study

This chapter presented the findings from the five research questions for this phenomenological study along with an additional analysis. An in-depth document analysis of the algebra curriculum documents using the constant comparison method was performed and the results reported in supporting tables. Chapter five contains the research results, implications of the study, and suggestions for further research.

CHAPTER 5: SUMMARY, DISCUSSION, AND CONCLUSIONS

Introduction

In Chapter four, the research questions were studied, the data analyzed, and the results reported for the algebra curriculum analyses. Chapter five starts with a summary of the study that includes components from chapter two. The summary includes a brief report of the "purpose of the study, the theoretical framework, research questions or hypotheses, methodology, and findings" (Lunenburg & Irby, 2008, p. 226). Next, a discussion of the results from the document analysis reported in chapter four is included. The findings will be related to mathematical practices today and recommendations will be made for further research. Last, a summary of the intent of this study is presented at the conclusion.

Summary of Study

The researcher studied the problem of content omissions in the school district algebra curriculum which may lead to knowledge gaps in mathematics for some students. The researcher was concerned that omissions in the curriculum could be a factor in low passing rates on the Algebra EOC exam for ninth grade students in a Medium Sized Rural School District. The population of interest were only ninth grade students because the majority of advanced students take the Algebra EOC exam in the eighth grade.

The purpose of this study was to analyze school district curriculum alignment with state and national standards to find content omissions that may contribute to low Algebra End of Course (EOC) exam scores in ninth grade. The ninth grade algebra and eighth grade pre-algebra curriculum for a Medium Size Rural School District was examined through a document analysis process to look for missing content that may lead to knowledge gaps in the content of the course. If content omissions were in the curriculum, they could be added to the curriculum to increase student performance. The algebra textbook was also analyzed for omitted content to see if it was a factor on the low ninth grade algebra EOC exam scores.

The conceptual framework that guided the study was based on the idea of scaffolding educational material based on prior learning. Lev Vygotsky and Jean Piaget were both leaders in understanding how children learn and the chunking of material into digestible bites (McLeod, 2014; McLeod, 2015). Later, David Ausubel and Jerome Bruner built on the concept of scaffolding of related material (Culatta, 2013b; Hannum 2005a). The scaffolding of material is essential to curriculum alignment. Robert Gagne would add to the work of other theorist and say that students need to have prior skills. According to Gagne, students can build on those skills and achieve higher learning (Culatta, 2013a; Hannum, 2005e). The attention that Gagne gave to prior learning led the researcher to inquire about which embedded mathematic skills and pre-algebra requirements are needed for the success in the algebra course. Curriculum alignment in this study is based on the scaffolding of algebra curriculum to maximize learning gains both within the course and over multiple years.

There were five research questions that guided the study. The research questions were:

1. Which algebra domains or standards have the lowest student performance based on the ninth grade Algebra EOC exam (2015)?
2. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the algebra curriculum that may contribute to the low scores on those standards?
3. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the pre-algebra curriculum that should align with those algebra standards?
4. Based on document analysis and expert opinion, what are the knowledge skills embedded in the algebra curriculum that if missing, will contribute to below proficiency on the Florida algebra state standards?
5. Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the missing content standards and skills, if any, in the adopted text book that should align with the district curriculum, state standards, and expert opinion?

The research questions were researched and documented in chapter four of this study.

The methodology for this phenomenological study used a constant comparison method in a document analysis of algebra curriculum documents. The study was based on the answers for the first research question that asked which algebra domains receive low scores by ninth grade students in a Medium Sized Rural School District. Based on those domains, the algebra standards were matched with the local algebra standards for a Medium Sized Rural School District. The local algebra standards or skills were coded and then compared with the algebra state standards to look for content omissions. Next, the pre-algebra curriculum was also compared with the coded local algebra standards to see if the algebra skills were introduced in the pre-algebra course or if there were omissions. The layered embedded skills were also documented to develop a full picture of the needed skills in the algebra curriculum for a Medium Sized Rural School District. Last, a textbook analysis was performed and compared with the coded local algebra standards to see if any local standards were omitted from the textbook. An additional analysis was performed on the coded local algebra standards to examine the amount of time students received to process the material.

This study found that ninth grade algebra students did score significantly lower than their eighth grade counterparts in the three domains on the Algebra EOC for a Medium Sized Rural School District. The document analysis showed that the algebra curriculum and the textbook were aligned with the state standards and have few omissions in the algebra curriculum document for a Medium Sized Rural School District. The study also showed that the pre-algebra curriculum has omitted topics that may not adequately prepare students for ninth grade algebra. There were 77 embedded skills reported in the study showing the importance of curriculum alignment in mathematics for both elementary school and middle school. Lastly, the additional analysis showed that the amount of material that must be covered in a ninth grade algebra course may not allow for enough processing time for mastery. These findings will be discussed in detail in the next section.

Discussion of the Findings

This section will present a discussion of the findings from the qualitative document analyses of the algebra and pre-algebra curriculums for a Medium Sized Rural School District. The findings will be discussed in the order of the research questions. After the findings are discussed, the implication for practice and recommendations will be made for further studies.

Research Question One

Which algebra domains have the lowest student performance based on the ninth grade Algebra EOC exam (2015)?

