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The Education of the Elementary Mathematics Specialist: A Program Evaluation

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THE EDUCATION OF THE ELEMENTARY MATHEMATICS SPECIALIST: A PROGRAM EVALUATION

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APPROVAL OF DISSERTATION

We, the faculty supervising the work of **Lee Ann Vecellio**, affirm that the dissertation, *The Education of the Elementary Mathematics Specialist: A Program Evaluation*, meets the high academic standards for original scholarship and creative work established by the Ed.D. Program in **Curriculum and Instruction** and the College of Education and Professional Development. This work also conforms to the editorial standards of our discipline and the Graduate College of Marshall University. With our signatures, we approve the manuscript for publication.

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ABSTRACT

Over the past 30 years, there has been a growing need to strengthen educators' mathematical skills through additional training. Nationwide, companies such as Exxon Mobile (1988) have created mathematics and science initiatives to improve teachers' skills in the classroom. It is important that school systems explore ways to ensure students receive quality mathematics instruction from well trained, confident teachers who understand the content, can use instructional/assessment strategies, and to understand how students learn mathematics. The purpose of this study was to examine the confidence levels in mathematical content and pedagogy of graduates of the Elementary Mathematics Specialist (EMS) program. This study presented what benefits the program provided graduates and graduates' perceptions of their mathematics content knowledge and pedagogy due to participation in the program. This mixed-methods study used a convergent-parallel approach to examine perceptions of graduates. This study included a researcher-developed Likert scale survey, focus group discussion, interviews, and a review of course content and course syllabi to collect both quantitative and qualitative data. Results indicated most graduates had high levels of confidence in content knowledge and pedagogy across all National Council of Teachers of Mathematics Standards after completion of this program. High levels of confidence in this intensive EMS program validated the objectives of this program to provide graduates with greater mathematics content knowledge, differentiated instruction mathematical skills, collaboration among colleagues, mathematical leadership skills, and greater autonomy in their work.

CHAPTER ONE: INTRODUCTION OF THE STUDY

Introduction

Most individuals remember their elementary and middle school mathematics classes: Multiplication, Division, Algebra I, and Geometry. These components of mathematics were quite challenging in and of themselves. The content in the courses was complicated and at times, appeared to be daunting for those of us who are not math-minded. Students struggle to master elementary mathematics for various reasons. Whatever the reasons, their struggles are only compounded in high school if elementary mathematics content such as division and multiplication have never been successfully mastered.

West Virginia (WV) public school students continue to struggle with performance in their summative math assessment. State standardized test results from 2014-2015 indicate that "only 18 percent of ninth-graders, 15 percent of 10th-graders, and 20 percent of 11th-graders across the state were rated 'proficient' on the Smarter Balance Assessment" (WV Metro News, 2015). When compared to other states on the National Report Card (2013), West Virginia ranks as one of the 13 lowest states for mathematics scores for fourth and eighth graders (National Report Card, 2013).

Enter the Elementary Mathematics Specialist (EMS) program at Marshall University. This program is designed to train individuals who either have a master's degree or are working towards their master's to gain certification as an EMS. This program focuses on increasing teachers' confidence in their ability to teach mathematics to students, act as mathematics leaders in their educational communities, and to strengthen their own mathematical content knowledge.

All of these goals are intended for these teachers to help K-6th students improve mathematics achievement.

Feedback from graduates is critical in continuing to design a program that addresses needs of local Boards of Education, the State Department of Education, teachers, and students. Without student candidates' feedback it would be difficult to determine what parts of the program are effective and what needs improvement. This study is a program evaluation using graduate candidate feedback.

Statement of the Problem

Elementary teacher confidence levels and content knowledge are sometimes the reason for a disconnect between mathematics instruction and levels of understanding achieved by the students being taught. The question posed when starting the evaluation of the EMS program was, "Does the program prepare teacher candidates as mathematical leaders in the educational environment?" If the United States is going to stay competitive in STEM areas, then the capacity of its students to do mathematics must improve. William Schmidt, a Michigan State University professor who studies how the U.S. matches up against other countries, found most eighth-graders cannot do simple mathematical tasks such as adding fractions (Hechinger Report, 2010). This skill is mastered in other countries by the fourth grade. According to the "National Report Card" (2013), only 39 percent of fourth-graders, 34 percent of eighth-graders, and 23 percent of twelfth-graders score at or above the proficient level in mathematics. Further, a 2009 report from Jobs of the Future found 60 percent of community colleges require students to take a developmental mathematics course before taking any college level math courses (Jff.com, 2009).

Elementary Mathematics Specialist programs should focus on raising the capability of the teachers in their mathematical comfort and confidence levels. By raising confidence levels, schools should see improvement in student mathematics achievement scores. When the knowledge base and confidence of the teachers increase, so will the student scores in mathematics.

Purpose of the Study

The purpose of this study is to examine the effectiveness of the EMS program on the confidence and mathematics content knowledge of its teacher candidates. The Elementary Mathematics Specialist (EMS) Program allows professionals with an undergraduate degree in education to take eight courses online focused on breaking down mathematics typically seen in grades Kindergarten through sixth grade. This program was created to help teachers that are generalists in elementary education hone their skills in mathematics to build confidence and increase mathematics proficiency and pedagogy skills. All 50 states have standards of what students should learn in mathematics (Hechinger, 2010). Though these standards vary, national experts agree that many states' content standards are too voluminous for students to have success (Hechinger, 2010). The EMS's responsibility is to break down these standards into understandable and useful lessons. By looking at the teacher participant perceptions of the EMS Program, we hope to uncover what benefits the program is providing graduates, and uncover their perceptions of their effectiveness to increase student performance in mathematics. The study will utilize a mixed methods approach consisting of a survey designed specifically for this research and focus group/interviews.

Rationale of the Study

It is necessary that elementary teachers understand the critical role they play in teaching mathematics to students (Reys & Fennell, 2003). It is equally important that county Boards of Education explore ways to ensure students receive quality mathematics instruction from well trained, confident teachers who understand the content, can use instructional/assessment strategies, and know how students learn mathematics. In recent years, there has been a call for a challenging mathematics curriculum at all levels, and especially at elementary levels (NCTM, 2000). For most students, their perceptions and attitudes of mathematics is shaped during the elementary years, which is difficult, if not impossible, to change after this time. Students who learn mathematics by rules, facts, and procedures through memorization are unlikely to have positive attitudes toward mathematics (Reys & Fennell, 2003).

The fact the elementary teachers are supposed to be the master of many subjects is not only doubtful, but also improbable. The problem starts at the preservice level of a teacher's education. Most teachers are only provided two or three courses on mathematics that are focused on content and methods. These mathematics courses lack emphasis on subject area specialization (NCTM, 2000). Battista (1994) argues additional courses in mathematics must be properly designed:

> The additional mathematics that teachers take must be taught accurately. That is, it must be taught to ensure understanding takes place. Unfortunately, most university mathematics courses reinforce rather than debunk the view of mathematics as a set of procedures to be memorized. Because such courses simply perpetuate the mathematical miseducation that occurs in grades K–12, requiring teachers to take more of them will do little to solve the problem. (p. 468).

The lack of teacher preparation and the quality of the mathematics courses leaves little chance of changing teacher beliefs of how to teach mathematics based on how they were taught. There are many standards available to look at that provide suggestions on improving teacher preparation for the field. For example, the Conference Board of Mathematical Sciences (2001) released a report showing elementary teachers should complete nine hours of mathematics courses that encompass number, algebra, geometry, measurement, and data analysis. The report further suggested that elementary mathematics be led by an EMS, starting no later than fifth grade. Elementary Mathematics Specialists—teachers with particular knowledge, interest, and expertise in mathematics content and pedagogy—create the best environment for learning mathematics (Reys & Fennell, 2003).

The Exxon/Mobil Educational Foundation supported the creation of a national network of school district projects that are focused on the development of mathematics specialists and leaders at the elementary school level (Reys and Fennell, 2003). The EMS is a teacher whose preparation and interest in mathematics content and pedagogy are solidified with special training and leadership activities. Ferrini-Mundy and Johnson (1994) found school-based leadership provided by mathematics specialists appeared to be critical in maintaining reform efforts: "They helped spread ideas, facilitate communications among teachers, plan and initiate staff development, and address political problems with administrators and community members" (p. 119).

An assumption can be made that if all elementary schools employed an EMS, fewer referrals would take place for special education testing and Student Assistance Team support. Faculty and staff morale may increase as confidence levels and student performance increase. Comradery among staff and school wide training activities are also likely to occur with EMSs present in the school.

Some expectations are increased confidence in the graduates related to teaching mathematics and taking an active leadership role among faculty. It also is an expectation that out of 50 graduates participating in the study, not all of the surveys will be returned. There will hopefully be a strong correlation between the qualitative and quantitative data. Another expectation is the increase in student performance in schools where the graduates are located. If there is an increase in student performance it will be determined based on graduate feedback in follow up interviews.

Significance of the Study

Under this standards-based conceptual framework, the program will not only help counties where graduate candidates reside and work, but also improve state support in creating EMS positions. The state only offers Title I math support with no other math specialist positions in counties. This study will help further support the program to create needed positions in mathematics across the state and potentially in other states where graduate candidates reside.

This is a new program that has not been formally evaluated. The program is needed and designed to assist administrative and instructional staff in interpreting data and designing approaches to improve student achievement and instruction. It ensures that the curriculum is aligned with state and national standards and their school division's mathematics curriculum. It also, promotes teachers' delivery and understanding of the school mathematics curriculum through collaborative long-range and short-range planning. It focuses on facilitating teachers' use of successful, research-based instructional strategies, including differentiated instruction for diverse learners. Finally, the program is designed to collaborate with administrators to provide leadership and vision for a school-wide mathematics program. Moreover, this research will provide useful data determining the effectiveness of the current EMS program as well as professional development that needs to occur for educators teaching math curriculum.

Research Questions

The following research questions were investigated:

Research Question 1: What are graduate candidate perceptions of their confidence in their mathematics content and pedagogy knowledge due to their participation in the Elementary Mathematics Specialist program?

Research Question 2: What are graduate candidate perceptions of their confidence in their teaching skills and practices due to their participation in the Elementary Mathematics Specialist program?

Research Question 3: What are graduate candidate perceptions of their confidence in their mathematics leadership skills due to their participation in the Elementary Mathematics Specialist program?

Definition of Terms

Elementary Mathematics Specialist program. Gradate mathematics education program as described by Marshall University Course Catalog. The courses of the Elementary Mathematics Specialist Program emphasize deep learning of mathematical content as well as mathematics educational leadership and progressive mathematics pedagogy appropriate for teaching elementary students.

Candidate perceptions of mathematics teaching confidence. Candidate confidence as measured by study survey and candidate interviews.

Candidate perceptions of mathematics teaching pedagogy. Candidate mathematics pedagogy as measured by study survey and candidate interviews.

Candidate perceptions of mathematics content knowledge. Candidate mathematics content knowledge as measured by study survey and candidate interviews.

Candidate Perceptions of the Marshall University EMS Program survey. Candidate perceptions survey based on National Council of Teachers of Mathematics (NCTM) standards, as described by NCTM is the world's largest mathematics education organization, with 60,000 members and more than 230 Affiliates throughout the United States and Canada; it was founded in 1920 (NCTM, 2017). The Standards for school mathematics describe the mathematical understanding, knowledge, and skills that students should acquire from prekindergarten through grade 12. The five Content Standards each encompass specific expectations, organized by grade bands: Number & Operations, Algebra, Geometry, Measurement, and Data Analysis & Probability.

Elementary Mathematics Specialist. Teacher leaders who are responsible for supporting effective pre-K–6 mathematics instruction and student learning. The specific roles and responsibilities of EMS professionals vary according to the needs and purposes of each setting, but their expertise and successful experience at the elementary level are critical. At the classroom level, an EMS professional may teach mathematics to elementary students in one or more grade levels or work with particular groups of students to provide remedial or enrichment support services. At the school or district level, EMS professionals may work primarily with teachers as coaches, in a professional development capacity or targeting school-wide improvement in mathematics.

Content Standards. Broadly stated expectations of what students should know and be able to do in particular subjects and grade levels.

Assumptions of the Study

It can be assumed that some students enrolled in the West Virginia public education system are struggling in mathematics while maintaining higher grades in most other courses. Low mathematics grades could partly be due to teachers not fully understanding the curriculum they are expected to teach (Switzer, 2015). Researchers identified important relationships between instructional practices and student's academic achievement (Bottia, Moller, Mickelson, & Stearns, 2014). It also can be assumed that students may have already convinced themselves they are not good at mathematics due to not acquiring the foundational skills needed for success.

Limitations and Delimitations of the Study

We were limited to graduates of the EMS program our university created. We were also limited by those graduates that were willing to take the survey and provide feedback on their perceptions. This study did not investigate student performance in the schools outside of perceptions of the graduates. It also did not do any comparisons of other programs at other universities and this university's EMS program. Because the State of West Virginia is in the early inception of creating the EMS position through the West Virginia Department of Education, EMS graduates may not have the position title in their respective counties of an EMS. Due to this limitation, EMS graduates may only be providing assistance to their schools informally and not in the official role as an EMS. This study was a current view of the perspectives of the graduates thus far and not a longitudinal study of graduates over time.

The limitations of this study are that the participants are graduates from 2016 Spring through 2018 December. Another limitation is the program has only been in existence since the 2015 Spring semester and therefore has a limited set of results that can be researched. The participants of the study have only been from West Virginia thus far. I will only be conducting a limited number of follow-up interviews for this study.

CHAPTER 2: REVIEW OF THE LITERATURE

A literature search was conducted to examine elementary teacher professional development, teacher confidence levels, existing programs, STEM research, and elementary math teachers' personal experiences when they were students. Search results revealed the research on elementary mathematics teachers is vast, and the challenge was to narrow down the research to information specifically relevant to a program evaluation study. The search also included looking at mathematics teachers as mentors and leaders in their respective learning communities.

Literature Search Process

EBSCOhost and ERIC were used to search the US Department of Education, PsychARTICLES, and PsychINFO databases in eight separate searches for each of the issues being investigated in the current study: professional development, retention and promotion, covering/recovering content, NCTM content standards, STEM in elementary schools, Dewey's objectives for mathematics, elementary teachers' previous learning experiences, and confidence in teaching math. The search terms "elementary math teacher" and "professional development," "pre-service," "confidence," "mentors," "collaboration," and "learning experiences" were designated to appear in the **article title**. This strategy was used to ensure that the literature was focused solely on elementary mathematics teachers, as opposed to students and their progress in mathematics. Because this strategy found only 40 articles related to "elementary mathematics teachers," the search was expanded by using references from these 40 articles to find additional articles that covered the topics further. I also utilized the National Council of Teachers of Mathematics (NCTM) as an additional resource for articles.

National Council of Teachers of Mathematics (NCTM) Content Standards

Exxon Mobile (1988) became a founding sponsor of a National Math and Science Initiative with a $125 million commitment to the non-profit organization. At this same time, they launched the *K-5 Mathematics Specialist Program* with grants provided to 120 districts across the country to train and place mathematics specialists in elementary schools. They made an additional $60 million commitment to support schools in Louisiana, North Dakota, and Pennsylvania. Virginia was one of the first states to take advantage of the initiative and thus has more programs for Elementary Math Specialists (EMSs) than any other state—seven in total at various colleges and universities. NCTM also have more data related to the effectiveness of EMS programs than any other state currently.

NCTM (2010) defines an Elementary Mathematics Specialist (EMS) as a teacher-leader who is responsible for providing valuable teacher-colleague support for Pre-K to sixth grade and for enhancing student learning. EMSs are not to be confused with a Mathematics Coach, which NCTM (n.d.) defines as an individual who is well versed in mathematics content and pedagogy and who works with educational professionals to improve student learning. These Math Coaches are not required to have specialized mathematics endorsements on their licensures nor have they completed a set group of required courses to receive the endorsement. Often, they have completed some undergraduate mathematics courses, possibly as a minor in college. These two terms, EMS and Math Coach, are often used interchangeably without many people realizing the distinction between the two.

The Elementary Mathematics Specialist and Teacher Leaders Project is designed to support those professionals who know and understand mathematics, and who effectively lead and mentor their colleagues (ENS&TL, n.d.). This project is supported by the Brookhill Institute of Mathematics. The project regularly provides for the continuing professional development and mentoring of a cadre of mathematics teacher-leaders and elementary school mathematics specialists in Maryland. The project will continue to examine the impact of the work of mathematics specialists at the regional and national level. While the call for EMS professionals began over two decades ago, currently only a few states and provinces offer advanced certification for EMS professionals (NCTM, 2000). As a result, the research on the impact of EMS professionals is still emerging. However, the available research acknowledges that EMS professionals have positive impacts on teachers and students. Currently there are 19 states that are fully certified and 8 states in the process, including West Virginia (see Figure 1).

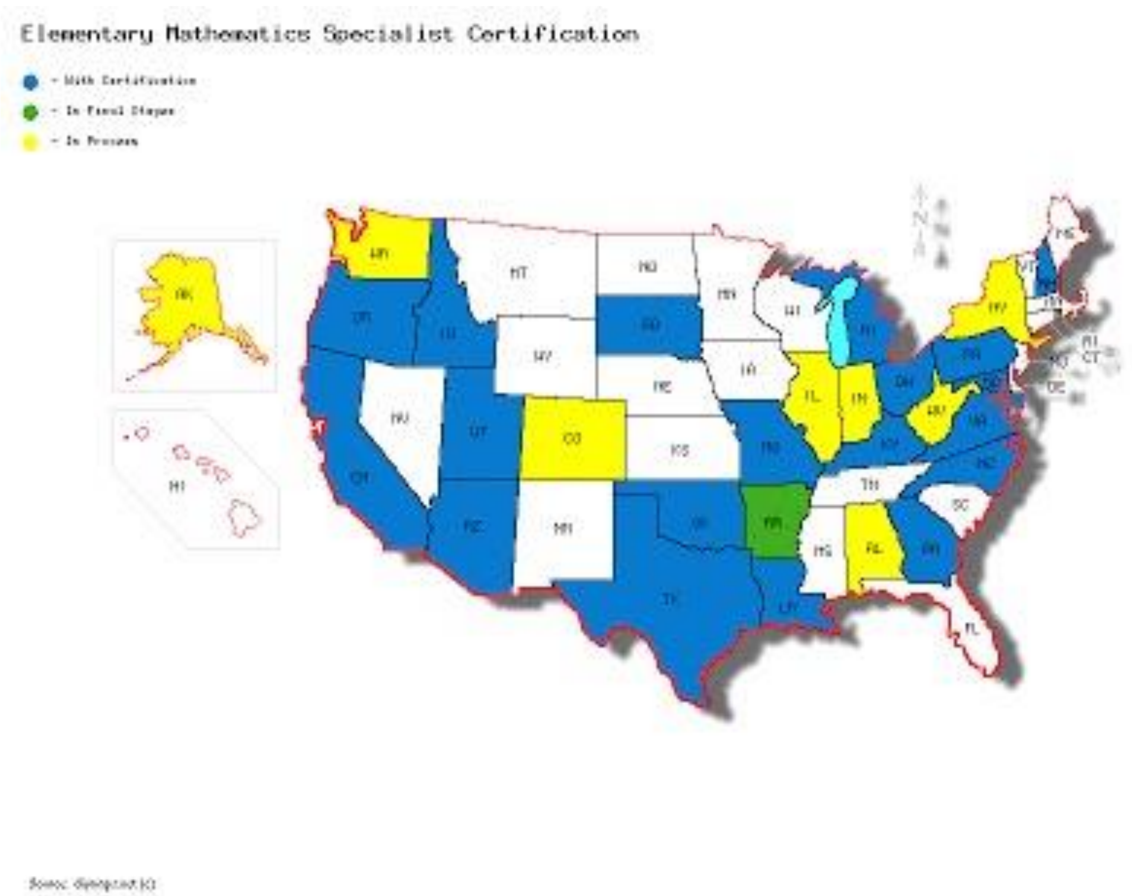


Figure 1-State by state progress toward full certification of EMS programs.

The EMS's role and responsibilities may vary based on the needs of the school; however, their expertise and successful experiences at the primary level are critical. In the classroom, the EMS may teach mathematics to the students or work with a targeted group for remedial and enrichment support services. At the district or school level, the EMS provides professional development or targets school-wide improvement programs for mathematics. In this capacity, the EMS helps strengthen teachers' understanding of mathematics content and develops effective pedagogy and assessment. Some EMSs may develop curriculum, assessment, and policy as a responsibility in their school districts. The five elements EMSs should have mastered upon entering into their role are: (1) a deep and vast understanding of mathematical content, including the expert knowledge needed for teaching, (2) strong knowledge of the primary content, (3) expertise in using and helping others use effective instructional and assessment practices that are informed by knowledge of mathematical learning trajectories, (4) a specialized skill set for working with adult learners, and (5) leadership skills that are influential and supportive in educational efforts to improve the teaching and learning of mathematics.

NCTM CAEP Standards (2012) – Elementary Mathematics Specialist (Advanced Preparation) lists seven standards that effective EMS candidates should exhibit.

> **Standard one: Content Knowledge**—effective EMSs should demonstrate and apply knowledge of key mathematics concepts, algorithms, procedures, connections, and applications within and among mathematical content domains.
>
> **Standard two: Mathematical Practices**—effective EMSs solve problems, embody mathematical ideas, recognize elements of structure, generalize, engage in mathematical communication, make connections as essential mathematical practices, and reason, prove, and employ mathematical models to precision.

Standard three: Content Pedagogy—effective EMSs apply knowledge of curriculum standards for mathematics and knowledge of their relationship to student learning within and across mathematical domains to teach elementary students and coach/mentor elementary teachers. They incorporate research-based mathematical experiences and include multiple instructional strategies and mathematics-specific technological tools in their teaching and coaching/mentoring to develop all students' mathematical understanding and proficiency.

Standard four: Mathematical Learning Environment—effective EMSs exhibit knowledge of all ages of learning, development, and behavior. They use this knowledge to plan and create learning opportunities and to assist teachers in planning and creating successive learning opportunities grounded in mathematics education research, where students are actively engaged in learning mathematics and building from prior knowledge and skills.

Standard five: Impact on Student Learning—EMSs provide evidence that, as a result of their instruction or coaching/mentoring of teachers, elementary students' conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and application of major mathematics concepts in varied contexts have improved. Elementary mathematics specialists support the continual development of a positive disposition toward mathematics. These mathematics specialists show that new student mathematical knowledge has been created as a consequence of their ability to engage students or coach/mentor teachers in mathematical experiences that are developmentally appropriate, require active engagement, and include mathematics-specific technology to build new knowledge.

Standard six: Professional Knowledge and Skills—effective EMSs are lifelong learners and recognize that learning is often a collaborative effort. They participate in and plan mathematics-focused professional development experiences at the school and/or district level, draw upon mathematics education research to inform their practice and the practice of colleagues, continuously reflect on their practice, use and assist teachers in using resources from professional mathematics organizations, and demonstrate mathematics-focused instructional leadership.

Standard seven: Elementary Mathematics Specialist Field Experience and Clinical Practice—EMSs engage in a planned sequence of field experiences and clinical practices under the supervision of an experienced and highly qualified mathematics educator. They develop a broad experiential base of knowledge and skills working with a range of student and adult learners, including elementary students (e.g., primary, intermediate, struggling, gifted, and English-language learners) and elementary school teachers, both novice and experienced, in a variety of school and professional development settings. They develop and use interpersonal and leadership skills to engage school-based and other professionals in the improvement of mathematics programs at the school and/or district levels.

The NCTM's *Principles and Standards for School Mathematics* stressed that student learning depends on the experiences teachers present to students in the classroom (NCTM, 2000). Thus, teachers need to understand the math content they are teaching to create learning experiences that will support student learning. The Council has six principles with overarching themes: equity, or high expectations and strong support for all students; curriculum, which needs to be coherent, focused on important mathematics, and well-articulated at any grade level;

teaching, or understanding what students know and need to learn; assessment, to support mathematics and furnish useful information to teachers/students; and, technology, which is essential for teaching and learning math (2000). These principles highlight the basic characteristics of a high-quality mathematics instructional program and provide guidance for making educational decisions (Robinson, 2006).

The five content standards are numbers and operations, algebra, geometry, measurement, and data analysis and probability (NCTM, 2000). The five standards highlight the mathematical processes that students draw on to acquire and use their content knowledge (Robinson, 2006). When programs are being designed, they often neglect to truly address NCTM's process standards, such as problem solving, reasoning and proof, communication, connections, and representation. NCTM (2000) outlines how each process standard should look in the classroom. It is this part of the standards that often gets lost in translation. For example, for kindergarten through twelfth grade, each student should be able to build new knowledge through problem solving, resolve questions that arise in mathematics and in other contexts, apply and adapt a variety of appropriate strategies to solve challenges, and monitor and reflect on the process of math.

Each of the standards are broken into four grade-level bands: Pre-K through second grades, third through fifth grades, sixth through eighth grades, and ninth through twelfth grades. Each content standard includes a set of expectations specific to that grade band (Robinson, 2006). *Principles and Standards* provides a catalyst for the continued improvement of mathematics education (NCTM, 2000). It represents the best current understanding of mathematics teaching and learning and the contextual factors that shape it (NCTM, 2000).

Mathematics Teachers' Professional Development

Research has found that what teachers know and what they do make a difference in student achievement and outcomes (Darling-Hammond, 2000). School systems are spending more time determining ways to offer professional development to their teachers to increase student learning. Destimone (2009) found that "moving beyond discrete activities such as workshops, local and national conferences, college courses, special institutes, and centers are the newer, more complex and broad-based views on how to conceptualize teachers' professional development that have begun to emerge over the past decade" (p.182). Academic coaching through interactive and social learning communities, whether formal or informal, has been identified as the better method for professional development for elementary mathematics teachers (Destimone, 2009). This design, using EMSs for training within the schools and county, acts as a powerful mechanism for teacher growth and development.

After more than two decades of mathematical reform, teachers are still entering the profession ill-prepared to teach mathematics in the way that was envisioned by the standards (Lloyd & Behm, 2005). To accomplish the goals of improving teachers' knowledge of mathematics and mathematical pedagogy and of transforming instructional practices, teachers need to better understand how students learn math (Brendefur, et al., 2013). Having greater understanding of pedagogical content is at the center of professional development. Brendefur et al. conducted a six-year professional development study, with each year consisting of one content area. The first year focused on numbers, number operations, and algebra; the second year focused on measurement and geometry. To develop their skill sets, the teachers worked to understand how students learned the topics, with significant time spent developing their own knowledge of the topics by investigating rich problem-solving situations. They learned to use various models and notational systems that provide teachers the means to model and extend students' mathematical development and reasoning. The results indicated that teachers' content knowledge increased across all areas from pre-test to post-test data (Brendefur et al., 2013).

Polly, Neale, & Pugalee (2013) conducted a year long, task-focused professional development program to examine if such a program influenced teachers' beliefs, knowledge, and practices in mathematics. The professional development program was focused on exploring, modifying, and implementing cognitively-demanding mathematical tasks. The pre- and post-measures were subtracted from one another, which showed gain scores for the mathematical knowledge for teaching assessment. Teachers also demonstrated an increase in pedagogies that are student-centered and align to the goal of the professional development program (Polly et al., 2013).

Elementary mathematics teachers have found themselves balancing a number of competing requirements such as adhering to mathematics reform initiatives set forth by their states or counties, meeting parental/administrative expectations, plus finding ways to help students perform well on summative assessments. Added to these responsibilities is the pressure from state departments of education to meet adequate yearly progress (AYP) or face ramifications (Schoenfeld, 2002). School districts have tried to combat AYP issues through other forms of professional development that focus on the individual needs of the elementary teacher (Walker, 2007). However, once the teachers are licensed, the trainings are often infrequent and lacking depth of content (Borland & Associates, 2005). One way to remedy infrequent trainings is to provide enriched professional development through a dynamic pedagogy model called connections, representations, and misconnections (CRM) (Walker, 2007). By looking at how teachers implement parts of the CRM elements throughout the instructional process, Walker analyzed and compared teachers' talk and their practice, because teachers' perceptions did not align with the reality of their classroom (2007). Using videotaped lessons, student work samples, and teacher reflections on this professional development model were an important component of the study because all of these materials "situate the mathematics in context resembling the elementary classrooms in which the subject matter is to be employed" (American Mathematical Society, 2001, p. 94). Walker believed this model could be used regardless of the textbook or curriculum in use at schools, which could be provided by the EMS employing this model with the staff.

Often, educators only think of assistance for students and not for teachers. This model addresses inflexible attitudes about mathematics and its teaching, lack of deep understanding of basic mathematical concepts, and a teacher-centered approach to teaching that does not use students' substantial knowledge of mathematics. The research found that by using this model, EMSs experienced greater confidence when teaching math, had more engaging lessons that incorporated the students' critical thinking skills, and promoted cooperative learning in the classroom (Walker, 2007).

Equity in Mathematics

NCTM's policy on ensuring equity when teaching math states: "Creating, supporting, and sustaining a culture of access and equity require being responsive to students' backgrounds, experiences, cultural perspectives, traditions, and knowledge when designing and implementing a mathematics program and assessing its effectiveness. Acknowledging and addressing factors that contribute to differential outcomes among groups of students are critical to ensuring that all students routinely have opportunities to experience high-quality mathematics instruction, learn challenging mathematics content, and receive the support necessary to be successful. Addressing equity and access includes both ensuring that all students attain mathematics proficiency and increasing the numbers of students from all racial, ethnic, linguistic, gender, and socioeconomic groups who attain the highest levels of mathematics achievement" (NCTM, n.d.). Teaching mathematics with equity is a critical part of the equation, because it provides ample opportunities for every student, including those that are marginalized, to learn mathematics that are rigorous and relevant to their lives (Jackson & Jong, 2017). This rigor and relevance aligns with William Doll's Four Rs of education—rigor, relations, richness, and recursion (Doll, 2013). He stresses that every ending is a new beginning with recursion. These four Rs are used many times in the subjects of mathematics and science. Mathematics builds on previous knowledge that sometimes has to be revisited to go forward with new material.

Thus, teaching mathematics through an equitable lens provides access plus opportunities for students to learn rigorous and challenging mathematics in the classroom and the community (Jackson & Jong, 2017). Rousseau & Tate (2003) suggest teachers reflect on how students' backgrounds impact their learning of mathematics and the role of mathematics in society. Bartell (2011) examined teachers enrolled in a graduate course focusing on teaching social justice in mathematics and noted they had anxiety negotiating mathematics and social justice in their teaching practice. Jackson and Jong (2017) found teaching mathematics with differentiated instruction promotes greater equity. The PSTs participating in the study agreed that, in order for all students to learn mathematics, the teachers (PSTs) needed to allow students to use and share multiple strategies when solving math problems and ensure the content was "relatable and relevant" to students.

Further, NCTM's position on equity in mathematics states, "creating, supporting, and sustaining a culture of access and equity require being responsive to students' backgrounds, experiences, cultural perspectives, traditions, and knowledge when designing and implementing a mathematics program and assessing its effectiveness" (NCTM, 2014). NCTM identifies that all stakeholders must have access to challenging math curriculum taught by skilled instructors such as teachers supported by EMSs, monitor their progress and adjust as needed, and offer remediation or additional challenges when appropriate. This remediation can help to deter social promotion and retention that can occur when a student has not mastered math at a certain grade level.

Sipple, Killeen, and Monk (2004) determined students retained in a grade fare the same or worse in terms of academic achievement than they would if they had been promoted. Grade retention or social promotion is treated as a fixed, one-time intervention. These lower performing students that were promoted or retained in a lower grade could also be retained or promoted in a secondary grade or could be evaluated for special education services. By using EMSs to provide differentiated instruction for these at-risk students, teachers are trained and monitored to ensure cultural experiences and backgrounds are not an issue in every student's mathematics education.

Uncovering Content, Not Recovering Content

Teachers with deeper mathematics knowledge can provide students with opportunities to better understand mathematics and mathematics procedures. Discovering and uncovering content can take place and precedence over covering and recovering content. To accomplish this, differentiated training that focuses on individual teacher's needs and is embedded within teachers' daily work in schools needs to take place with the use of EMSs. These EMSs fill a knowledge gap created when elementary teachers have a teaching load consisting of a full range of subjects, focusing heavily on English and Language Arts (Fennell, 2008).

EMSs facilitate teachers' use of instructional strategies, including differentiated instruction to a diverse population. Differentiated instruction is shown through Stein's and Smith's (2011) work summarizing five training practices to help teachers design and implement math lessons while helping students gain math knowledge. These lessons anticipate student responses to challenging mathematical lessons, monitor students' responses to tasks while working in pairs and/or small groups, select students to present their mathematical work during whole-class instruction, sequence student responses to be displayed in a particular order, and connect student responses with key mathematical ideas.