There were three domains reported on the 2015 Algebra EOC exam from the Florida Standard Assessment. It is important to note that the 2015 Algebra EOC exam was a pilot year so scores were not reported as a scale score at the time of this research. For each student, Florida school districts were given the number of correct responses for each domain on the Algebra EOC exam. The three tested domains for the Medium Sized Rural School District (2015e) were:

1. Algebra and Modeling,
2. Functions and Modeling, and
3. Statistics and Number Systems.

For brevity, the three domains were referred to as Algebra, Functions, and Statistics. Again, because the testing year was a pilot year, a passing score was not given to school districts at the time of this study. The Medium Sized Rural School District (2015e) set 50% as an arbitrary comparison number to see how ninth grade students scored in comparison to eighth grade students on each domain of the Algebra EOC exam. Once the lowest domains were established, the document analysis was performed on the algebra standards for the lowest domains.

Algebra

For the Algebra domain, a significant percentage of eighth graders scored higher in this domain than ninth grade students. There was a 28.07% difference between eighth grade scores and ninth grade scores in the Algebra domain. Only 2.11% of ninth graders answered half the questions correct in this domain compared to 30.18% of eighth graders. Of the 1405 eighth grade students who completed the 2015 spring Algebra EOC exam, 424 students (30.18%) answered 50% of the questions in the Algebra domain correctly. Although the eighth graders scored higher than ninth grade students, the eighth grade percentage is also low. Of the 1707 ninth grade students who completed the 2015 spring Algebra EOC exam, only 36 students (2.11%) answered 50% of the questions in the Algebra domain correctly. These results show that ninth graders are scoring significantly lower than eighth graders necessitating an analysis of the algebra curriculum document for the Algebra domain.

Functions

For the Functions domain, a significant percentage of eighth graders scored higher in this domain than ninth grade students. There was a 24.05% difference between eighth grade and ninth grade scores in the Functions domain. Only 1.29% of ninth graders answered half the questions correct in this domain compared to 25.34% of eighth graders. Of the 1405 eighth grade students who completed the 2015 spring Algebra EOC, 356 students (25.34%) answered 50% of the questions in the Algebra domain correctly. Although the eighth graders scored higher than ninth grade students, the eighth grade percentage is also low. Of the 1707 ninth grade students who completed the 2015 spring Algebra EOC exam, only 22 students (1.29%) answered 50% of the questions in the Algebra domain correctly. These results show that ninth graders were scoring significantly lower than eighth graders necessitating an analysis of the algebra curriculum document for the Functions domain.

Statistics

For the Statistics domain, a significant percentage of eighth graders scored higher in this domain than ninth grade students. There was a 32.64% difference between eighth grade and ninth grade scores in the Statistic and Number System domain. Only 22.38% of ninth graders answered half the questions correct in this domain compared to 55.02% of eighth graders. Of the 1405 eighth grade students who completed the 2015 spring Algebra EOC exam, 773 students (55.02%) answered 50% of the questions in the Statistic domain correctly. Of the 1707 ninth grade students who completed the 2015 spring Algebra EOC, only 382 students (22.38%) answered 50% of the questions in the Statistic domain correctly. Even though the scores were higher in this domain, the results show that ninth graders were scoring significantly lower than eighth graders necessitating an analysis of the algebra curriculum document for the Statistics domain.

Results

There were three tested domains or categories for the Algebra EOC exam. The domains were Algebra, Functions, and Statistics. The results showed that ninth graders were scoring significantly lower than eighth graders on the Algebra EOC exam and the algebra curriculum document analysis for all three domains was necessary. Even though the eighth graders scored higher in all domains, their performance overall was still low. Less than half of all eighth grade students answered 50% of the domain questions correctly except in the statistics domain.

Research Question Two

Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district algebra curriculum that may contribute to the low scores on those standards?

Algebra

According to the Florida Standards Assessment (see Appendix A for tested algebra standards) the Algebra domain from research question one has four tested clusters or themes. Because ninth grade students scored significantly lower on the Algebra domain than eighth grade students, all four themes were studied. The themes were:

1. Polynomials and Rational Expressions,
2. Creating Equations,
3. Seeing Structures in Expressions, and
4. Reasoning with Equations and Inequalities. (Florida Standards, 2015a)

The standards from each of these themes were matched with the coded local algebra standards and only one omission was found in the algebra curriculum documents. The omission was for algebra state standard MAFS.912.A-APR.2.3 which asks students to "Identify zeros of the polynomials" (Florida Standards, 2015a, p. 44) and "use the zeros to construct a rough graph" (Florida Standards, 2015a, p. 44). However, the curriculum document only states in the local standard to "factor polynomials using any method [and] use the x-intercepts of a polynomial function and the x-y table to construct a rough graph of the function" (Medium Size Rural School District, 2015m, p. 1). A case could be made that one cannot use the x-intercepts without identifying them first, but this skill was marked as omitted. The other 94 coded skills were found in the curriculum document for this domain showing that alignment was present between the Medium Sized Rural School District algebra curriculum documents and the Florida Mathematics Standards.

Functions

According to the Florida Standards Assessment (see Appendix B for tested algebra standards), the Functions domain in research question one has three tested clusters or themes. Because ninth grade students scored significantly lower on the Functions domain than eighth grade students, all three themes were studied. The themes were:

1. Interpreting Functions,
2. Building Functions, and
3. Linear, Quadratic, and Exponential Models. (Florida Standards, 2015a)

The standards from each of these themes were matched with the coded local algebra standards and no omissions were found in the algebra curriculum documents for the Medium Sized Rural School District (2015b). Some of the coded local algebra skills were used more than once. All 112 coded skills for this domain were found in the curriculum document showing that alignment was present between the Medium Sized Rural School District algebra curriculum documents and the Florida Mathematics Standards.