Big ideas are a pedagogical practice for math curriculum that infuse and weave fundamental mathematical ideas/concepts across lessons or units (Slayer, Curran, & Thyfault, 2002). Big ideas refer to "concepts such as place value, expanded notation, mathematical properties, and equivalence across instructional topics. Big ideas assist learners in the generalization of mathematical concepts and learners move away from banks of isolated knowledge and facts" (p. 60). These big ideas help students learn the content and understand it piece by piece without sacrificing a step that may cause the student to need recovery. It helps teachers build on their own previous knowledge and present them as facilitators of the information students need to learn. The teacher is the most important factor in establishing the climate of the classroom and in making content accessible (Ginott, 1972).

Mathematics and John Dewey

Dewey states "in any social group . . . we find some interests held in common, and we need a certain amount of interaction and cooperative intercourse with other groups" (1916, p. 83). The standard for evaluating social groups derives from the expression of traits related to internal cohesion and external interaction (Stemhagen & Smith, 2006). As Dewey describes these different elements, internal cohesion is present when societal direction emerges from multiple, varied points of common interest, and external interaction occurs when groups previously isolated from one another (owing to class, education, ideology, nationality, etc.) are able to interrelate and reconstitute their social habits based on these relationships (Stemhagen & Smith, 2006). Dewey's notion of necessary interaction and cooperative intercourse with other groups epitomizes what EMSs are trying to accomplish in schools. There is not separation of the math expert and the generalist elementary teacher. Instead, there is collaboration between elementary teachers and the math expert, with varied points of common interest (the students succeeding in math), and they are able to combine their knowledge for the benefit of the students' mathematical needs.

Dewey wanted schools to teach students to think: "Skill obtained apart from thinking is not connected with any sense of the purposes for which it is to be used . . . . It leaves a man at the mercy of his routine habits and of the authoritative control of others . . . . Information severed from thoughtful action is dead, a mind-crushing load" (Dewey, 1916). Dewey asserted we need objectives, yet autonomy, plus respect and flexibility in the classroom. The more "trained" the teacher is in teaching mathematics, the more autonomy can be expected. He believed what is useful in society should provide the basis for school curriculum. The problem should be significant to the learner, thus prompting a need to seek a solution. The problem also needs the parameters set so that an answer can be discovered. Dewey did not consider textbook mathematics problems to be lifelike nor reality based. To summarize Dewey's problem solving approach for instructing students: the activities should be student-centered based on the curriculum; teachers should act as facilitators that guide students to select relevant lifelike problems needing solving; students best increase their mathematics skill set by doing, not passively listening; giving students a purpose and gaining their interest will increase their effort and perseverance; and the teacher's role is to provide encouragement and assistance to students in attaining solutions to problems (Dewey, 1916).

Dewey sought to conjoin the topics of learning, teaching, and teacher education under the common heading of the human potential for growth (Greenwalt, 2018). This growth happens through the students' experiences. Teachers and teaching should focus on assisting students to organize, direct, and maximize life experiences. This teaching style relies on the "educational significance of social arrangement as a means used to educate youth" (1916/Dewey 1997, p.89). Therefore, it should be noted that Dewey's views of teaching and learning are grounded in naturalism. Dewey believed that education-as-growth stretches across lifespans and is continuous. Both teachers and students are learning new concepts and ideas regularly about mathematics. Therefore, EMSs would need to supply teachers and students with the conditions to ensure growth (Greenwalt, 2018).

Dewey believed scientific foundations were the starting point for teacher education (Greenwalt, 2018). The goal is to assist the teacher or teacher candidate in becoming a thoughtful and alert student of education themselves (Dewey, 1904/1965, p. 320). All teacher mathematics education courses should have a practical component and should be composed as typical and intensive, rather than extensive and detailed. The practical work serves the purpose of enlivening and awakening the teacher to the meaning and vitality of educational principles (Greenwalt, 2018). To prepare these teachers to be ready for the classroom, Dewey aimed to build the technically proficient educator by first building knowledge of the method of intelligence. Building knowledge is not technical proficiency; instead, they should grow over the course of their careers. Growing over the course of their careers is contradictory to the current way Common Core requirements and Board-approved teaching materials are currently utilized. which goes back to the initial statement in this section about autonomy for the teacher and the need for growth, new directions, and evolving educational techniques and materials.

Boaler (2015) found that students often see math as a series of arbitrary steps needed to be memorized with little comprehension. In direct contrast, Tafton and Andrews (2002) found "when children make sense of mathematics, they will develop deeper understanding of important concepts. This means making connections with their informal mathematical knowledge and making connections among mathematical ideas." (p.10). Just as Dewey believed, one needs to pull together both experiences and concepts (Furman, 2017). As Dewey suggests, the EMS program should train teachers to bridge the gap between research and practice through progressive models that center on experiential learning.

STEM in the Elementary Schools

Science, Technology, Engineering, and Mathematics (STEM) initiatives are happening all over the country. These initiatives are needed to help increase interest in these fields as children head to college. However, the preparation of teachers often fails to ensure that these new teachers (or current teachers) in elementary education have appropriate knowledge of the disposition toward math-intensive subjects and mathematics itself (Epstein & Miller, 2011). Often these teachers can obtain a degree in education without being required to take any STEM courses such as calculus, statistics, mathematics, or chemistry. Because they lack experience in these subjects, teachers are less likely to encourage students' curiosity about math and science or their confidence to pursue careers in STEM fields. Strengthening teacher preparation, training existing teachers on new curriculum, and providing EMSs are all ways to improve STEM learning. Elementary teachers' preparation programs need to include more rigorous mathematics and science courses, not just in content but also pedagogy. For existing teachers, EMSs can provide mathematical training on faculty senate days when students are not in school or even prior to the school year starting. EMSs can use information provided by the National Math and Science Initiative to identify programs with proven results to model their own school-based programs (Epstein & Miller, 2011).

In most of West Virginia, STEM is just starting to make its way into the classroom. High schools are adding engineering classes, and elementary and middle schools are utilizing robotics kits loaned to schools from NASA's Fairmont, WV, office. Those kits come with lesson plans helping teachers to create learning modules in engineering and science for younger students. Hefty (2015) found that "these integrated engineering units of study allow for application of mathematics skills in real-world contexts, removing engagement barriers, and enhancing the development of NCTM's Process Standards plus the eight Common Core Standards" (p. 424). Outside of these examples, STEM is a somewhat new movement in West Virginia that is leaving administrators looking at how they can incorporate more of these lessons at the elementary school level. One way for teachers to become less intimidated by integrating STEM into their lessons is by partnering with a local university for guidance on what activities and modules can be used in which grade levels. NCTM gives some examples of lessons by grade level for public elementary schools to use (Hefty, 2015).

Often these engineering units overlap math and science concepts and give momentum to the mathematics curriculum. The school can use a design process modeled in the engineering field: plan, design, check, and share (Hefty, 2015). NCTM's Process Standards are embedded in the model to provide students with strong habits of mind as they unearth the meaning behind the math. This model also builds on Dewey's viewpoint of naturalism; the usefulness of engineering models themselves provides the basis for the lesson. Also, teachers and students are becoming lifelong learners by adding STEM to the curriculum. When paired with textbook learning, hands-on activities resonate more with students. These learning techniques need to come from EMSs that act as mentors and in-service trainers to the school staff.

Effectiveness of Existing Programs

When researching the effectiveness of existing programs, two major areas regularly came up in the research concerning the impact of mathematics specialists: improving teacher instructional practice and improving student achievement (Galindo & Newton, 2017). NCTM defines teacher instructional practice as research-based teaching practices that are essential for a high-quality mathematics education for each and every student. These practices are combined with core principles to build a successful mathematics program at all levels (NCTM, n.d.). In the study by Galindo and Newton (2017), three categories of improvements were found in instructional practice: increase in teacher questioning, student engagement, and teaching for understanding. In varying degrees and utilizing a variety of methods, all the studies reported increases in student achievement, which was measured at the elementary and middle school levels. Other studies found Elementary Mathematics Specialists positively impacted student achievement on state-level assessments during the first and second years of a coaching program (Coniam, 2010; Zolligner, Brosnan, Erchick, & Bao, 2010).

According to the Elementary Mathematics Specialists and Teacher Leaders Project (EMS&TL), 20 states have established Elementary Math Specialist Certification Programs. There are an additional nine states, including West Virginia, that are in the final stages of having their programs up and running. In South Dakota, which has one of the established certification programs, a lead Mathematics Specialist travels each week to collaborate with Elementary Math

Specialists (EMS) located in various counties across the state (Cavanagh, 2008). The Mathematics Specialist mentors teachers and monitors teacher/student progress. Their programs' findings on Elementary Math and classroom teachers indicate "most elementary teachers are generalists who are asked to cover all subjects—math, science, reading, social studies—at their grade level. Where many have only completed one or two college-level courses in math . . ." (Cavanagh, 2008). In fact, the mathematics knowledge of future teachers in the U.S. was found to be weak when paralleled to that of future teachers in other countries whose students outpace U.S. students in mathematics (Center for Research in Mathematics and Science Education, 2007). South Dakota's program is designed to build teacher confidence and content knowledge in math by teaching studies in different ways and prodding students to explain their answers orally and in writing (Cavanagh, 2008). The program has helped 100 school districts with 180 teacher-leaders to advance their skills and improve student outcomes (Cavanagh, 2008).

Similarly, Virginia has seven universities providing certification as an EMS. Haver's study examining EMSs' effects in schools showed increased student achievement and involved 24,500 students in grades 3, 4, and 5 in 36 schools across five school districts (Haver, N.D.) Data indicated that EMSs had a statistically significant influence on student progress over time in all three grade levels (Haver, N.D.). The third-grade students scored 10 points higher in the Virginia summative assessment in the second year of the math specialists' arrival at the school and 16 points higher in the third year (Haver, N.D.). For the fourth and fifth graders, scores increased 15 points for fourth graders in the second year and 13 points in the third year; for fifth graders, scores increased 19 points in the second year and 20 points in the third year of study (Haver, N.D.). Interestingly, older students in the study made higher gains by having an EMS at their schools than did the lower grades. Elementary school is the time the students are learning multiplication, division, fractions, and decimals—all foundational skills that are needed to succeed in math as they enter middle school.

In addition to measuring success through summative assessment data, Whitenack and Ellington (2007) followed EMS cohort students through their coursework and measured if the EMSs' role in the schools while taking courses improved student and teacher understanding of mathematics. Whitenack and Ellington felt that better understanding EMS students' experiences in the degree program might support their work in schools (Whitenack & Ellington, 2007). They found that course experience helped create opportunities for EMS students to reason deeply as they worked though the curriculum and to make instructional decisions that support their students' learning (Whitenack & Ellington, 2007).

In the Marshall University EMS program, the classes are designed for the working professional; the students can sit down in the comforts of their home to take the classes in the evenings after work. These courses are designed in sequence of Mathematics for Elementary Teachers I to Elementary Math Methods and Supervised Field Experience. A series of courses that are all taught completely online offer the working professional the flexibility to work on the certification outside of the school day. The program prepares candidates to collaborate with individual teachers through co-planning, co-teaching, and coaching; and to assist administrative and instructional staff in interpreting data and designing approaches to improve student achievement and instruction. The program curriculum is aligned with state and national mathematics standards. The EMS program also promotes teachers' mathematics pedagogy for delivery of progressive mathematics teaching to enhance student understanding of the school mathematics curriculum. The program facilitates teachers' use of successful, research-based instructional strategies, including differentiated instruction for diverse learners; and provides opportunities to practice collaboration with teacher colleagues and administrators in order to provide leadership and ideas for a school-wide mathematics program.

The Marshall University EMS Program is designed using inductive lesson plans. These plans take the traditional sequence of lessons and flip the classroom. Essentially, inductive lesson plans use techniques such as discovery learning, inquiry-based learning, and problem-based learning to determine what knowledge the individuals can gain from them. In inductive learning students study examples of the content first, then students make generalizations leading to an understanding of the rule. The order of inductive learning is examples to rules. So, you would give the graduate students the examples first then let them organize them until they discover the rule for themselves (Gonzalez, 2014).

To provide greater understanding to the graduates in the program is the example of the adding and subtracting fractions module which involved: creating a concrete visual of the problem and its answer as exampled in the Add/Subtract/Fractions file that was provided. Then they were expected to work through the same problem using the abstract process as exampled in the Fraction/Process file in a resources section. Last, they should clearly show the use of equivalent fractions when needed for solving these problems abstractly. Inductive reasoning is a concept that can work with very simple concepts, like the fraction processes, or more complex ones, such as the foundations of geometry, and is appropriate for any grade level (Gonzalez, 2014).

Elementary Teachers' Personal Math Experiences

Do most elementary teachers choose elementary education at least partly because no "higher" math was required? Do male teachers at the elementary school level have a more positive attitude toward math than their female counterparts? Do teachers unknowingly pass on animosity toward math to their students? These are all questions Chavez and Widmer (1982) asked in-service teachers who were identified as having math anxiety. They gave the teachers a "Math Attitude Inventory" whose results warranted closer scrutiny (Chavez & Widmer, 1982). Findings indicated 17% of females and 8% of males were categorized as math anxious. When follow-up questions were given, most teachers felt they did well in elementary school math saying, "I was a good student, but less good in math" (Chavez & Widmer, 1982). At the secondary and college levels, half of the teachers participating in the study had problems. The sources of their trouble were math content, low grades, their parents' impatience with their lack of mathematics success, and inadequate, impatient, or sarcastic teachers (Chavez & Widmer, 1982).

Most teachers will not readily admit that, in their formative years, mathematics was not their favorite subject nor one they excelled in. Negative mathematics experience is a difficult memory to discard and it often has a way of being front and center in their professional lives. Many teachers go through what Kaplinsky (2016) describes as the uncomfortable feeling of realizing that one is finally making sense of math, combined with the reality that for so many years one had not. Often teachers do not want to admit that they struggled with a subject they are faced with teaching to others. Kaplinsky (2016) highlights the dreaded timed math tests that the teacher expected students to complete as much of as they could in a short period of time. He realized he never got as far on the tests as his peers. Kaplinsky (2016) realized that although he made it through elementary mathematics, when he made it to junior high, he did not take a pre-Algebra class before Algebra, and he felt ill-prepared to be successful up to Algebra. The math curriculum did not take the students step-by-step to what would eventually lead up Algebra.

Another teacher recalls a series of booklets in the fourth grade, where they were to complete each chapter/unit and then take a test, which if they passed, they moved on to the next unit. If not, they repeated the self-guided unit until mastery was demonstrated. Wingert (2014a) highlighted her regular memorization of math facts growing up as the method to learn math and how it affected her in her own teaching. She panicked when her math coach switched her math textbooks from basic memorization to critical thinking techniques (Wingert, 2014a).

When the teacher is not excited about the subject she is teaching, often the students pick up on this lack of enthusiasm and feel the same about learning the subject. A lack of enthusiasm is similar to accounts of teachers who were once students learning math.

Spatig and Amerikaner (2014) conducted a longitudinal study of girls in a southern county of West Virginia. This study took place during the majority of the girls' high school careers and on into college. The researchers found many of the girls could not qualify for an in-state scholarship, even though the girls excelled in reading, because the girls were unable to attain the score needed on the math portion of the exam. Often the girls felt they were not pushed to succeed in their high school math classes as much as their male counterparts. Many individuals from around the state have similar stories regarding early math experiences, though they have gone on for advanced degrees. Oftentimes, they had to make up the difference between what they struggled to master in youth mathematics classes and the math courses they needed to complete to attain a degree (Spatig & Amerikaner, 2014). Had this southern WV county employed an EMS in the elementary school, the girls may have had stronger mathematics skills needed to acquire the scholarship. The EMS could have provided co-teaching in the classroom and in-service trainings for K-6 teachers in the county.

Pre-service Teacher Math Preparation

A current obstacle facing teachers in the field is training new teachers to engage in challenging mathematics instruction (Lampert et al., 2013). Despite research that is ongoing and currently related to pedagogies of teachers' mathematics education, there is little knowledge of the range of instruction in teacher methodology courses (Lampert et al., 2013). In an effort to understand the relationships among teachers' characteristics and features of teacher prep-programs, Cavanna, Drake, and Pak (2017) researched the different opportunities to learn through methods courses. Though the study looked at the candidates' opportunities to teach, it did not examine whether they were learning the mathematical content (Schmidt, Bloemeke, & Tatto, 2011).

The National Council on Teacher Quality (NCTQ) outlines five standards for the mathematical preparation of elementary school teachers: teachers learn mathematics not as a set of procedures but at the conceptual level, the admittance requirements for education schools have more rigor, stricter exit requirements be put into place at education programs, mathematics methods and content courses be more closely aligned and administered in a way that allows for supervised practical experiences, and mathematical content be taught by the mathematics department of the school of education (NCTQ, 2008, pp. 11-12). NCTQ also has a set requirement of courses for pre-teacher training. The courses include: 40 hours of numbers and operations, 30 hours of algebra, 35 hours of geometry and measurement, and 10 hours of data analysis and probability (NCTQ, 2008). The NCTQ conducted a survey of 257 syllabi from 77 undergraduate institutions in 49 states to determine if course offerings adequately prepared teachers to teach kindergarten through fifth grade and the findings revealed very few covered the math content needed by teachers and many did not teach algebra (NCTQ, 2008). In addition, states differed on what they deemed necessary for mathematics training, and they used textbooks that were inadequate in content for math prep programs. The requirements for acceptance into these programs were low and almost anyone could be accepted (NCTQ, 2008). Finally, NCTQ (2008) found many programs did not offer rigorous content and did not have high expectations of their students.

When examining post-baccalaureate training for teachers in the elementary school setting, the annual *Improving Teacher Preparation, State Teacher Policy Yearbook* (2012) found only one state truly addressed training for elementary school teachers in mathematics: Massachusetts. Those teachers received training in conceptual mathematical knowledge and in the content they taught. These teaching candidates were required to pass rigorous exit exams before they could be fully certified to teach in the school system (NCTQ, 2012).

The Council for the Accreditation of Educator Preparation (CAEP) (2013) requires teacher preparation standards to have content and pedagogical knowledge, a clinical practice, and a program impact. These standards are used in interdisciplinary collaborative mathematics approaches for pre-service teachers. Also, the Praxis II and, in some cases, the Pre-Professional Skills Test (PPST) exams are required for teacher certification and licensure. The PRAXIS SERIES: Professional Assessments for Beginning Teachers is a series constituting a system designed to assess the skills of beginning teachers. While one component of the PRAXIS II: Subject Assessments is designed to assess future teachers' depth and knowledge of subject matter plus pedagogical principles, some teachers struggle with the math content section of this evaluation (Cole et al., 2000).

Teacher Confidence in Mathematics

These requirements are designed to ensure teachers are prepared to teach all subjects as well as concentrate on specific subject matter. Even though these requirements are in place, many teachers take the PPST, and they sometimes struggle on specific areas of Praxis I, such as mathematics. Studies over the past thirty years found pre-service teachers' lack of knowledge in mathematics resulted in negative attitudes toward the subject (Ramey-Gossert & Schroyer, 1992). Math anxiety appeared to be a major problem for pre-service teachers, accounting for a larger percentage than among other university majors (Harper & Daane, 1998). Kelly and Tomhave (1985) found pre-teachers scored higher than any other group on the Mathematics Anxiety Rating Scale (MARS). This math anxiety was defined by Trujillo and Hadfield (1999) as "a state of discomfort that occurs in response to situations involving mathematical tasks that are perceived as threatening to one's self-esteem" (p. 22). Some scholars think math anxiety is the panic and mental disorganization someone experiences when they are required to solve mathematical problems (Bursal & Paznokas, 2006).

So, what is the answer to helping with math anxiety? One possible solution is to help pre-service teachers gain math confidence through additional mathematics course work prior to graduation, especially math courses that emphasize math pedagogy. Also, those teachers already in the field need in-service trainings provided by their county and state. Bursal and Paznokas (2006) studied students enrolled in three methods courses focused on mathematics, science, and social studies. These courses were not designed as treatments, so no manipulation was utilized in the study. Using the Revised-Mathematics Anxiety Survey (R-MANX), Bursal and Paznokas (2006) found obvious differences among the students. Findings indicated students with low math anxiety tended to respond more confidently to most items on the test than did their moderate or high anxiety classmates (p.175).

Teacher confidence has also been linked to the quality of teachers' knowledge about pedagogy (Norton, 2017). Teachers' knowledge and pedagogy occurs a couple of ways. When confidence is related to confidence to teach or perform a job/task, in this case the enactment of pedagogy, the term "self-efficacy" is frequently used (Bleicher, 2004; Sander & Sanders, 2003). Bleicher drew on the work of Bandura (1977) to note that people are motivated to act if they believe an expected outcome will be favorable and they have the confidence to perform the necessary action successfully. Perceived self-efficacy was thought to contribute to the motivation and performance outcomes of the students being educated, and the lack of self-efficacy in a teacher is directly related to students' lack of risk-taking and perseverance in the subject (Norton, 2017). Lack of self-efficacy manifests itself in avoiding teaching specific aspects of mathematics, little variation in pedagogy, or reliance on scripted/unscripted pedagogy with little contribution from the educator.

Through regular in-service trainings that can take place at the schools the teachers work in, the EMSs can provide new ways to address how math can be introduced to the teachers' classes (Wingert, 2014b). Trainings can take place over weeks, possibly after school, to coach teachers on how to develop lessons that emphasize students' critical thinking skills. EMSs can also monitor how the teacher is introducing new math material into the classroom and then flip their role with the teacher. The teacher would then observe the EMS teaching her/his class and see how the EMS is working with students on new math information.

Mathematics Teacher Leadership

Elementary school teachers are generalists that are placed in the spotlight in each classroom to act as the leader for that class. They are expected to be the authority on all subjects they teach, and they are able to transfer this knowledge to their students. Some teachers do not always like to admit when they have a weakness in mathematics. Enter the EMSs and how they can partner with teachers to strengthen school staff's leadership skills. NCTM describes EMS professionals as such: "teacher-leaders can have a significant influences by assisting teachers in building their mathematical and pedagogical knowledge . . . . Teacher-leaders support on a day-to-day basis ranging from conversations in the hall to in-classroom coaching to regular grade-level and departmental seminars focused on how students learn mathematics can be crucial to a teacher's work life" (Fennell, 2006).

Another component of the EMS is not every teacher has the skills necessary to be effective as a mathematics specialist. Some criteria that should be factors to consider are:

- The teacher's background in mathematics content and pedagogy
- How much teaching experience at the elementary level
- Their interest in serving as an EMS
- Acceptance by other teachers and ability to lead
- Ability to work with not only teachers, but also students/parents/community

The effectiveness of the candidate should be documented through their resume and transcripts. The interests, acceptance, and leadership qualities are more difficult to evaluate but equally important. Many excellent teachers have difficulty mentoring others, or they unknowingly intimidate their colleagues (Reys & Fennell, 2003).

Often in elementary classrooms, teachers have their own teaching style and determine how to best present the mathematics curriculum to students. For EMSs to get buy-ins from these teachers to partner with them, they need to show teachers what EMSs are observing in real classrooms. To demonstrate what is taking place the EMSs observe the teachers and create lists of improvements such as examples teachers should use, how to present complicated math sections, and how to communicate math to their students (Zrike & Connolly, 2015). Another way to demonstrate what is happening in classrooms, the EMS can attend common planning times for all grade levels and hearing the feedback from teachers regarding their mathematics classes. What the EMS in Zrike and Connolly's study found was that many teachers were asking too many funneling questions. Funneling questions in mathematics can be defined as starting with general questions and then drilling down to more specific points. In the case of the teachers, once the EMS worked with them on simplifying their questions showed in five out of 10 classes, teachers talked more frequently than students talked. Teachers talking more than students is problematic because when the teachers are talking a large percentage of the time, there is little time left to gauge if the students are learning and understanding. Zrike and Connolly's EMS was able to provide the teacher with feedback from the observation and provide them with ways to rephrase questions to spark critical thinking skills in the student instead of funneling questions to check for understanding.

Teacher-leaders act as resource providers to help their colleagues by sharing mathematics instructional resources (Harrison & Killion, 2007). Acting as resource providers takes place through sharing websites, instructional materials, articles, lessons, and assessment tools. Teacher-leaders are also instructional and curriculum specialists who help colleagues find and implement effective teaching strategies. Understanding content standards, how various parts of the curriculum connect, and how to use the curriculum in planning instruction and assessment is crucial to ensuring consistent curriculum implementation throughout the school (Harrison & Killion, 2007).

Program Evaluation Techniques

When determining which program evaluation techniques to use that would best fit the Elementary Mathematics Specialist Program, I reviewed the *Program Evaluation* by Fitzpatrick, Sanders, & Worthen (2011). The first thing to consider was if this evaluation should be formal or informal. An informal evaluation could result in faulty judgements. Faulty judgement happens when, as examiners, we are limited to making judgements instead of observations due to the lack of opportunities to make observations in different settings about teachers or students and when we are limited by our past experiences, which can inform and create bias in our judgements. Then one can assume formal evaluations follow structure. Formal evaluations plan for multiple observations of teachers and students in different settings. These evaluations account for bias and address concerns about limitations. Thus, formal program evaluation can be defined as a systematic method of collecting, analyzing, and using information to answer questions about projects, policies, or programs regarding their effectiveness and efficiency (Creswell, 2003). We needed to determine if the use of the evaluation and its objects was to empower teachers. Was it to strengthen the program? Is it to gain accreditation from NCTM? Is it to reinforce the need to have EMSs in each elementary school or county? Or some combination of all the above? To do this, one must determine what the client hopes to uncover from the evaluation.

It is important to identify if the evaluation is formative or summative. Though sometimes the lines of distinction between formative and summative are blurred, it is still imperative to highlight the decisions or choices the evaluation serves (Fitzpatrick et al., 2011). It can be considered a formative evaluation if the primary purpose is to provide information for program improvement. It can be considered a summative evaluation if it provides information to serve decisions or assist in making judgements about program adoption, continuation, or expansion, particularly when looking at the program's overall worth.

For my program evaluation techniques, I will employ a mixed-methods approach that is summative. The approach I will use is a convergent parallel (Creswell, 2003). This mixed methods approach is beyond conducting both qualitative and quantitative research together. I will need to integrate both data to obtain insights for triangulation to gain a more in-depth understanding of the EMS program being researched. Using this sequence allows me to not just look at participants' perceptions but also examine the schools' summative assessment data since the EMSs began working with the respective schools.

An objectives-oriented evaluation approach will help determine whether some or all of the program objectives are achieved and also determine how well they were achieved (Fitzpatrick et al., 2011). Using this approach, I will be able to compare performance data with behaviorally-stated objectives. This approach provides the program director with information that is relevant to their mission. This evaluation can then be used to improve the program by identifying weaknesses that may not have otherwise been identified. In order to reduce bias, Scriven's (1972) goal-free evaluation will be utilized. The goal-free evaluation is used to make evaluators aware of the bias that can be imposed by a focus on particular program elements. "The rationale behind this is to reduce bias that occurs from knowing program goals and to increase objectivity in judging the program as a whole" (Fitzpatrick et al., 2011, p. 168). To accomplish a goal-free evaluation, I will avoid becoming aware of all the primary goals, focus on the actual outcomes, and note unanticipated side effects. The information for the systems assessment gathered from the study will help to make alterations to the program and potentially create better partnerships with the University, state Department of Education, and counties the EMSs are serving. The information gathered will strengthen the program by offering enrolled individuals advanced placements for secured positions upon completing the program. Lastly, the information will create stronger program planning to review the layout and sequence of the coursework.

Planning for educational needs is probably the most important aspect the evaluation will illuminate. As educational needs change, the program should change and adapt to fit the needs of the public education system. Educational materials change on a regular basis and EMSs can help in providing professional development training to stay on top of current trends. Also, there is a great need for support in mathematics education, and counties may not realize the EMS program fills this void. Once the program gains momentum, the demand could increase for EMSs statewide and in the Appalachian region. Looking at individual enrollees' needs, such as needing all online programs or preferring hybrid classes, is just one aspect to consider. As enrollment increases, additional instructors may be required to help with instruction. Finally, revisiting and re-evaluating the program's curriculum often ensures up-to-date, relevant content that keeps future EMSs knowledgeable on current trends in mathematics.

CHAPTER THREE-METHODS

The West Virginia Department of Education (WVDE) and Council for the Accreditation of Educator Preparation (CAEP) require EMS programs to use strong program evaluations to determine overall program effectiveness and to assess whether or not program participants have improved mathematics understanding for teachers and performance of students, thereby reducing the amount of students struggling in mathematics, which was the program's goal. There is no one approach to program evaluation; instead it is what best uncovered the program's strengths and weaknesses. Evaluation methods were not considered without careful consideration about evaluation questions, program context, and characteristics, plus the perspectives of graduates and stakeholders (Fitzpatrick, et al., 2011).

Research Design

This research was a convergent parallel mixed-methods approach with a non-experimental descriptive design (Creswell, 2003). This study was conducted to examine participant perceptions of their training in the Elementary Mathematics Specialist (EMS) Program at Marshall University. An original questionnaire designed by the researcher was utilized for quantitative research questions. The survey was based on National Council of Teachers of Mathematics (NCTM guidelines and what NCTM focuses on for training Elementary Mathematics Specialists. The items incorporated NCTM standards and expectations. Qualitative data was collected with focus groups and individual interviews. Qualitative data was also obtained by an examination of the Elementary Mathematics Specialist Program course content and syllabi.

Population

The target population of this research was graduates of the EMS program at Marshall University. These graduates were scattered throughout the state of West Virginia working within the state public school system. Some of the participants worked through the EMS program while also pursuing a Master's in Education (36 hours). The master's program includes 21 hours of EMS courses and 15 hours of educational foundation courses. Other participants, who already had achieved a master's degree in education, worked through the EMS graduate certificate program (21 hours). Up to this point, there were approximately 56 graduates from this program. A total of 21 surveys and one partial survey of 56 were returned for the quantitative data. A total of 4 interviewees were recorded and transcribed for the qualitative data. See Table 1 for the EMS Plan of Study that includes the courses of this program.

Instrumentation

The quantitative data questionnaire designed by the researcher was called the Elementary Mathematics Specialist Perception Survey. The instrument for this research consisted of questions created to examine the perceptions of EMS program graduates' mathematics teaching and content knowledge confidence due to the educational training they received in the program. The survey also collected participant demographic data.

The survey was grouped into eight sections according to the NCTM Elementary Mathematics Specialist Standards. The standard titles were: Standard 1: Content Knowledge, Standard 2: Mathematical Practices, Standard 3: Content Teaching, Standard 4: Mathematical Learning Environment, Standard 5: Impact on Student Learning, Standard 6: Professional Knowledge and Skills, and Standard 7: Elementary Mathematics Specialist Leadership. Demographic data were collected to serve as independent variables. Demographics included gender, how long the graduate has been teaching in the public-school system, what grade level they teach, if there is a position for an EMS in their school district, and if the graduate is identified as an EMS in the school district.

Using a Likert-type, ordinal scale (Fink, 2017), respondents were expected to describe their mathematics teaching and content knowledge confidence due to the educational training they received in the program. The Likert scale choices consisted of: not confident, somewhat confident, confident, and very confident. For Standard Six the Likert scale consisted of: rarely, sometimes, often, and very often.

Qualitative data was collected with focus groups and individual interviews examining pre and post perceptions of candidate training in the program and identification of strengths and weaknesses of the program. Qualitative data was also obtained by an examination of the Elementary Mathematics Specialist Program course content and syllabi.

Pilot Study

A pilot study was conducted with a group of five Marshall University professors outside of the department and five graduate students that are not enrolled in the EMS program. The pilot study was completed to identify any survey issues concerning validity such as unclear directions, questions, answers and to address appropriateness of the language used on terms of readability. Literature supports the use of pilot studies in survey research for multiple reasons. Pilot studies allow the researcher to "identify whether respondents understand the questions and instructions," understand "whether the meaning of questions is the same for all respondents," and allow the student researcher to determine if "sufficient response categories are available" to the survey participants (Kelley, Clark, Brown & Sitzia, 2003, p. 263). There were 6 of 10 pilot surveys returned. The returned surveys had minimal comments with no major suggestions for altering the survey format, language, or content.

Data Collection

This research was projected to take place over four months for part of the Spring and Summer Semesters of the 2018-2019 school year. Qualitative and quantitative data were first collected through the use of the Elementary Mathematics Specialist Perception Survey. The researcher did supply a consent letter and a paper survey by either visiting the schools or emailing the surveys to the graduate participants (Appendix B & C). The participants were given two weeks to complete the survey and place it in a collection envelope that was mailed back to the researcher or picked up by the doctoral candidate researcher.

Qualitative data was collected through telephone interviews and focus groups. When using the sequential explanatory data collection process and analysis, the researcher first examined running themes throughout the qualitative data and overlap of these themes in the quantitative data collected through the survey. Then additional questions for interviews were created to gather data from follow up interviews. Additional qualitative data was collected by an examination of the Elementary Mathematics Specialist Program course content and syllabi.