Statistics

According to the Florida Standards Assessment (see Appendix C for tested algebra standards), the Statistics domain in research question one had one tested cluster or theme called *Interpreting Data* (2015a). Because ninth grade students scored significantly lower on the Statistics domain than eighth grade students, this theme was studied. The standards from this theme were matched with the coded local algebra standards and no omissions were found in the algebra curriculum documents for the Medium Sized Rural School District (2015b). All 36 coded skills for this domain were found in the curriculum document showing that alignment was present between the Medium Sized Rural School District algebra curriculum documents and the Florida Mathematics Standards.

<u>Results</u>

The findings indicated that the coded local algebra standards for the Medium Sized Rural School District were aligned with the algebra state standards. The results also showed that the coded skills were mapped out in the curriculum document for algebra teachers in the Medium Sized Rural School District. According to Squires (2012), lower performing students perform better when the curriculum is aligned with the state standards and state assessment (p. 133). Since alignment was present in the algebra curriculum, the lower scores in the Algebra domain for ninth grade students in the Medium Sized Rural School District were not caused by content omissions in the ninth grade algebra curriculum.

Research Question Three

Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the content omissions, if any, in the school district pre-algebra curriculum that should align with those algebra standards?

<u>Algebra</u>

According to Florida Standards Assessment (2015a), the Algebra domain had four tested clusters or themes. Because ninth grade students scored significantly lower on the

Algebra domain than eighth grade students, all four themes were studied. Those themes were:

1. Polynomials and Rational Expressions,
2. Creating Equations,
3. Seeing Structures in Expressions, and
4. Reasoning with Equations and Inequalities. (Florida Standards, 2015a)

Within each of the themes, the pre-algebra state standards were matched with the coded local algebra standards. The results showed that 58 of the 95 skills (61.1%) were introduced or practiced in the pre-algebra curriculum. Of the 58 skills that were introduced or practiced, many of them were limited to linear equations as opposed to nonlinear equations. The pre-algebra curriculum did not require students to explain, justify, or prove their reasoning when solving equations. Also, technology was not a focus in the pre-algebra state standards. The remaining 37 coded skills were not present or introduced in the pre-algebra curriculum document for the Medium Sized Rural School District (2015c). The consequences will be discussed more thoroughly in the implications for practice section.

Functions

According to the Florida Standards Assessment (2015a), the Functions domain had three tested clusters themes. Because ninth grade students scored significantly lower on the Functions domain than eighth grade students, all three themes were studied. Those themes were:

1. Interpreting Functions,
2. Building Functions, and
3. Linear, Quadratic, and Exponential Models (Florida Standards, 2015a).

Within each of the themes, the pre-algebra state standards were matched with the coded local algebra standards. Some coded skills were used more than once. The results show that 83 of the 112 coded skills (74.1%) were introduced or practiced in the pre-algebra curriculum. Even though students were asked to interpret nonlinear functions, the pre-algebra curriculum did not expect students to create and graph them. Students were only asked to create and graph linear functions. The other 29 coded skills were not present or introduced in the pre-algebra curriculum document for the Medium Sized Rural School District. The consequences will be discussed more thoroughly in the implications for practice section.

Statistics

According to the Florida Standards Assessment (2015a), the Statistics domain had one tested cluster or theme called *Interpreting Data*. Because ninth grade students scored significantly lower on the Statistics domain than eighth grade students, this theme was studied. Within this theme, the pre-algebra state standards were matched with the coded local algebra skills. The results showed that 25 of the 36 skills (69.4%) were introduced or practiced in the pre-algebra curriculum. The use of bivariate data was limited to scatter plots and frequency charts in the pre-algebra curriculum. Although the scatter plots were investigated in detail, pre-algebra students were not required to use correlation coefficients, understand causation, or use technology. The remaining 11 coded skills were not present or introduced in the pre-algebra curriculum document for the Medium Sized Rural School District. The consequences will be discussed more thoroughly in the implications for practice section.

Results

The findings indicated that the coded local algebra standards for the Medium Sized Rural School District may not be thoroughly aligned with the pre-algebra curriculum. The Medium Sized Rural School District (2015c) is following the required pre-algebra state standards in the curriculum map. However, the findings from this study showed that the pre-algebra course may not fully prepare students for ninth grade algebra. Posner (1992) found that vertical alignment was essential for students to make learning gains (p. 127) because students need to build on prior knowledge. Seely (2004) mentioned the importance of middle school students having strong foundational skills so they were prepared for algebra (p. 22). Also, success on state assessments, such as the Algebra EOC exam, can be impeded by the lack of vertical alignment between school years (McGehee & Griffith, 2001, p. 142). The omissions in the pre-algebra curriculum may contribute to the lower scores in the Algebra, Functions, and Statistics domains for ninth grade students in the Medium Sized Rural School District.

Research Question Four

Based on document analysis and expert opinions, what are the knowledge skills embedded in the algebra curriculum that if missing, will contribute to below proficiency on the Florida algebra state standards?

Because ninth grade students scored significantly lower on the three domains than eighth grade students, all three domains were examined. The coded local algebra standards were matched with pre-requisite skills decided upon by present or former algebra teachers. The list did not include operations such as addition, subtraction, multiplication, and division since those skills were precursors to all mathematical reasoning. Also, the general term "graphs" was used for graphing Cartesian graphs. Statistical graphs and charts were identified by name so the reader would not confuse them with Cartesian graphing.

The teacher team found 77 embedded skills that were pre-requisites for both pre-algebra and algebra courses. These skills are necessary for proficiency in the algebra course. This finding showed the important of curriculum alignment in the elementary and middle school years and will be discussed more in the implications for practice section.

Research Question Five

Based on the ninth grade Algebra EOC exam data and the related algebra content standards, what are the missing content standards and skills, if any, in the *adopted text book that should align with the district curriculum, state standards, and expert opinion*?

It is important to mention that the adopted textbook for the Medium Sized Rural School District was adopted under the previous mathematic standards before the creation of the Florida Mathematics State Standards that align with Common Core. The Medium Sized Rural School District (2015b) adapted the new algebra standards to the textbook that was in circulation. Textbooks are adopted often and curriculum documents should be updated to align with those textbooks. Also, online resources were often suggested when the textbook had deficiencies (Medium Sized Rural School District, 2015b). However, this research only examined the adopted algebra textbook at the time of this study. Topical alignment between the textbook and the coded local algebra standards does not mean that the textbook questions match the style of the algebra EOC exam questions and was listed as a limitation for this study. The findings in this study showed that the textbook was both aligned with the algebra state standards and the Medium Sized Rural School District's algebra curriculum blueprints. However there was limited coverage of some topics in the textbook due to the adoption of new mathematic standards.

Algebra

According to Florida Standards Assessment (2015a), the Algebra domain had four tested clusters or themes. Because ninth grade students scored significantly lower on the

Algebra domain than eighth grade students, all four themes were studied. Those themes were:

1. Polynomials and Rational Expressions,
2. Creating Equations,
3. Seeing Structures in Expressions, and
4. Reasoning with Equations and Inequalities. (Florida Standards, 2015a)

In research question two, the standards from each of these themes were matched with coded local algebra standards and only one omission was found in the algebra curriculum documents for the Medium Sized Rural School District (2015b). The one omitted skill was still included in the textbook analysis. Next, the coded skills were matched with topics and questions in the adopted algebra textbook. Some of the coded skills were used more than once. There was one omitted skill in the textbook. The algebra state standard, MAFS.912.A-APR.1.1, asked students to "Define Closure" which was not in the adopted textbook (Medium Sized Rural School District, 2015k, p. 1). Also, for standard MAFS.912.A-REI.4.11, there was limited coverage of graphing functions because rational functions and logarithmic functions were not included in the textbook (Medium Sized Rural School District, 2015i, p. 2). Additionally, 94 of the 95 coded skills for this domain were present in the adopted textbook showing that alignment was present between the Medium Sized Rural School District algebra curriculum documents and the adopted textbook.

Functions

According to the Florida Standards Assessment (2015a), the Functions domain had three tested clusters themes. Because ninth grade students scored significantly lower on the Functions domain than eighth grade students, all three themes were studied. Those themes were:

1. Interpreting Functions,
2. Building Functions, and
3. Linear, Quadratic, and Exponential Models.(Florida Standards, 2015a)

In research question two, the standards from each of these themes were matched with coded local algebra standards and no omissions were found in the algebra curriculum documents for the Medium Sized Rural School District (2015b). Next, the coded skills were matched with topics and questions in the adopted algebra textbook. Some of the coded skills were used more than once. Standard MAFS.912.F-IF.3.7 had limited coverage for graphing functions, interpreting graphs, and using technology in the textbook. This limitation was listed because trigonometric functions and logarithmic functions were not included in the textbook (Medium Size Rural School District, 2015m, p. 3). There were two omitted skills in the textbook. For standard MAFS.912.F-LE.1.1, there was no coverage for proving the growth of functions (Medium Sized Rural School District, 2015h, p. 3). Although the textbook covered the growth of linear and exponential functions, it did not ask students to prove "how" linear and exponential functions grow. The textbook did not cover composing functions found in state standard MAFS.912.F-BF.1.1. Additionally, 110 of the 112 coded skills for this domain were present in the adopted textbook showing that alignment was present between the Medium Sized Rural School District algebra curriculum documents and the adopted textbook.

Statistics

According to the Florida Standard Assessment (2015a), the Statistics domain had one tested cluster or theme called *Interpreting Data*. Because ninth grade students scored significantly lower on the Statistics domain than eighth grade students, this theme was examined. The standards from this theme were matched with coded local algebra standards and no omissions were found in the algebra curriculum documents for the Medium Sized Rural School District (2015b). Next, the coded skills were matched with topics and questions in the adopted algebra textbook. All 36 of the coded skills for the domain were present in the adopted textbook showing that alignment was present between the Medium Sized Rural School District algebra curriculum documents and the adopted textbook. Although data was analyzed and interpreted, the textbook did no expand on histograms so that standard was documented as having limited coverage.

Results

The findings of the second research question indicated that the coded local algebra standards for the Medium Sized Rural School District were aligned with the algebra state standards. These coded skills were used in the textbook analysis. The Function domain utilized some of the codes more than once. The results for the textbook analysis showed that most of the 95 coded skills were found in the textbook and mapped out in the curriculum document for algebra teachers. Since teachers often rely on the textbook for their classroom instruction, alignment was essential to keep up with the rigor of the state standards and increase student achievement (Freeman et al., 1983, p. 510; Porter et al., 1993, p. 654, 655). The lower scores in the Algebra domain for ninth grade students in the Medium Sized Rural School District could not be attributed to content omissions in the ninth grade algebra textbook.

Additional Research

Additional analysis was performed on each algebra unit of study for a Medium Sized Rural School District to examine the time allowance for the mastery of skills. The findings showed the following:

1. *Unit One: Representing Relationships Mathematically* had 15 days allotted for mastery of the 32 coded local algebra standards.
2. *Unit Two: Understanding Functions* had ten days allotted for mastery of the 27 coded local algebra standards.
3. *Unit Three: Linear Functions* had 25 days allotted for mastery of the 66 coded local algebra standards.
4. *Unit Four: Systems of Linear Equations and Inequalities* had ten days allotted for mastery of the 35 coded local algebra standards.
5. *Unit Five: Exponential Functions and Equations* had 15 days allotted for mastery of the 40 coded local algebra standards.
6. *Unit Six: Polynomial Expressions and Functions* had 15 days allotted for mastery of the 21 coded local algebra standards

7. *Unit Seven: Quadratic Equations and Functions* had 15 days allotted for mastery of the 41 coded local algebra standards.
8. *Unit Eight: Relationships that are not Linear* had 20 days allotted for mastery of the 52 coded local algebra standards.
9. *Unit Nine: Statistical Models* had 15 days allotted for mastery of the 33 coded local algebra standards.