Data Analysis

Quantitative data were in the form of Likert questions and yes/no answers. These data were analyzed using non-parametric statistics such as Chi-Square, Mann-Whitney, and Kruskal-Wallace tests. Percentages were calculated to describe demographic data. Demographic data were also used as independent variables for some of the non-parametric tests. Qualitative data from the focus groups and follow-up interviews were analyzed to identify themes. Transcription techniques were used to identify these themes and issues. Follow up interviews were conducted for clarification if needed and additional information that may have been critical to authentication of the graduate's perceptions. This examination of the program information included comparisons between the syllabi and course content with National Council of Teachers of Mathematics Standards and this professional organization's recommended characteristics of the Elementary Mathematics Specialist.

The internal consistency of all survey instruments assured adequate rigor of the research. The limitation of this research method was convenience sampling, which limits the generalizability of results.

CHAPTER FOUR: DATA ANALYSIS AND FINDINGS

This study was conducted to examine graduate perceptions/confidence levels and demographics of the group. The relationship between the survey and demographics was also examined. In addition, follow up interviews were conducted to determine strengths and weaknesses of the program and the triangulation between the quantitative and qualitative results. A complete description of the data collection process, data cleaning and coding, and analysis results are provided in this chapter. Results are organized according to the outline provided in Chapter 1.

Data were collected from a convenience sample of 56 subjects recruited from the graduate program. Recruitment began after IRB approval on April 21, 2019, and was completed on July 9, 2019, after the number of surveys determined to be necessary was collected. An Amendment was added and approved on June 25, 2019 to add phone interviews to the qualitative data; after the number of interviews determined to be necessary was collected the data were analyzed. Data collection utilized the Qualtrics survey generator program. Qualtrics is a web-based survey tool to conduct survey research, evaluations and other data collection activities (Qualtrics, 2019). The link for the survey was then emailed to the graduates for completion.

Participants were sampled from 56 graduates in the program, a total of 21 completed the survey and one partial survey. An additional 4 graduates were interviewed over the phone and in-person for follow up information regarding strengths and weaknesses. Permission was obtained using consent forms that were emailed to the graduates to print and save for their records.

Percentages

Demographic data about the participants were collected to be considered as independent variables. These variables were: grade level taught (K through 6 or administrator), years of experience (one through 25-plus), school level (elementary, middle, or other), EMS position in the county (yes or no), participant working as an EMS in the county (yes or no). The following table provides a summary of the demographics from 21 out of the 22 participants who responded to the survey.

The following tables discuss further the demographic breakdown of the participants in this study.

Table 1. Grade Taught

Kindergarten	2nd	3rd	4th	5th	Administrator
9.5%	23.8%	19.0%	9.5%	14.2%	23.8%

Most of the participants were teachers in the 2nd grade or did not teach in a school and were in an administrative capacity. The smallest amount of teachers were in the 4^{th} grade and Kindergarten. It should be noted that no participants were in grades 1^{st} and 6^{th}.

Table 2. Years of Experience in the Public-School System

1-5 years	6-10 years	11-15 years	16-20 years	20-25 years	25+ years
4.7%	28.5%	19.0%	14.2%	23.8%	8.5%

Most of the participants had between 6-10 years' experience teaching in the public school system. There was also a large percentage that had 20-25 years' experience. The data also shows not as many participants signed up for the program that were beginning their educational careers.

Table 3. Do You Teach in an Elementary or Middle School?

Elementary	Middle	Administrator
85.7%	4.7%	9.5%

The majority of the participants taught in an elementary school and only a small percentage taught in a middle school. There was a greater number of participants that were in an administrative capacity.

Table 4. Is There an EMS Position in Your County?

Yes	No
9.5%	90.4%

There were not very many EMS positions in any of the counties the participants were employed.

Table 5. Are You Working as an EMS in Your County?

Yes	No
23.8%	76.1%

The majority of participants were not working in an EMS position in their counties.

Quantitative Data Analysis

Frequency data from the Likert-Scale questions were analyzed using the Chi-Square test to compare what was observed and what would be expected by chance from the responses of the participants (Salkind, 2014). The Mann Whitney U Test was utilized to compare Likert responses for the two-group independent variables and the Kruskal-Wallis test was conducted to compare Likert responses for the more than two-group independent variables. The following gives details of the analysis for each of these tests.

Chi-Square Analysis of Likert Responses

Participants' responses to Questions 1 through 6 provided data concerning how confident they were in their content knowledge. NCTM Standard 1 Content Knowledge pertains to demonstrating and applying knowledge of major mathematics concepts, algorithms, procedures, applications in varied contexts, and connections within and among mathematical domains such as Number and Operations, Algebra, Geometry, Data Analysis & Probability, and Measurement (NCTM, 2012).

Table 6. Standard 1 Content Knowledge

	Participant Response Frequencies (n=22)					
Question	Not Confident	Somewhat Confident	Confident	Very Confident	Chi Square	P value attained
1 Number & Operations	0	0	10	12	22.3	0.00005 *
2 Algebra	0	4	11	7	11.8	0.00803*
3 Geometry	0	4	12	6	13.6	0.00344*
4 Measurement	0	6	6	10	9.2	0.02588*
5 Data Analysis & Probability	0	6	14	2	20.9	0.00011*
6 Knowledge of Modeling Math Standards	0	3	11	8	13.2	0.00408*

* Significance attained at $p<0.05$

The results indicated there was a significant difference between participant responses concerning their confidence in content knowledge. Overall, data show participants are confident or very confident in their content knowledge. For the *Measurement* question 4, participants were less confident in their skills where you see the responses are more evenly spread out between somewhat confident, confident and very confident. Most participants felt confident to very confident in the most areas of Content Knowledge, however they did not feel as confident with Measurement. National Council of Teachers of Mathematics defines Measurement as understanding measurable attributes of objects and the units, systems, and processes of measurement; and applying appropriate techniques, tools, and formulas to determine measurements.

Participant responses for Questions 7 through 13 provided data concerning how confident they were in Standard 2 Mathematical Practices pertaining to effective elementary mathematics specialists solving problems, representing mathematical ideas, reason, prove, using mathematical models, attending to precision, identifying elements of structure, generalize, engaging in mathematical communication, and making connections as essential mathematical practices (NCTM, 2012).

Table 7. Standard 2 Mathematical Practice

	Participant Response Frequencies (n=22)					
Question	Not Confident	Somewhat Confident	Confident	Very Confident	Chi Square	P value attained
7 Create Interdisciplinary Learning Exp.	0	6	12	4	13.6	0.00344*
8 Develop Methods for Students to Approach Math	0	5	9	8	8.9	0.03052*
9 Student Reflection	0	6	12	4	13.6	0.00344*
10 Students Linking New Math to Previous Knowledge	0	4	12	6	13.6	0.00344*
11 Students as Independent Learners	0	3	13	6	16.9	0.00074*
12 Students Attempt Challenging Problems	0	2	15	5	24.1	0.00002*
13 Evaluate Students Thinking	0	4	13	5	16.1	0.00104*

* Significance attained at $p<0.05$

The results indicated there was a significant difference between participant responses concerning their confidence in mathematical practices. Overall, data show participants are confident or very confident in their mathematical practice. For the *Develop Methods for Students to Approach Mathematics* question 8, participants were less confident in their skills where you see the responses are more evenly spread out between somewhat confident, confident and very confident. For question 8, participants felt less confident in using problem solving to develop conceptual understanding. National Council of Teachers of Mathematics defines Mathematical Practice as problem solving for developing greater understanding, making sense of a wide variety of problems and persevering in solving them, applying and adapting a variety of strategies in solving problems confronted within the field of mathematics and other contexts.

Participant responses for Questions 14 through 21 provided data concerning how confident they were in Standard 3 Content Teaching pertaining to applying knowledge of curriculum standards for mathematics and their relationship to student learning within and across mathematical domains in teaching elementary students and coaching/mentoring elementary classroom teachers (NCTM, 2012).

Table 8. Standard 3 Content Teaching

		Participant Response Frequencies (n=22)				
Question	Not Confident	Somewhat Confident	Confident	Very Confident	Chi Square	P value attained
14 Teaching Math to Students Appro. Stages of Development	1	5	9	7	6.3	0.0952
15 Teach Math to individual Learning Styles	0	4	12	6	13.6	0.00344*
16 Teach Math to Individual Strengths	0	4	13	5	16.1	0.00104*
17 Teach Math to Individual Needs	0	5	11	6	11.0	0.01124*
18 Evaluate & Use Math Strategies, Manipulatives, Technology	0	2	14	6	20.9	0.00011*
19 Use Different Active Learning Opportunities	1	2	13	6	16.1	0.00104*
20 Help Students Which Learning is for Them	0	6	12	4	13.6	0.00344*
21 Monitor Student Learning and Adjust Strat	0	3	15	4	23.4	0.0003*

* Significance attained at $p<0.05$

The results indicated there was a significant difference between participant responses concerning their confidence in content teaching. Overall, data show participants are confident or very confident in their content teaching. For Question 14 *Ability to Teach Mathematics Instruction Appropriate to Individual Students Stages of Development*, participants were less confident in their skills where you see the responses are more evenly spread out between not confident, somewhat confident, confident and very confident. Responses to Question 19 showed greater discrepancy in the responses *Use Different Active Learning Opportunities*. For questions 14 and 19, participants felt less confident in incorporating research-based mathematical experiences and include multiple instructional strategies and mathematics-specific technological tools in their teaching and coaching/mentoring to develop all students' mathematical understanding and proficiency.

Participant responses for Questions 22 through 28 provided data concerning how confident they were in Standard 4 Mathematical Learning Environments pertaining to exhibiting knowledge of child, pre-adolescent, and adult learning, development, and behavior. They use this knowledge to plan, create, and assist teachers in planning and creating sequential learning opportunities grounded in mathematics education research where students are actively engaged in the mathematics they are learning and building from prior knowledge and skills (NCTM, 2012).

Table 9. Standard 4 Mathematical Learning Environment

Question	Not Confident	Somewhat Confident	Confident	Very Confident	Chi Square	P value attained
	Participant Response Frequencies (n=22)					
22 Assess Appropriate Services for Sp. Needs Students	0	6	12	4	13.6	0.00344*
23 Create Classroom Climate that is Safe and Open	0	1	13	8	20.5	0.00013*
24 Make Appropriate Provisions for ESL Students	2	11	7	2	10.3	0.01572*
25 Create Learning Envir. with Climate of Inquiry	1	2	13	6	16.1	0.00104*
26 Create Independent work Envir. for Students	0	2	15	5	24.1	0.00002*
27 Demonstrate Sensitivity to Culture and Gender	0	4	10	8	10.7	0.0133*
28 Model Effective Communication Strategies	0	0	16	6	31.0	<0.00001*

* Significance attained at p<0.05

The results indicated there was a significant difference between participant responses concerning their confidence in mathematical learning environment. Overall, data show participants are somewhat confident, confident or very confident in their mathematical learning environment. For the *Ability to Make Appropriate Provisions for Students who Use English as a Second Language* question 24, participants were less confident in their skills where you see the responses are more evenly spread out between not confident, somewhat confident, confident and very confident. More participants thought they were only somewhat confident (11 responses) than any other category marked. Question 25 the *Ability to Create a Learning Community in Which Students Work Collaboratively in a Climate of Inquiry* also had a wide distribution of responses. Participants' responses were split between not confident, somewhat confident, confident, and very confident.

Participant responses for Questions 29 through 33 provided data concerning how confident they were in the Standard 5 Impact on Student Learning pertaining to providing evidence that as a result of their instruction or coaching/mentoring of teachers, elementary students' conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and application of major mathematics concepts in varied contexts have increased (NCTM, 2012).

Table 10. Standard 5 Student Learning

Participant Response Frequencies (n=22)						
Question	Not Confident	Somewhat Confident	Confident	Very Confident	Chi Square	P value attained
29 Collect Student Data for Analysis	0	1	14	7	22.7	0.0005*
30 Maintain Records of Student Work	1	1	13	7	18.0	0.00044*
31 Solicit Information About Student From Parents	2	2	14	4	18.0	0.00044*
32 Solicit Information About Student From Colleagues	1	1	14	6	20.5	0.00013*
33 Utilize Reflection of Students' Characteristics	1	4	13	4	14.7	0.00207*

* Significance attained at $p<0.05$

The results indicated there was a significant difference between participant responses concerning their confidence in student learning. Overall, data show participants are not confident, somewhat confident, confident or very confident in their student learning. Though the responses were spread out over all four options the majority of the responses fell under confident for every question under Standard Five.

Participant responses for Questions 42 through 44 provided data concerning how often they participated in Standard 6 Professional Knowledge and Skills pertaining to being lifelong learners and recognize that learning is often collaborative. They participate in and plan mathematics-focused professional development experiences at the school and/or district level, draw upon mathematics education research to inform their practice and the practice of colleagues, continuously reflect on their practice, use and assist teachers in using resources from professional mathematics organizations, and demonstrate mathematics-focused instructional leadership (NCTM, 2012).

Table 11. Standard 6 Knowledge and Skills

	Participant Response Frequencies (n=21**)					
Question	Rarely	Sometimes	Often	Very Often	Chi Square	P value attained
42 Conduct Math Prof. Development Training	8	11	1	1	14.6	0.00217*
43 Participate in Math Professional Development	0	10	7	4	10.4	0.01525*
44 Participate in Math Professional Organizations & use resources	3	10	4	4	5.8	0.11877

* Significance attained at $p<0.05$ **Only 21 surveys were utilized because one participant did not complete all needed information.

The results indicated there was a significant difference between participant responses concerning their participation in professional development and use of professional resources. Overall, data show participants are not participating in mathematics professional development and use of professional resources. In Standard Six, a trend is seen with most responses falling in the sometimes category. The most statistically significant responses on the survey are also in Standard Six, under questions 42 and 44. Question 42 inquired if the participant *Conducts*

Mathematics Professional Training to Improve Teaching and many marked rarely or sometimes. Question 44 inquired if they *Participate in Mathematics Professional Organizations and/or use Mathematics Professional Organizations as Resources to Improve Teaching* and many marked rarely or sometimes.

Participant responses for Questions 34 through 41 provided data concerning how confident they were in Standard 7 Elementary Mathematics Specialist Leadership pertaining to engaging in a planned sequence of field experiences and clinical practice under the supervision of an experienced and highly qualified mathematics educator (NCTM, 2012).

Table 12. Standard 7 Elementary Specialist Leadership

	Participant Response Frequencies (n=22)					
Question	Not Confident	Somewhat Confident	Confident	Very Confident	Chi Square	P value attained
34 Ability to Collaborate with Interdisciplinary Teams	1	5	9	7	6.3	0.0952
35 Ability to Collaborate with Colleagues	1	1	13	7	18.0	0.00044*
36 Ability to Use Leadership Skills to Improve Math	1	1	14	6	20.5	0.00013*
37 Ability to Coach & Mentor New Teachers	1	3	13	5	15.0	0.00174*
38 Ability to Conduct Teacher Meetings	1	7	12	2	14.0	0.00291*
39 Ability to Collaborate with Teachers	1	2	12	7	14.0	0.00291*
40 Ability to Partner with Other School-Based Professionals to Develop Shared Vision	1	2	15	4	22.7	0.0005*
41 Ability to Partner with Other School-Based Professionals	1	6	11	4	9.6	0.02192*

* Significance attained at $p<0.05$

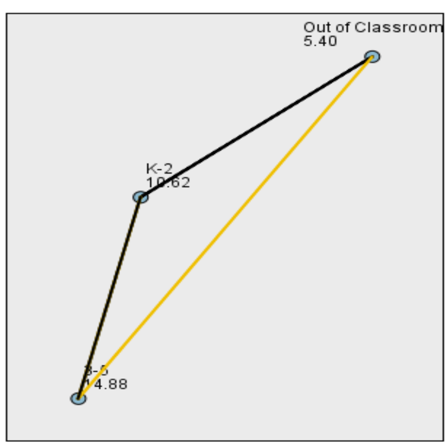
The results indicated there was a significant difference between participant responses concerning their confidence in elementary specialist leadership. Overall, data show participants are not confident, somewhat confident, confident or very confident in their elementary specialist leadership. Though the responses were spread out over all four options the majority of the responses fell under confident for every question under Standard Seven.

Mann-Whitney U and Kruskal-Wallace Analysis

The Mann-Whitney U compared the participants' responses concerning their confidence for each NCTM Standard when grouped according to: (1) EMS position in the county (yes or no) and (2) participant working as an EMS in the county (yes or no). The results indicated there was no statistically significant difference between responses due to this grouping. See Appendix E for the Mann-Whitney U analysis tables.

The Kruskal-Wallace compared the participants' responses concerning their confidence for each NCTM Standard when grouped according to: (1) grade level taught (K through 6 or administrator), (2) years of experience (one through 25-plus). The school level (elementary, middle school) was not examined due to only one participant being from the middle school. Significance in the Kruskal-Wallace was found only under Standard One Question Five *Probability.* See Figure 2. See Appendix F for the remaining Kruskal-Wallace analysis tables.