The results showed that there were a large number of skills to be learned in a fixed amount of days. The amount of material to be mastered does not leave much time for remediation of skills or extra practice to attain mastery. Those allotted days also included formative and summative assessments. Teachers had to follow the suggested pacing if completion of the curriculum happened before the implementation of the Algebra EOC exam. Textbooks were often the main mode of instruction in the classroom when following the pacing guides. Freeman et al. (1983) mentioned that there were too many instructional topics in many textbooks (p. 510). With the amount of algebra skills required, the minimal time allowance for each unit may contribute to lower scores on the Algebra EOC for ninth grade students.

Implications for Practice

The implications of this study can be applied to educational structures which are adopting Common Core standards for algebra. A three prong system of curriculum alignment was established in the literature review. The three prongs include instruction, written curriculum, and state assessments (English & Steffy, 2001, p. 14, 15). This study concentrated on the written curriculum and the state assessment. The results of this study have several implications for practice pertaining to the structuring, sequencing, and instructing of the algebra course.

Research Question One

In Research Question One, there were significant differences between the performance of ninth grade algebra students and eighth grade algebra students on the Algebra EOC exam. The eighth grade students were assumed to be the advanced mathematic students. Because ninth grade students have lower performance on end of course testing, the course may need to be designed differently to meet their needs. A school district may need to consider offering Algebra A and B courses to allow for added time to master algebra skills. This may be difficult to offer with the rigorous requirements for on-time high school graduation. A possible solution is to have all students take pre-algebra in seventh grade then offer Algebra A in eighth grade and Algebra B in ninth grade for low performing students.

Research Question Two

Since the written algebra curriculum for a Medium Sized Rural School District aligned with the state mathematics standards and algebra assessment, school district administrators must examine classroom instruction and teacher pedagogy. Classroom instruction and teacher pedagogy could contribute to the low performance on the Algebra EOC exam among ninth graders. It is important that colleges of education and school district administrators provide professional development in best teaching practices for algebra classrooms. Teachers need to use research-based teaching strategies (Hattie, 2009) for mathematical instruction to see growth in student achievement. Also, it is important that teachers are teaching the entire curriculum, using the Mathematical Practice Standards (see Appendix D), and reviewing tested standards regularly.

Research Question Three

Because many of the coded local algebra standards were not present in the pre-algebra curriculum, the researcher concluded that gaps were found in the pre-algebra course. For example, many of the pre-algebra standards only address linear functions, not giving students enough exposure with nonlinear functions. The structure of the pre-algebra course may need to be adjusted to improve algebra preparation especially in the areas of nonlinear functions, proving functions, and modeling functions. Currently, the pre-algebra curriculum has a large amount of material and time given to geometry skills (Medium Sized Rural School District, 2015c). Eight standards from the Expressions and Equations domain, five standards from the Functions domain, four standards from the Statistics domain, and nine standards from the Geometry domain are tested on the Grade 8 FSA Mathematics exam (Florida Standards, 2015b). The FSA exam forces school districts to split the pre-algebra curriculum between algebra and geometry. The restructuring of the pre-algebra course could prove to be vital for students who take algebra in the ninth grade since they are typically less proficient in mathematics than the advanced students. It is important to note that the eighth grades algebra students performed better than ninth grade students on the algebra EOC exam even with the gaps in the pre-algebra curriculum. Because many of the eighth grade students are high performing students, they may be better equipped to compensate for the lack of curriculum alignment between pre-algebra and algebra courses. However, the alignment between the two classes may be crucial for ninth graders who must pass the Algebra EOC exam to graduate.

Research Question Four

There were 77 embedded skills or algebra pre-requisites documented by the teacher team. These finding have a couple implications for practice. First, the teaching quality of these skills are of utmost importance. Hattie (2009) gives the quality of teaching a large effect size ($d = 0.44$; p. 115). Elementary teachers need to use good teaching practices that promote higher order thinking. For example, a teacher can either focus on how to perform a skill or the reasoning behind the skill. Ideally, teachers will do both in their classrooms. If these embedded skills are missing, students may struggle in secondary mathematic courses, such as algebra. For example, MAFS.2.MD.4.10 asks second grade students to "Draw a picture graph and bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in the bar graph" (Florida State, 2015b, p. 1). Although it would be detrimental to the student, it is possible for teachers to teach the bar graph technique without teaching conceptual understanding of what a bar graph truly represents. As that student progresses through yearly mathematic courses, he or she may have deficits in understanding that impede algebra thinking.

Second, younger students do not always have the vocabulary or writing skills to describe their conceptual understanding of a task. A discussion among the teacher team brought up the importance of students verbalizing and visualizing the reasoning behind their solutions, even in grades as early as pre-school. Hattie (2009) identified a large effect size ($d = 0.64$) for self-verbalization and self-questioning techniques (p. 193) showing that these techniques have a positive effect on learning.

Research Question Five

Since the adopted algebra textbook showed alignment with the algebra curriculum for a Medium Sized Rural School District, district administrators must examine other areas of concern, including classroom instruction and teacher pedagogy, to identify the cause of low student performance on the Algebra EOC exam. Professional development in best teaching practices for mathematic courses, such as algebra, is essential. Teachers need to use research-based teaching strategies (Hattie, 2009) for mathematics to see student growth in the classroom. Also, it is important that teachers are teaching the entire curriculum and not skipping areas that they feel are not important. Selecting textbooks that fully align with curriculum can help teachers complete the entire curriculum and cover the essential topics especially since many teachers instruct completely from the textbook (Freeman et al., 1983, p. 510).

Additional Research

The amount of time for mastery of algebra skills should be addressed. Passing the Algebra EOC exam is a graduation requirement in the state of Florida which makes algebra a critical course for many students. Bruner mentioned spiral curriculum or the reviewing of previously learned material, as an important tool in learning (Hannum, 2015b). According to Harden and Stamper (1999), “A spiral curriculum is one in which there is an iterative revisiting of topics, subjects or themes throughout the course. A spiral curriculum is not simply the repetition of a topic taught. It requires also the deepening of it, with each successive encounter building on the previous one” (p. 141). Since spiral curriculum is essential, teachers need enough time to implement this critical review.

As mentioned earlier, a school district may need to consider offering an Algebra A and Algebra B course to allow for added time to master algebra skills. One suggestion is to offer Algebra A to eighth grade students who struggle in middle school mathematics. This allows for ninth grade students to move to Algebra B and stay on track for graduation. If Algebra A and B are not an option, then an additional mathematics study hall could be necessary. However, prior to considering the doubling of mathematics in the same year, a struggling student’s attitude towards mathematics may need to be examined since a negative attitude could have a negative effect on learning.

Recommendations for Further Research

The researcher recommends that further research be conducted in several areas. Since the written algebra curriculum showed alignment with the algebra state standards, a study should be performed on teacher pedagogy to see if proven teaching methods are being used in algebra classes. Even within the digital age, independent practice of skills has been shown to have a small effect size (d = 16; Hattie, 2009, p. 145). Even more so, problem-based learning is helpful for deepening existing knowledge but not for introducing new skills (Hattie, 2009, p. 211). Not only should teacher pedagogy be studied in algebra classes to see if teachers are using best practices, but a study of full coverage of the content material should be conducted as well. A study may include looking at a teacher's plan book to see the covered content for the course.

Another area of research that would be beneficial is to examine if ninth grade students who are given two years (Algebra A and Algebra B) for algebra mastery outperform ninth grade students who complete the algebra course in one year. With the amount of material that is required to be mastered in the scope and sequence of the course, the time allowance for mastery may not be sufficient. The algebra course scope and sequence may not allow enough time for remediation and review.

Another study that could be beneficial is on the effectiveness of the pre-algebra classes. The researcher recommends a study to determine if students who focus exclusively on algebra skills are more prepared for algebra course work than students whose pre-algebra course blends the algebra content with geometry standards. The amount of content in the algebra course, along with the algebra graduation requirement, could be insurmountable to ninth grade students who struggle in mathematics. More time on algebra skills may prove useful to pre-algebra students who take algebra in ninth grade.

Lastly, a study of the teaching methods and best teaching practices in elementary school could prove to be beneficial. The embedded skills for algebra are often taught in elementary school. It would be useful to know if teachers are teaching rote process skills or conceptual understanding of mathematical tasks. Skills that are not mastered in lower level grades could ultimately affect a student's processing in more difficult problem-solving situations.

Conclusions

A qualitative document analysis was performed on algebra curriculum documents for a Medium Sized Rural School District. The alignment looked at algebra standards in the low performing domains of Algebra, Functions, and Statistics for ninth grade algebra students. The document analysis compared the algebra state standards with the local curriculum standards showing alignment was present. Alignment was also present in the text book used for the algebra course. However, further analysis showed that the pre-algebra alignment had gaps that may lead to knowledge voids for ninth grades students. Also, the amount of information that ninth grade algebra students are expected to retain may be too large for students to achieve mastery in the amount of time provided. Since there was alignment between the school district curriculum, the state standards, and the adopted textbook, then school districts, along with teacher education programs, could concentrate on teacher pedagogy in mathematic courses.

APPENDIX A:
ALGEBRA STANDARDS ON THE ALGEBRA EOC

Table 42

Algebra Standards On The Algebra EOC

Conceptual Category	Domain	Cluster	Standard
Algebra	Seeing Structure in Expressions	Write expressions in equivalent forms to solve problems.	MAFS.912.A-SSE.2.3—Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. c. Use the properties of exponents to transform expressions for exponential functions.
Algebra	Arithmetic with Polynomials and Rational Expressions	Perform arithmetic operations on polynomials.	MAFS.912.A-APR.1.1—Understand that polynomials form a system analogous to the integers; namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.
Algebra	Arithmetic with Polynomials and Rational Expressions	Understand the relationship between zeros and factors of polynomials.	MAFS.912.A-APR.2.3—Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Conceptual Category	Domain	Cluster	Standard
Algebra	Creating Equations	Create equations that describe numbers or relationships	MAFS.912.A-CED.1.1—Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. MAFS.912.A-CED.1.2—Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. MAFS.912.A-CED.1.3—Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. MAFS.912.A-CED.1.4—Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
Algebra	Reasoning with Equations and Inequalities	Understand solving equations as a process of reasoning and explain the reasoning.	MAFS.912.A-REI.1.1—Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Conceptual Category	Domain	Cluster	Standard
Algebra	Reasoning with Equations and Inequalities	Solve equations and inequalities in one variable.	MAFS.912.A-REI.2.3—Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. MAFS.912.A-REI.2.4—Solve quadratic equations in one variable. a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form. b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula, and factoring as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.
Algebra	Reasoning with Equations and Inequalities	Solve systems of equations.	MAFS.912.A-REI.3.5—Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. MAFS.912.A-REI.3.6—Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Conceptual Category	Domain	Cluster	Standard
Algebra	Reasoning with Equations and Inequalities	Represent and solve equations and inequalities graphically.	MAFS.912.A-REI.4.10—Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). MAFS.912.A-REI.4.11—Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. MAFS.912.A-REI.4.12—Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half planes.