Pairwise Comparisons of GradeLevel



Each node shows the sample average rank of GradeLevel.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Out of Classroom-K-2	-5.225	3.043	-1.717	.086	.258
Out of Classroom-3-5	-9.475	3.043	-3.113	.002	.006
K-2-3-5	-4.250	2.669	-1.592	.111	.334

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Figure 2-Kruskal-Wallace Pairwise Comparison Question 5

The significance indicated participants who taught grades 3-5 were more confident in probability than were participants who were out of the classroom. The significance possibly occurred because teachers in 3-5 use probability more frequently in these grades than other teachers and administrators. See Appendix F for these analysis tables.

Qualitative Data Analysis

Qualitative data was collected through a focus group and phone interviews. The qualitative nature of the research reflects an emphasis on an illuminative study that provides insight of the participant's confidence levels. The data collected yielded a detailed and information-rich glimpse at participants' personal confidence levels associated with the content from the EMS program. The findings conducted by the researcher are a result of inductive analysis conducted by this researcher, focused on the details and specifics of the data in an effort to identify patterns and themes about participant confidence levels. There were two participants in the focus group held in the northern part of the state and two participants through phone interviews. The questions presented to both the focus group and the phone interview were the same. The seven numbered questions and four unnumbered questions participants were given are in Appendix D. The questions were grouped according to prior to attending the program, after attending the program, and how the EMS program has impacted their current role in their school district.

Initial coding of focus group and interview transcripts revealed distinct words, terms, or phrases. These were grouped by the research questions of prior to attending the program, after attending the program, and impacts of the program plus strengths and weakness each with its own set of subcategories or themes. Under the prior to attending the program questions, codes can be grouped under favorite subject and lack of differentiated instruction. These themes all relate to impacts the EMS program had on the participant's confidence levels prior to completion. A note should be made, there is an overlapping connection between these categories created. To give an example, a participant may be strong in learning math, but it is not necessarily transferring to the students through differentiated instruction.

Table 13. Prior to Entering the EMS Program

Themes	Favorite Subject	Lack of differentiated instruction
Sub-themes	*Math minded *Strong math talk *Belief in progress monitoring program(PMP)	*Need for resources or tools acquisition *Too much content *Small group instruction deficit

The participants all marked they are math minded and have enjoyed the subject of Mathematics most of their academic careers. They understand math talk and have a strong belief in the progress monitoring program the county has adopted in helping struggling math learners. Another common sub-theme is the notion the participants believe there is too much math content to be covered in the course of a semester or school year. Participants also pointed out there are not enough resources and tools acquisition to help students who struggle to understand math content. Finally, small group instruction was found to be important, but a challenge for teachers to find the time to include in the daily math routine.

To further illustrate these sub-themes, below you will find comments of the interviewees and how they demonstrate the sub-theme.

Table 14. Theme - Favorite Subject

Subthemes	Comments Illustrative of this Point
Math Minded	"I would say I'm a strong math person. It was kind of always my favorite subject in school."
Strong Math Talk	"I would try to use phrases in my teaching like, "can you explain what we just went over to me" or "How did you solve that" to gauge if they were really understanding and committing to memory what we were learning."
Belief of Progress	"We are using IReady in our county, so it makes it easier to meet the

Monitoring Program	weekly math curriculum requirements."

Table 15. Theme - Lack of Differentiated Instruction

Subthemes	Comments Illustrative of this Point
Need for Resources & Tools Acquisition	"I personal know that teachers I work with share materials for lessons, but we don't always have the money to purchase what we need. We received some grant money that allowed us to purchase extra supplies."
Too Much Content	"The curriculum that we use, the pacing looked like it was going to be horrific. So, the first year that we used it we tried to make our own pacing guide. And then the second year we realized that it did not work." "What I see as being a challenge is trying to cover math concepts and they are just so stressed that they make sure they cover all the concepts and things that they don't get to do enrichment."
Small Group Instr.	"By not getting to do enrichment, such as small group instruction and project based learning, we are not helping our struggling learners."

The second area of questions related to after the participants completed the EMS program. For this section, completely new themes and sub themes emerged that warranted new charts to illustrate the perspective after completion. Also, with this section there is an overlapping connection between these categories developed. An example is, acquiring more skills and resources lead to better understanding of student frustrations when learning certain math concepts.

Table 16. After Graduating from the EMS Program

Themes	Change in Perspective	Networking
Sub-themes	*Greater Effectiveness	*Collaboration
	*Understanding the learning gap	*Sense of Community
	*Better Strategies	*Shared Experience

The participants all mentioned that as a result of the program they acquired better strategies for teaching specific areas of Mathematics. Some participants thought they gained greater effectiveness in working out the problems themselves to greater understand deficits when working with children in Mathematics. One major development was those teachers who are math minded understood the learning gap for mathematics in children that struggle to grasp mathematics concepts and strategies. During the interview, participants felt there was a greater sense of community for mathematics as a result of the program. They communicated with other participants at different schools they normally would not have had the opportunity to because of the online discussion/forum in the program and have continued this community upon completion. The teachers collaborated through grade level team meetings and title one services, techniques and examples with non-graduates of the program to improve teacher and student mathematical skills. They talk amongst themselves about the shared experience of going through the program and how it overlaps programs taking place in their counties.

Table 17. Theme - Change in Perspective

Subthemes	Comments Illustrative of this Point
Greater Effectiveness	"So I think that actually having to do the math myself gave me a better understanding of my student's frustrations and also the stuff that it takes to arise at an answer. For example, doing the geometry course, I was not super familiar with geometry because in second grade what I've been teaching for five years, all that we were doing was identifying spaces and vertices, and identifying shapes. So I wasn't necessarily having to find the measurement of the angles. I wasn't you know supper familiar with a reflex angle or finding the complementary angle to another one. Just so upper level skills I was not supper familiar with and I felt like having to do that was really good for me to have that in my back pocket for my students and then also to understand where they were coming from. Because it could be a little frustrating to know that the answer in the back of the book was 90 and my answer is 82. So trying to figure out what did I do wrong? And how can I get it 90, you know the process of writing that answer and identifying errors within my work."
Understanding the Learning Gap	"I think as far as working with teachers just helping the teachers to understand the importance of making the students understand like why things work the way that they do. Not just showing them algorithms and do this to get the answer but understanding why it works.
Better Strategies	"I think just giving me some resources and just kind of reconsidering different ways to teach concepts and that students can easily understand them. Umm…and just giving me a deeper understand of like why math works the way it does. I think back to the fractions class, it helped me gain a little bit more knowledge about why some things work the way that the do. I had a good idea of fractions, but there were definitely things that were like "Oh, that's why that works!". Some kind of "ah ha moments"."

Table 18. Theme - Networking

Subthemes	Comments Illustrative of this Point
Collaboration	"I have shared in grade level team meetings, but that's only three people. The ideas we learned in the program I have shared with my small team." "Our school had a big turnout for this program, nine. Our principal has called on me before for math support. I can't say that she has necessarily called on me more now after completing the program than before. But, I will say that our title I interventionist or principal has asked her to consult with me on strategies and different activities that I've done in my classroom as a result of the program to share with her. She then shares with more students than I would see in my classroom. I'm glad you brought that up, I was thinking whole school, but yes, I would definitely agree with that."
Sense of Community	"I think more in our conversations amongst ourselves, we were able to help each other with our strengths and weaknesses. I know there was one class where we really looked at some different like ways to teach for lack of a better word instructional strategies. And then as we went through other classes we were able to kind of see how some of those strategies might tie into some of the content once we started getting more into the content. We kind of referred back to "Oh remember that strategy we learned about in that class we can apply that here," that sort of thing."
Shared Experience	"I really like the discussion pieces. You know they would…like back to our practicum for instances. We would video ourselves, there were discussion pieces within and I don't know if it was that exact module. But, anyway we had it throughout the program we had to conduct discussions with people who are our colleagues but not necessarily people who were within our building or see every day. I felt that that was really helpful to see their ideas and be able to bounce my ideas off of them and kind of share in between."

The final area of the questions focused on the impacts of the program plus strengths and weakness. These impacts could be in the form of leadership opportunities or acting as mentors. For this section, some completely new themes and sub themes emerged as well as some common sub themes already seen in other categories that warranted new charts. There were contradictions in perceptions of the number of in-person classes required between the strengths and weaknesses.

Table 19. Impacts of the Program

Themes	Leadership	Strengths	Weaknesses
Sub-themes	*Math expert *Greater autonomy *Collaboration	*Teacher confidence * Discussions *Content knowledge *Only a few meetings *Scope & sequence	*Content K-2 *Math targeted assessments *More sit-down meetings *Amount of work

Many of the participants discussed the collaboration they have in their counties through a Math for Life campaign and being part of a mathematics cadre as a result of completing the EMS program. These individuals are viewed in their schools and county as mathematics experts that are a source of help when a teacher needs direction. Because of this role, these participants have gained greater autonomy within their current roles.

During the interviews, strengths and weaknesses were identified for the EMS program. There were contrasting thoughts on the number of in-person meetings that should take place; some stated there were not enough while others did not like having very many meetings at all. There were more strengths identified than weaknesses and the weaknesses were issues that are easily addressed. For the strengths, teacher confidence in their skills increased. The online discussions as part of the class requirements was considered an attribute as well as content knowledge and the scope and sequence of the program. For the weaknesses, some participants thought the Kindergarten through Second grade levels content was not enough. They wanted to see more targeted assessments for struggling mathematics learners and that the amount of work involved in the program was too much.

Table 20. Theme - Leadership

Subthemes	Comments Illustrative of this Point
Math Expert	"So just in general between the cadre and people having a little bit more confidence with math and also with the new program. You know we're in the Math for Life campaign, I just feel that there has been a lot of things going on recently and it just helped to improve teacher's confidence and giving them a little more autonomy. But it's kind of a collaboration of different things that have been going on to get to that point. Math for Life is a statewide initiative and the state gave each county control over what that looks like in each county and what their goals are going to be. Each county has created a Math for Life team, which creates what the vision will look like. One of the goals is professional development for teachers, so it was perfect timing with this program."
Greater Autonomy	"I think the way the program has changed for me, is my school uses me more for guidance on mathematics related questions and being a …….. I have more autonomy to decide what strategies to use with my students."
Collaboration	"I think that I would get together with the other two teachers from my school and we would do homework together and it's just powerful to have somebody else to bounce ideas off of and say "Am I doing this right? I didn't get the same answer as you, let's look through and see what we did wrong or who's right and who's wrong," and two heads are better than one. It was always just nice to be able to work together and not be alone."

Table 21. Theme - Strengths

Subthemes	Comments Illustrative of this Point
Teacher Confidence	"It helped me gain that deeper understanding of math and math concepts. But then we can help our students a little better, because we have a deeper understanding."
Discussions	"I think as far as working with teachers just helping the teachers to understand the importance of making the students understand like why things work the way that they do. Not just showing them algorithms and do this to get the answer but understanding why it works."
Content Knowledge	"The program helped provide us with that content knowledge. Covering multiple areas I wouldn't have necessarily have a deep knowledge of teaching" "The fractions section really helped. It sticks out to me." "I think the fractions lesson, yes, and all the material for fourth and fifth grade."
Only a Few Meetings	"The discussion and being able to collaborate with teachers, but not necessarily having to meet together was really good. I mean being a busy mom of two, it was really easy to accomplish my assignments and still feel like I was in touch with the people I was working with. It would not be realistic for me to go to a classroom at night or on the weekend. You know online really was a really great strength for this program I feel."
Scope & Sequence	"I think the way the curriculum was set up was extremely helpful. The scope and sequence of the entire case five, case six curriculum, and content that they needed to know was a strength."

Table 22. Theme - Weaknesses

Subthemes	Comments Illustrative of this Point
Content K-2	"I didn't feel that there was a whole lot that was primary. I don't remember doing a whole lot that was Kindergarten, first or second." "I thought the program was weak in the early grades. There was a lot of Content for 3-6, but very little that I noticed for K-2."
Math Targeted Assessment	"I would have liked to see more targeted assessments embedded in the program."
More In-Person Meetings	"The lack of required class meeting and the amount of work." "I'm also a face to face learner, and like we only met a couple of times each semester and those were very valuable sessions. But, they were few and far between and I know we're teachers and I understand why we did it that way. We've all got children most of us, and lives. But, I learn better in a group setting and face to face than I do online. I would have liked to have more opportunities to meet face to face."
Amount of Work	"There was a lot of math. There was more math than lesson planning and things like that. I think that is what threw a lot of people off. We were not expecting to be doing math ourselves. We were expecting to be learning more about you know techniques for how to implement math in your classroom." "The lack of required class meeting and the amount of work."

The following addresses the research questions and how the qualitative data from focus groups and interviews and quantitative data combined answered the questions. For the percentages listed in responses, they were calculated using quantitative data from each standard (the total number of often and very often responses for each standard divided by the total number of responses for each standard (O+VO/Total Responses = %)).

RQ 1: What are graduate candidate perceptions of their confidence in their mathematics content and pedagogy knowledge due to their participation in the Elementary Mathematics Specialist program? To answer this question, Standards 1 and 3 were reviewed.

The majority of the participants on the survey for these sections marked confident or very confident 83% for Standard 1 Content Knowledge and 81% for Standard 3 Content Teaching. In the qualitative data, indicated interviewees have greater effectiveness in teaching, better strategies, collaboration with other educators, and understood the learning gap they encountered in students and how to address this gap.

RQ2. What are graduate candidate perceptions of their confidence in their teaching skills and practices due to their participation in the Elementary Mathematics Specialist program? The results can be found in the quantitative data under Standard 2 Mathematical Practices, Standard 4 Mathematical Learning Environment, and Standard 5 Impact on Student Learning. Most of the survey participants marked confident or very confident, 81% for their choice on Standard 2. On Standard 4, 81% marked confident or very confident for the Mathematical Learning Environment. On Standard 5, 87% marked confident of very confident for the Impact on Student Learning. Interviewees thought teacher confidence and content knowledge were both strengths of the program that they experienced after completion of the program.

RQ3: What are graduate candidate perceptions of their confidence in their mathematics leadership skills due to their participation in the Elementary Mathematics Specialist program? The results for the quantitative portion of the study indicated Standard 6 Professional Knowledge and Skills participants were not given as many opportunities to conduct professional trainings on a school or county wide level 33%. For Standard 7 Elementary Mathematics Specialist Leadership, 80% of the time participants are coordinating with school interdisciplinary teams, collaborating with colleagues, using leadership skills to improve mathematics, coaching/mentoring others, conducting teacher meetings, and partnering with school-based professionals. To further illustrate the leadership skills, on the qualitative section interviewees responded they have greater autonomy in their careers, are considered math experts in their schools, and collaborate more frequently with their colleagues and are often included in county wide math initiatives.

For the qualitative data obtained by the examination of course content and syllabi, a summary of the key assignments, activities, and themes from these documents was compiled and compared to NCTM standards and goals for the Elementary Mathematics Specialist. This summary is presented in Appendix G.

CHAPTER FIVE: CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter will present a summary and discussion of the study, the population used in the study and also major findings. Implications from the study analysis as well as recommendations for future research are provided.

Summary of Purpose

The purpose of this study was to examine graduates' perceptions of confidence in their content knowledge and pedagogy provided through the Elementary Mathematics Program (EMS). This study was conducted to determine if the EMS program increased teachers' confidence in their ability to teach mathematics to students, act as mathematics leaders in their educational communities, and to strengthen their own mathematical content knowledge. This program was designed as an intensive professional development program to hone the skills of educators, increase personal confidence, and mold these individuals into future leaders in mathematics within their communities.

Summary of Population

The population for the study consisted of all 56 candidates who have graduated from the Elementary Mathematics Specialist program in the academic years 2015 through 2018. The program was newly developed and began in the Spring of 2015. Respondents to the survey totaled 22 graduates (39% of the total population). Of the total respondents, one of the 22 did not respond to Standard 6 and the demographic questions. The focus group and interviews consisted of four participant graduates (7% of total population). All of these participants were seasoned professionals with five or more years' experience in the public-school system. Of the graduates who returned surveys, 100% were female and the majority were teaching at an elementary school with anywhere from six to twenty-five years' experience. Most of the participants taught in grades 2nd through 5th (with only one or two in grades Kindergarten or 6th). None of the participants held a formal Elementary Mathematics Specialist position in their county; however, some had worked with teacher colleagues in an advisory capacity.