Note. Adapted from "Florida Standards Assessment." (2015a). Algebra 1 EOC Item Specifications, [Draft, FSA], pp. 1-66. Retrieved from http://fsassessments.org/wp-content/uploads/2015/03/Algebra-1-Test-Item-Specifications.pdf

APPENDIX B:
FUNCTION STANDARDS ON THE ALGEBRA EOC

Table 43

Function Standards On The Algebra EOC

Conceptual Category	Domain	Cluster	Standard
Functions	Interpreting Functions	Understand the concept of a function and use function notation.	MAFS.912.F-IF.1.1—Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = (fx).
			MAFS.912.F-IF.1.2—Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
			MAFS.912.F-IF.1.3—Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
Functions	Interpreting Functions	Interpret functions that arise in applications in terms of the context.	MAFS.912.F-IF.2.4—For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
			MAFS.912.F-IF.2.5—Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
			MAFS.912.F-IF.2.6—Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Conceptual Category	Domain	Cluster	Standard
Functions	Interpreting Functions	Analyze functions using different representations.	MAFS.912.F-IF.3.7—Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. c. Graph polynomial functions, identifying zeros when suitable factorizations are available and showing end behavior. d. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude and using phase shift. MAFS.912.F-IF.3.8—Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. b. Use the properties of exponents to interpret expressions for exponential functions. MAFS.912.F-IF.3.9—Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

Conceptual Category	Domain	Cluster	Standard
Functions	Building Functions	Build a function that models a relationship between two quantities.	MAFS.912.F-BF.1.1—Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. b. Combine standard function types using arithmetic operations. c. Compose a function.
Functions	Building Functions	Build new functions from existing functions.	MAFS.912.F-BF.2.3—Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.
Functions	Linear, Quadratic, and Exponential Models	Construct and compare linear, quadratic, and exponential models and solve problems.	MAFS.912.F-LE.1.1—Distinguish between situations that can be modeled with linear functions and with exponential functions. a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. MAFS.912.F-LE.1.2—Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input -output pairs (include reading these from a table). MAFS.912.F-LE.1.3—Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

Conceptual Category	Domain	Cluster	Standard
Functions	Linear, Quadratic, and Exponential Models	Interpret expressions for functions in terms of the situation they model.	MAFS.912.F-LE.2.5—Interpret the parameters in a linear or exponential function in terms of a context.

Note. Adapted from "Florida Standards Assessment." (2015a). Algebra 1 EOC Item Specifications, [Draft, FSA], pp. 1-66. Retrieved from http://fsassessments.org/wp-content/uploads/2015/03/Algebra-1-Test-Item-Specifications.pdf

APPENDIX C:
STATISTICS AND PROBABILITY STANDARDS ON THE ALGEBRA EOC

Table 44

Statistics And Probability Standards On The Algebra EOC

Conceptual Category	Domain	Cluster	Standard
Statistics and Probability	Interpreting Categorical and Quantitative Data	Summarize, represent, and interpret data on a single count or measurement variable.	MAFS.912.S-ID.1.1—Represent data with plots on the real number line (dot plots, histograms, and box plots). MAFS.912.S-ID.1.2—Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. MAFS.912.S-ID.1.3—Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). MAFS.912.S-ID.1.4—Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.
Statistics and Probability	Interpreting Categorical and Quantitative Data	b.	MAFS.912.S-ID.2.5—Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. MAFS.912.S-ID.2.6—Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. b. Informally assess the fit of a function by plotting and analyzing residuals.

Conceptual Category	Domain	Cluster	Standard
			c. Fit a linear function for a scatter plot that suggests a linear association.
Statistics and Probability	Interpreting Categorical and Quantitative Data	Interpret linear models.	MAFS.912.S-ID.3.7—Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. MAFS.912.S-ID.3.8—Compute (using technology) and interpret the correlation coefficient of a linear fit. MAFS.912.S-ID.3.9—Distinguish between correlation and causation.

Note. Adapted from "Florida Standards Assessment." (2015a). Algebra 1 EOC Item Specifications, [Draft, FSA], pp. 1-66. Retrieved from http://fsassessments.org/wp-content/uploads/2015/03/Algebra-1-Test-Item-Specifications.pdf

APPENDIX D:
MATHEMATICAL PRACTICE STANDARDS

Table 45

Mathematical Practice Standards

Standards
MAFS.K12.MP.1.1: Make sense of problems and persevere in solving them.
MAFS.K12.MP.2.1: Reason abstractly and quantitatively.
MAFS.K12.MP.3.1: Construct viable arguments and critique the reasoning of others.
MAFS.K.12.MP.4.1: Model with mathematics.
MAFS.K12.MP.5.1: Use appropriate tools strategically.
MAFS.K12.MP.6.1: Attend to precision.
MAFS.K12.MP.7.1: Look for and make use of structure.
MAFS.K12.MP.8.1: Look for and express regularity in repeated reasoning. (p. 4-7)

Note. Adapted from "Florida Standards Assessment." (2015a). Algebra 1 EOC Item Specifications, [Draft, FSA], pp. 1-66. Retrieved from http://fsassessments.org/wp-content/uploads/2015/03/Algebra-1-Test-Item-Specifications.pdf

APPENDIX E:
CODED LOCAL ALGEBRA STANDARDS AND SKILLS

Table 46

Coded Local Algebra Standards and Skills

Code	Definition
ANA-DATA	Analyze data and statistics
ANA-FUNC	Analyze functions-linear and nonlinear
APP-OPER	Apply operations to polynomials and functions
CAL-DATA	Calculate statistics including frequencies
CC-DATA	Compare or contrast data and statistics
CC-FUNC	Compare and contrast functions including transformed functions and characteristics of functions
CC-PARTS	Compare or contrast parts of a functions such as domain and range
CHO-METH	Choose method for solving or for analyzing statistical data
CLA-EXPR	Classify expressions
COB-FUNC	Combine functions
COM-FUNC	Compose functions
CON-ARGU	Construct an argument
CRE-EQUA	Create equations-linear and nonlinear
CRE-EQUA-2	Create a system of equations
CRE-FUNC	Create functions including real world situations
CRE-INEQ	Create inequalities
DEF-CLOS	Define closure
DEF-DATA	Define characteristics of statistical data
DEF-FUNC	Define functions
DEF-GRAP	Define key features of graphs
DEF-PART	Define or determine parts of an expression, equations, or functions
DEF-QUAN	Define are explain quantities
DEF-RECU	Define the recursive process
DER-FORM	Derive a formula
DES-DATA	Describe data including outliers
DES-RELA	Describe/determine the relationship
DET-EQUA	Determine when to use an equation
DET-FUNC	Determine if relation is a function
DET-INEQ	Determine when to use an inequality
DET-SOLU	Determine solutions of an equation
DET-STEP	Determine steps for problem solving
EVA-FUNC	Evaluate functions-linear and nonlinear
EXP-FUNC	Explain or describe functions and characteristics of functions. Apply explanation to linear and nonlinear functions
EXP-QUAD	Explain parts and forms of quadratic expressions
EXP-PROP-E	Explain properties of quantities in exponential expressions
EXP-PROP-Q	Explain properties of quantities in quadratic expressions
EXP-SOLU	Explain solutions including complex solutions

Code	Definition
EXP-STEP	Explain steps in problem solving
FAC-EQUA	Factor a quadratic equation or quadratic expression
FAC-POLY	Factor polynomials and/or functions
FOR-TABL	Form and interpret tables including coordinate and frequency tables
GRA-COOR	Graph or recognize coordinates
GRA-EQUA	Graph equations
GRA-FUNC	Graph a functions or polynomials. Apply to linear and nonlinear functions
GRA-INEQ	Graph inequalities including systems
GRO-DECA	Classify and solve growth and decay problems
IDE-FORM	Identify equivalent forms of functions
IDE-FUNC	Identify types of functions
IDE-OPER	Identify operations
IDE-PART	Identify parts of functions including domain and range and parts of graphs. Apply to linear and nonlinear functions.
IDE-PROP	Identify properties of equality, exponents, and/or polynomials
IDE-QUAN	Identify, define, or determine quantities
IDE-SOLU-I	Identify graphical and numerical solutions to inequalities. Identify characteristics of the graphs and number lines
IDE-STRU	Identify structures of an expression
IDE-ZERO	Identify zeros of a polynomial
INT-DATA	Interpret data sets
INT-EXPR	Interpret expressions in terms of a context
INT-FUNC	Interpret functions including real world situations
INT-GRAP	Interpret graphs and key characteristics of graphs or tables
INT-PART	Interpret parts of an expression, an equation, or a function
INT-SLOP	Interpret slope and key characteristics of slope
INT-SOLU	Interpret solutions
JUS-METH	Justify method
JUS-QUAN	Justify quantities
JUS-SOLU	Justify solutions
JUS-STEP	Justify steps or process
LAB-GRAP	Label graphs
MOD-DATA	Model data
MOD-FUNC	Model functions
MOD-RELA	Model relationship including real world situations.
PRO-EXPR-E	Produce equivalent forms of exponential expressions
PRO-EXPR-Q	Produce equivalent forms of quadratic expressions
PRV-FUNC	Prove characteristics of functions
REA-EQUA	Rearrange equations or formulas
REC-CONS	Recognize constraints
REC-DATA	Recognize statistical data including frequencies
REC-EXPR-	Recognize forms of an expression-linear and nonlinear

Code	Definition
REC-FUNC	Recognize all types of functions and function notation
REC-GRAP	Recognize graphical representations and key features
REC-PART	Recognize parts of an expression, equation, or function
REC-SEQU	Recognize that sequences are functions
REC-SLOP	Recognize slope
REP-CONS	Represent constraints by equations and inequalities
REP-DATA	Represent data
REW-EXPR	Rewrite expressions
SOL-EQUA	Solve equations including systems of equations. Apply to linear and nonlinear equations. Applies to any method of solving equations.
SOL-FUNC	Solve functions. Apply to linear and nonlinear functions.
SOL-INEQ	Solve linear inequalities or system of inequalities
SOL-SLOP	Solve problems with slope
SUM-DATA	Summarize statistical data
TRA-EXPR-E	Transform exponential functions
TRA-FUNC	Transform a function,-symbolic or graphical. Include recognizing shifts. Apply to linear and nonlinear functions
USE-PROP	Use properties of equality
USE-TECH	Use technology
WRI-FUNC	Write functions. Include function notation. Apply to linear and nonlinear functions.

Note. Adapted from "Medium Size Rural School District" (2015b). Algebra I curriculum blueprint. *Curriculum and Instruction*. http://www.lake.k12.fl.us/Page/92

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