Major Findings

Research Question 1- Content and Pedagogy Knowledge

Summary

Research Question 1 was stated as, "What are graduate candidate perceptions of their confidence in their mathematics content and pedagogy knowledge due to their participation in the Elementary Mathematics Specialist program?" A Chi-Square test for expected frequencies was used to determine participants' perceived confidence levels concerning NCTM Standard 1 Content Knowledge and Standard 3 Content Teaching. Analysis revealed a statistically significant difference between the Likert responses in these two standards. For Standard 1, 83% of the graduates chose confident or very confident for their responses. For Standard 3, 81% of the graduates chose confident or very confident for their responses. These high levels of confidence for Standard 3 show participants are varying their strategies of delivery of the content to learners with all needs involving mathematics.

Similarly, to the quantitative data, the qualitative data also indicated high levels of confidence in content knowledge and content teaching. For the qualitative data concerning Standards 1 and 3, thematic analysis was data driven and yielded participant response results such as greater effectiveness in teaching; stronger content knowledge; and, improved teacher confidence. Some of the teachers even stated, "It helped me gain that deeper understanding of math and math concepts. But then we can help our students a little better, because we have a deeper understanding." The teachers discussed content knowledge as a positive benefit of the program saying, “The program helped provide us with that content knowledge. Covering multiple areas I wouldn’t have necessarily had a deep knowledge of teaching.” Graduate participants also gave feedback on how the program could be improved. Feedback included adding more mathematics examples than what is in the program currently regarding support in the classroom to create greater differentiated instruction.

Literature and Discussion

The significant results related to Standard 1 and Standard 3 show high levels of participant confidence in content knowledge and content teaching. This high level of confidence could be due to course content. Overall, all of the EMS program courses provide instruction in mathematics content, real-world application of mathematics content, and mathematics teaching. High levels of confidence show graduates have the ability to show how mathematics applies to other academic areas as well as everyday life. This confidence also shows the ability to accurately identify appropriate problem-solving techniques given the situation and analyze mathematical ideas and relationships.

Specifically, a closer look at each course provides more validation of how the program enhanced graduates’ confidence in mathematics content knowledge and teaching. CIME 501 Mathematics for Elementary Teachers II, provides a comprehensive examination of rational numbers and mathematics classroom activities for real-world application of fractions. (marshall.edu/coepd). Next, CIME 555 Technical Mathematics for Educators starts with more familiar concrete problems and transitions to complex, novel and abstract problems. The emphasis in this course is placed on percent, decimals, ratio and proportion, basic geometry, measurement, and graphing in the context of real-world applications. Mathematical tools such as number sense, pattern making, estimation, working backward and multiple representations of problems are integrated with using the graphing calculator, spreadsheet tools, and online resources. The Algebra course provides a solid foundation in basic algebra topics throughout this course. The goal of this course is to deliver the content objectives and methods needed by prospective teachers for instruction of students in algebra. Algebra topics include structure of algebra; integer arithmetic; linear, quadratic, and exponential equations; solving equations; interpretation of graphs; and pedagogy for introduction of algebra to elementary and middle school students. This course focuses on using inductive and deductive reasoning skills, as well as having the ability upon completion to analyze mathematical ideas and relationships and communicate the results to different audiences. Finally, the Geometry course offers instruction in relationships of points, line segments; applying the Pythagorean Theorem to solve problems; describe relationships among sets of special quadrilaterals; and, solve problems using the properties of special quadrilaterals. These areas are just to outline a few areas of the geometry class which describe the role of mathematics in other academic disciplines and in everyday life.

The program also provides instruction concerning mathematical technology for teachers to gain greater awareness of what tools are available to teach children, along with providing opportunities for teachers to gain confidence in using them. Examples include geometric software to explore topics such as: geometric shapes, mathematical arguments, coordinate geometry, transformations, symmetry, geometric modeling, area and volume. Plus, an application software course class which offers hands-on experience using applications software (databases, multimedia, spreadsheets, word processing) and explores a range of related topics for schools, including state and national standards, current trends and issues, internet and communication technologies, and hardware accessories. The graduates utilize graphing calculators and online activities in multiple math related sites. Plus, NCTM illuminations offers lesson plans, interactive activities, mobile games, and brain teasers all related to mathematics.

Marshall's EMS program utilizes courses that adhere to National Council of Teachers of Mathematics (NCTM) standards. The courses are taught systematically as the teachers would encounter them as they progressed through elementary school, each course building on prior knowledge gained from the previous course. Grade-appropriate content, activities, and examples are embedded in each course. These activities help teachers have tools in the mathematical skill set to address every type of learner. The high levels of content knowledge confidence can be seen in particular in data from the survey concerning Standard 1 Content Knowledge. Questions 1 through 6 of the survey aligned with the EMS program course plan of study related to Numbers & Operations, Algebra, Geometry, Measurement, Data Analysis & Probability, and Modeling Mathematics Standards-based Instruction. The content is indicative of a level of strong rigor in the program designed to increase confidence across 7 grade levels of mathematical content, K-6th grade. Similarly, the rigor was found in William Haver's (n.d) research on Virginia's preparation programs for EMSs. Haver acknowledged the Virginia EMS programs trained teachers in rigorous mathematical concepts focused on content, pedagogy, and coaching classroom teachers to improve student performance as well as confidence in teachers' mathematical skills.

The high levels of mathematics pedagogy confidence can be seen in particular in data from the survey concerning Standard 3 Teaching Content. Questions 14 through 21 of the survey aligned with the EMS program emphasis on learning about students' different learning styles, individual strengths and needs, monitoring student learning, and adjusting strategies as needed. This section of the survey also emphasized varied teaching strategies, the use of manipulatives, varied materials, and technology to reach goals, as well as inductive teaching models. Specifically, a closer look at each course provides more validation of how the program enhances graduates' confidence in mathematics content teaching. In CIME 500 Elementary Teachers I, there is an emphasis placed on inductive teaching models for lesson planning and mathematics classroom activities for application of elementary mathematics concepts (marshall.edu/coepd). As teacher leaders and mentors, they provide assistance in offering students opportunities to do mathematics, discussing it and connecting it to both theoretical and real-world contexts. In CIME 673 Practicum, the practicum students create lesson plans with inductive teaching components included in these plans. The practicum students are required to actively include their students in a meaningful way in an effort to improve student learning, motivation, and enjoyment of the lesson. Each course also utilizes modeling and pedagogy for teaching mathematics to elementary students. These courses offer integration of real-world examples for greater understanding.

Program courses also include exposure to educational philosophies and theories. In particular graduates study the Multiple Intelligence Theory of Howard Gardner in CIME 500. Participants use the components of this theory in their lesson planning activities. The teacher's ability to teach to different learning styles could be better explained by Howard Gardner's work on Multiple Intelligences (1993). He believed logical knowledge involved reasoning skills used heavily in mathematics. Gardner also found that having the content knowledge deeply and the confidence to teach allowed individuals to be able to teach to all types of intelligences and to familiarize children with other types of intelligences.

> "There is evidence from many areas of science that unless individuals take a very active role in what it is that they are studying, learn to ask questions, do things hands-on to recreate things in their own mind and then transform them as is needed, the ideas will disappear. The student may have a good grade on the exam, we may think this student is

> learning but a year or two later there is nothing left. If they carry out an activities themselves, analyze the data, made a prediction, these things will adhere for the long term. Where if you only memorize facts there is nothing to hold onto.” (Gardner, 1993).

All of these skills are considered critical thinking skills that help to solidify what a student is learning and commit it to long-term memory for later use. These critical thinking skills are why the EMS program uses inductive and deductive reasoning skills, hands-on activities, and establishing their own predictions to solidify mathematics understanding.

As for how to facilitate inductive reasoning, elementary school teachers must be proficient in content knowledge, pedagogical knowledge, and pedagogical content knowledge (Shulman, 1986). In particular, Murawska and Zollman (2015) found that it is crucial for the teacher to be skilled in inquiry techniques to stimulate the students’ thinking strategies in mathematics. Further, classroom norms should be developed to provide a comfortable environment conducive to meaningful dialogue throughout the inductive reasoning activity. For students to deepen their understanding and correctly use their inductive reasoning skills, experiencing cognitive dissonance while working with mathematical pattern tasks can be important. Therefore, a series of tasks that give students a chance to speculate and discuss is a great way to help cultivate this type of classroom norm. These tasks build on what the graduates of the program are trying to emulate and teach to their students, establishing theories and making predictions.

The advantages of promoting inductive reasoning in the classroom outweighs the potential hurdles such as getting students, as well as teachers, familiar with inductive models. These models are progressive and very different from traditional teaching. Not only has inductive reasoning been used extensively in real life and across disciplines, but it can also promote conceptual understanding and mathematical proficiency, thus aligning with current mathematics education initiatives (NCTM 2000). This form of teaching also allows students to be actively involved in the lesson.

In the qualitative data, the results of interviewees and focus group attendees indicated a perspective change in how they viewed their confidence in mathematics instruction prior to the program and after completion of the program. Most indicated they had strong mathematical skills prior to entering the program, and after completion they had additional skills to help their students succeed. Themes identified prior to completion of the program included: collaboration, need for resources, strong math talk and acquisition of tools and too much math content. Upon completion of the program, graduate perceptions shifted to collaboration, increased confidence, understanding the learning gap and greater effectiveness. Comments from interviews included one teacher even stated, "It helped me gain that deeper understanding of math and math concepts. But then we can help our students a little better, because we have a deeper understanding." This gain could be attributed to the transformational learning theory. Merriam (1996) thought this theory had several strands with the underlying perspective being as adults participate in powerful learning experiences, they become changed in fundamental and lasting ways. Additionally, transformational learning may be viewed as a frame of reference based on past experiences that have shaped the view of one's world (Sutton, 2017). Wingert (2014b) surveyed elementary teachers who completed a mathematics 10-week course. He found teachers reported being more confident and having multiple ways to teach mathematics to their students. Also, Wingert found school principals were more confident that their school's students would fare well with a new Common Core curriculum having a mathematics specialist on staff.

While data showed high levels of confidence, there were a few areas the graduate participants were less confident in Standard 1. For Questions 4 and 5, respondents answered somewhat confident more on these two questions. These two questions dealt with measurement and data analysis/probability. Concerning Standard 3, for Questions 14, 17, and 20 respondents answered somewhat confident more on these three questions. These three questions dealt with teaching math appropriately to the individual's stage of development; teaching math appropriate to the student's needs; and, helping to identify which active learning opportunities work well for students. The lower confidence levels responses on these questions could be due to graduates' struggles with differentiating instruction to meet every student's mathematical level and needs. Therefore, it is suggested that the Elementary Mathematics Specialist Program include more emphasis on these educational issues.

In summary, the Marshall EMS courses successfully helped with teacher confidence in mathematics content and pedagogical knowledge due to participation in the program. This confidence increase is consistent with findings of evaluations from similar mathematical education specialist programs and should be considered as an indicator of success for mathematical intervention that should be used across the state. Sending teachers from every county in the state to participate in this substantial preparatory program could ensure mathematical gains in content and pedagogy knowledge for all 55 counties in West Virginia.

Research Question 2 – Teaching Skills and Practices

Summary

Research Question 2 was stated as, "What are graduate candidate perceptions of their confidence in their teaching skills and practices due to their participation in the Elementary Mathematics Specialist program?" A Chi-Square test for expected frequencies was used to determine participants' perceived confidence levels concerning NCTM Standard 2 Mathematics Practices, Standard 4 Mathematical Learning Environment, and Standard 5 Impact on Student

Learning. Analysis revealed a statistically significant difference between the Likert responses in these three standards. For Standard 2, 81%, Standard 4, 81% and Standard 5, 87% of the graduates chose confident or very confident for their responses. These high levels of confidence in Standard 2 show participants' confidence in mathematical practice. This confidence helps graduates encourage their students to become independent learners, have confidence in self-reflection, and tackle challenging problems for learners with all needs involving mathematics. For Standard 4, 81% showed confidence in designing a learning environment with all needs involving mathematics. For Standard 5, 87% showed participant confidence on the impact on student learning, and utilizing student data to improve students' learning process.

High confidence levels were also shown in the qualitative data. Thematic analysis that was data driven yielded greater effectiveness in teaching, better strategies, collaboration with other educators, and understanding the learning gap they encountered in students and how to address this gap. Some participants thought, "I have shared in grade level team meetings, but that's only three people. The ideas we learned in the program I have shared with my small team." They also found they were stronger in understanding learners' differences offering, "I think as far as working with teachers just helping the teachers to understand the importance of making the students understand like why things work the way that they do. Not just showing them algorithms and do this to get the answer but understanding why it works."

Literature and Discussion

The significance in Standard 2 shows high levels of participant confidence in mathematical practices. This confidence could be due to course content. Marshall's EMS program utilizes courses that adhere to National Council of Teachers of Mathematics (NCTM) standards. Each of these standards had high levels of confidence for every question on all three standards. Standards 2, 4 and 5 are regarding communication, student learning, and relationship building. These standards can also be found in the work of Sutton, Burroughs, and Yopp (2011) who outlined eight domains of mathematics coaching knowledge that are somewhat similar to the NCTM standards: "Assessment, Communication, Leadership, Relationships, Student Learning, Teacher Development, Teacher Learning, and Teacher Practice" (p. 16). They also thought these standards were imperative to have for mathematics success.

In Standard 2 the high levels of confidence was most substantial on question 12, *My ability to encourage students to attempt challenging problems.* The participants had high levels of confidence in prompting students to tackle problems outside of their comfort levels. Abaziou (2018) found teacher support throughout the problem-solving stage is essential to student success. Students often struggle with persistence and are uncomfortable with the idea of trying a solution if they are not confident that it will yield the desired results, which leads them to refuse to take risks. EMSs can help the student get past this fear to give them a greater advantage in math and in many other areas of daily life.

Specifically, a closer look at the courses provides more validation of how the program enhanced graduates' confidence in mathematical practices. CIME 500 Mathematics of Elementary Teachers I also includes Standard 2. This course prepares graduates to reason abstractly and reflectively, plus utilize appropriate mathematical vocabulary and symbols to communicate mathematical ideas, thus, giving the students the skills to solve challenging problems using positive math talk. CIME 501 Mathematics of Elementary Teachers II also uses these techniques to help organize mathematical thinking and use the language of mathematics to express ideas precisely. CIME 555 Technical Mathematics for Mathematics Educators puts an emphasis on vocabulary, mathematical expression, and problem-solving from a mathematical perspective.

Another part of mathematical practice is interdisciplinary learning experiences. Research indicates by using an interdisciplinary or integrated curriculum it can provide opportunities for greater relevance, less fragmentation, and more stimulating experiences for learners (Frykholm & Glasson, 2005). Interdisciplinary teaching hinges on the way students best acquire knowledge, the important role of not only reaching students during their developmental stage but influencing the teaching of subjects, and the supportive involvement of both students and teachers planning and learning together to modify the instruction of the end product- student achievement (Jacobs, 1989). To accomplish this goal, modeling is recognized as a powerful vehicle for promoting students' understanding of a wide range of key mathematical and scientific concepts. Also, it helps them appreciate the potential of mathematics as a critical tool for analyzing important issues in their lives, communities, and society in general (Greer, Verschaffel, & Mukhopadhyay, in press). Graduates in the EMS program gained the skills to act as mathematics mentors and provide modeling techniques to students and staff. For students, modelling provides opportunities for children to elicit their own mathematics as they work problems.

In Standard 4, the high level of confidence was found in Question 26 *My ability to create a learning community in which students work independently in a climate of inquiry* and Question 28 *My ability to model effective communication strategies.* The program provided the techniques needed to effectively accomplish these activities, thus, providing students with an environment open to inquiry and assistance.

Research has found that despite having the mutual goal of supporting the teaching and learning of elementary mathematics, teachers may not all have equal roles and responsibilities. These teacher leaders' job descriptions differ greatly in schools and districts across a single county (Fennell, Kobett, & Wray, 2013; McGatha, 2010). Yackel (2000) determined the concepts of mathematical norms in a region can be used to more clearly describe what we might mean by inquiry mathematics and how it can be utilized in the classroom. Further NCTM (2000) found through communication, ideas become objects of reflection, refinement, discussion, and amendment. The communication process also helps build meaning and permanence for ideas and makes them public (p. 60). Qualitative data reinforced the graduates' confidence in Standard 4 with teachers stating they were able to understand the reasoning behind each area and how to approach math to better help each student's needs to create a collaborative work environment with a climate of inquiry. Coursework that incorporates Standard 4, involves all classes that utilize modeling and pedagogy for teaching mathematics. But, specifically CIME 673, the graduates assess and build a classroom that will be a climate of inquiry by initially gathering student backgrounds, assessing their strengths and weaknesses, determining their range of abilities in mathematics, and the most prevalent learning styles. Building a classroom is also seen in their lesson plans and are they creating a safe environment for learning. These courses integrate mathematics with real world examples to solidify understanding.

For Standard 5, the high level of confidence occurred in Questions 29 and 32, *My ability to collect student data for analysis and improvement of instruction* and *My ability to solicit information about students from other colleagues.* Assessment data empower teachers to make informed instructional choices that will better support student academic needs. Craig Jerald in a 2006 brief on collecting and using data to increase student achievement (p. 2), discussed why teachers and administrators examine data as part of the school improvement process, school improvement teams become more efficient and effective and teachers develop more positive attitudes about their own and their students' abilities. Standard 5's positive survey responses were further reinforced through the qualitative data; interviewees indicated collaborative work environments they experienced as a result of the program and a stronger sense of their mathematical communities.

Specifically, a closer look at each course provides more validation of how the program enhanced graduates' confidence in mathematics' impact on student learning. With all good pedagogical strategies, analyzing student progress is needed. In CIME 673, an action research activity is required which had teachers give pre and post-tests with statistical analysis of the data including a narrative of how the data analysis informs the graduates of their students' progress towards learning the intended objectives.

In the qualitative data, statements such as "I think just giving me some resources and just kind of reconsidering different ways to teach concepts and that students can easily understand them……it helped me gain a little bit more knowledge about why some things work the way that they do…..Oh, that's why that works" reinforce the effectiveness of the program. Also, using strong math talk for better communication strategies such as, "I would try to use phrases in my teaching like, "can you explain what we just went over to me" or "How did you solve that" to gauge if they were really understanding and committing to memory what we were learning." These simple questions and conversations a teacher has with their students ensure understanding and addresses any issues the student may have with the lesson.

While data showed high levels of confidence, there were a few areas the graduates were less confident in, Standard 2, 4, and 5. For Standard 2, Questions 7, 8, and 9 had respondents answer somewhat confident more on these three questions. These three questions dealt with creating interdisciplinary learning experiences to integrate problem-solving techniques; developing methods to encourage students to approach math from different perspectives; and, encouraging student reflection. For Standard 4, Questions 22, 24, and 25 had respondents answer not confident and somewhat confident more on these three questions. These three questions deal with assessing appropriate services for special needs students; making appropriate provisions for ESL students; and, creating learning communities in which students work collaboratively in a climate of inquiry. Many general education teachers have limited training when working with special education students. In Standard 5, Questions 31 and 33 had respondents answer not confident and somewhat confident more on these two questions. These two questions relate to soliciting information about students from parents and utilizing reflection of students' characteristics, their community, and the school environments to improve and personalize teaching for students. Though the program provided the training to accomplish these skills, graduates may need to set up greater lines of communication with parents with help from the administrators in the schools.

In summary, the Marshall EMS courses successfully increased teacher confidence in mathematical practices, the learning environment, and the impact on student learning after completion of the program. This confidence increase is consistent with findings of evaluations from similar mathematical education specialist programs and should be considered as an indicator of success for mathematical intervention that should be used across the state.

Research Question 3 – Mathematics Leadership Skills

Summary

Research Question 3 was stated as, “What are graduate candidate perceptions of their confidence in their mathematics leadership skills due to their participation in the Elementary Mathematics Specialist Program?” A Chi-Square test for expected frequencies was used to determine participants’ perceived confidence levels concerning Standard 7 Elementary Mathematics Specialist Leadership. For NCTM Standard 6 Professional Knowledge and Skills the Likert scale concerned participant participation in professional development and use of professional resources. Analysis revealed a statistically significant difference between the Likert responses in these two standards. For Standard 7, 80% of the graduates chose confident or very confident for their responses. Standard 6, 33% of the graduates chose often or very often. (Note how this standard shows higher percentage of rarely or sometimes responses.)

High confidence levels or participation levels were shown in the qualitative data. Thematic analysis that was data driven yielded participants’ greater effectiveness in becoming an Elementary Mathematics Specialist leader and professional knowledge. Participants discussed having greater autonomy, “I think the way the program has changed for me, is my school uses me more for guidance on mathematics related questions and being a … I have more autonomy to decide what strategies to use with my students.” They also communicated, “just in general between the cadre and people having a little bit more confidence with math and also with the new program. You know we’re in the Math for Life campaign, I just feel that there has been a lot of things going on recently and it just helped to improve teacher’s confidence and giving them a little more autonomy.” They continued to discuss their part on the county Math for Life team, to be viewed as a math expert helping to create new math initiatives in the county. Graduates also gave feedback on how the program could be improved. Graduates want to feel further empowered to assess their students' mathematical need through testing. One graduate offered, "I would have liked to see more targeted assessments embedded in the program." Ways to improve student success through identifying students' weaknesses and strengths is always welcomed and something the program will take into consideration.

Literature and Discussion

The significance in Standard 7 shows high levels of participant confidence in Elementary Mathematics Specialist Leadership. This confidence could be due to graduates using their leadership skills among their peers and gaining more responsibilities within their counties. The course that provided leadership was CIME 673 Elementary Mathematics Methods and Supervised Field Practicum K-6. This course required professional development for graduates to have regular teacher as leader meetings which encompassed two meetings with teacher colleagues and one with a school administrator such as a principal. These meetings involved assessing success concerns, tools, support, and questions regarding teaching mathematics. The administrator meeting involved successes, challenges, extra-curricular activities related to mathematics, education-based activities, and any questions.

NCTM (2000) describes the importance of EMS professionals working with teachers in this way: "Teacher-leaders can have a significant influence by assisting teachers in building their mathematical and pedagogical knowledge.... Teacher-leaders' support on a day-to-day basis ranging from conversations in the hall to in-classroom coaching to regular grade-level and departmental seminars focused on how students learn mathematics—can be crucial to a teacher's work life." Further, the National Mathematics Advisory Panel (2008) notes the important role of EMS professionals working with students:

> The use of teachers who have specialized knowledge in elementary mathematics teaching could be a practical alternative to increasing all elementary teachers' content knowledge (a problem of huge scale) by focusing the need for expertise on fewer teachers (p.2).

A number of studies describe positive changes in teachers' practice as a result of interacting with an EMS professional including: actively engaging students, emphasizing reasoning and problem-solving over skills-based lessons, using students' work to inform instruction, and effectively planning lessons (Wisconsin Mathematical Council, 2012). Studies also document that as EMS professionals gained experience, they had significant positive impacts on student achievement.

Participant responses and their high levels of confidence in Standard 6 could be attributed to the lack of opportunity in their counties. Each county does not always provide equal opportunity for career advancement, despite having the educational training. The placement of mathematics specialists in elementary schools is not a new practice. In fact, specialized positions to support the departmentalization of elementary schools were first recommended in the 1920s (Fennell, 2011).

> Mathematics specialists at the elementary school level are becoming increasingly important as we acknowledge the complexities of elementary mathematics teaching and learning. But how did this all get started, anyway? Calls for mathematics specialists, mathematics coaches, or elementary mathematics instructional leaders are certainly not new to the mathematics education
> Community (p. 53).

Though positions may not be available in some counties where the graduates live, the program incorporates Standard 6 in the coursework. CIME 673 encourages students through leadership activities with staff and administrators, by looking at all angles of how the environment, structure of the coursework, student weaknesses, possibilities for support, and additional training for staff should be the focus of teacher leaders.

Qualitative data for Standard 7 showed confidence in Elementary Mathematics Specialist Leadership; they were part of a math cadre campaign in their counties. The program offers counties the opportunities to gather a cohort to go through the EMS program. A cohort is a group of students who work through a program curriculum together to achieve an individual certification together. This cohort design was extremely helpful to our graduate participants for collaboration and support. When the program is online, setting up the participants' experiences took place through online forums, collaboration in group projects, and groups of the cohort meeting to discuss assignments. A sound body of literature based on empirical studies now exists to confirm what early adopters of Web-based communications technologies announced a decade ago (Gundawardena & Zittle, 1997), community is important to the success of online learners.

Further, Gibbons and Cobb (2017) identified potential group coaching practices from the research on professional development and teacher learning that included (*a*) doing mathematics, (*b*) analyzing student work, (*c*) analyzing classroom video, and (*d*) rehearsing high-leverage practices. They point out that these practices can serve as a beginning framework, but additional research is needed to understand the usefulness of these practices in group settings. Coaches should have a deep knowledge of instructional practice and theory so they can support teachers in (*a*) assessing their own practice (Gibbons & Cobb, 2016) and (*b*) making connections between theory and practice (Alloway & Jilk, 2010; Sutton, et al. 2011).

McGatha (2017) found support for all areas of EMS training and work stating: "Across all the instructional practice studies, researchers saw improvements (in varying degrees) in teacher instructional practice including increases in teacher questioning; student engagement; and teaching for understanding. Though considerably greater research is required to determine the extent of the benefits for teachers and students the evidence is overwhelmingly supportive of the benefits for having the support of an EMS in elementary school" (p. 75).

In Standard 7, Questions 34, 38, and 41 had respondents answer not confident and somewhat confident more on these three questions. These three questions relate to collaborating with school interdisciplinary teams to create interdependent, relevant learning activities; conducting teacher meetings to discuss critical issues, policy initiatives, and curriculum trends related to math; and, partnering with other school-based professionals to develop an action plan for school improvement. This increase in graduates being less confident on these questions could be based on their job requirements and descriptions.

Standard 6 Questions 42, 43, and 44 had respondents answer rarely or sometimes on these three questions. These three questions relate to conducting math professional development training; participating in math professional development training to improve teaching; and, participating in math professional organizations' and/or use math professional organizations' resources to improve teaching. It should be noted that the demographic data showed for graduates' counties there are no formal Elementary Mathematics Specialist positions available. It may be concluded that the EMS program should provide more information about professional development, give participants more opportunities to create/practice professional development leadership, and provide more information regarding professional mathematics organization.

So what can be done to improve leadership opportunities? Leadership opportunities within the program will be discussed first. The most obvious is to require an internship in EMS during the last semester of the program. By adding an internship, the program ensures the future graduate will be viewed as a mathematics expert and by doing so establishes the need to create EMS positions. In adding the internship, the EMS is viewed as a leader in the school. They assume that role by earning the respect of the other teachers, by being approachable, by continuing to learn, and by using interpersonal skills that ultimately allow them to influence the instructional practice of their peers (Campbell, n.d.). Often, counties will bring outside agencies and individuals to train teachers in mathematics techniques and strategies, spending resources that could be better used by having an EMS.

Second, the program could require leadership activities as assignments in the respective schools the teachers are employed. An example would be to have the teachers observe a teacher in their school classroom when they are working on mathematics content with the students. EMS student teachers could offer technique interventions discussed in the program coursework to the observed teacher and then observe the change in delivery after the intervention takes place.

After reviewing the data, the convergent view is that the two methods are complementary and compatible. Results of the study indicated teachers were confident in their own abilities to learn mathematics with many stating it was their favorite subject in school, and the feedback from the interviews indicated this program did strengthen their skills. The data did show high levels of confidence in teacher abilities to differentiate instruction to their students based on the pre and post questions in the qualitative data. The program did provide confidence to some graduates to act as mathematics leaders within their educational communities, and it did strengthen their own mathematical content in 3-6 grade levels. The program appeared to attract individuals that had strong mathematics skills and not attract those individuals who struggle to teach mathematics based on feedback from the interviews and focus group. Most stated in the interview, "they had either always been strong in mathematics or that mathematics was their favorite subject when they were in school." It is not surprising that individuals did not admit as adults if they were weak in mathematics. The participants also mentioned in the interviews and focus group they were anticipating more strategies for teaching students, not focusing on strengthening their own mathematical skill set. What the participants left the program with was confidence and greater understanding in their own content knowledge and pedagogy to share with their students and colleagues.

The participants commented during the interview and focus group that the program involved a large amount of work. Any program related to mathematics will involve chunks of work to gain better understanding of different approaches to mathematics content, as well as the breakdown of why the problem is designed the way it is and what the answers show. The amount of work also covered multiple areas that helped teachers gain a deeper knowledge of teaching. Often teachers enter the public-school system teaching only a few different grades in the course of a career. This program exposes teachers to different areas of mathematics to show how each lesson continues to build a foundation for students to continue to advance.

Demographics Analysis

Participant demographics were also used as independent variables to examine differences in responses due to these demographics. The demographics used in the analysis included gender, years teaching in the public-school system, grade level taught, whether they worked as an EMS, and if they worked in an elementary or secondary school. For the Kruskal Wallace test how the graduates responded to survey questions was compared to grade level taught. The Kruskal Wallace test indicated slight significance.

Throughout this part of the data analysis, all but one analysis concerning demographics showed no significance in responses. The one that did show significance appeared for Standard 1, Question 5 for the “grade levels taught” demographic. This analysis concerned content knowledge in data analysis and probability and indicated graduates who taught grades 3-5 were more confident in probability than were graduates who were out of the classroom. This significance on Standard 1 Question 5 could be a chance occurrence considering most other questions showed no significance. The overall lack of significance on the Kruskal Wallace could be attributed to there being no difference in confidence due to the amount of work experience or grades levels taught, the participants would respond to each standard similarly.

The Man Whitney was also utilized as part of the analysis. The Mann Whitney compared responses of graduates whether or not they were working as an EMS and whether or not there was an EMS position in their counties. The responses of the graduates showed no difference in confidence levels if they were working as an EMS in their counties nor if there was an EMS position in the county. This lack of significance may be due to the limited positions as EMSs across the state. As more positions are added this may be analysis that may need revisited.

Suggested Program Improvements

Based on feedback from the graduates, online learning may not be for every student. The self-paced nature of online learning and the peer isolation does not always appeal to every learner. Instructors need to be mindful of this and adjust online instruction accordingly. New technology is becoming available to add more online interaction between instructor and those students struggling with the lack of interaction with others. Also, though online learning may not be for all, the program might consider having an introductory class on online learning. Based on the feedback regarding the volume of work required, it is suggested the program provide students with opportunities to work in pairs to collaborate on some activities. Participants also noted the large amount of work required for the program. This program may not be suited for all learners, but will strengthen participants' mathematics skills upon completion.

To provide greater leadership opportunities, it is suggested the program add an observation with feedback activity to the coursework, and provide the students with semester long internship opportunities with public school districts. In addition, administrators of the program may conduct outreach to county Boards of Education to discuss the value of having an EMS position in their counties. This discussion may help to create internship positions that could lead to permanent EMS positions.

Implications

This study will be beneficial to administrators and teachers for strategic planning of changes needed for higher student success rates, staff professional development, and classroom management. The program allows graduates to focus on their own areas of weakness and gain valuable skills that will advance their mathematical teaching careers. The program allows graduates to target areas of concern they have for a student and work with them individually. The graduates also can provide students with supplemental work as the student transitions from one grade to the next to better prepare for what is to come. The graduates can provide in-service trainings to their schools to spearhead new mathematics strategies that will not only help students, but also could raise the overall scores on the mathematics summative assessment. Recognize that change in instruction happens primarily when support relates to teachers' specific classroom instructional needs (Confer, 2006).

A by-product of the program allows teachers greater classroom management during mathematics lessons. Often, students who struggle to learn mathematics may display escape avoidance behavior to remove themselves from the learning environment. Providing activities that focus on the teacher's skills mastered in the program creates meaningful learning lessons that address all students' mathematical needs, thus, creating less down time for managing behavioral interruptions and focusing on lessons. This new technique creates the environment of uncovering new mathematical content, not recovering mathematical content that was not mastered.

Marketing the program to teachers that may not be as strong in mathematics, though could use additional coursework to become confident in their skills would be suggested. There were some participants in the program who were not in the classroom. Focusing the marketing of the program for teachers who would like to improve their mathematics skills, instead of administrators who will disseminate the information to their school would also be suggested.

Recommendations for Further Study

To build on this research, looking at the graduate's classroom mathematical performance on the summative assessment would be beneficial. This is to determine the impact EMSs have on their students' achievement. There is a need to work with school districts to establish EMS positions that can offer incentive for teachers to pursue the EMS certification. More research should be conducted on if having EMS positions available in school districts across the state would provide incentive to draw more applicants to the program.

Another area to research is conducting a pre and post investigation of teachers' mathematical beliefs and classroom teaching practices. Pre and post research would be geared toward uncovering any change in the teacher's perspective on their mathematical beliefs and the change that occurs in their teaching practices. It would be beneficial to look at adding assessment tools into the program for teachers to use as mathematical assessments for determining the child's level of mathematics ability. Assessment tools may empower teachers to feel like they can better target the deficit in mathematics and provide strategies to help the student achieve.

Lastly, placing more strategies into the program content may help teachers, once they have mastered the coursework, see how they could present these strategies to their students. Though there were teaching strategies presented in the program, there may need to be examples of additional strategies. Strategies can be presented using online technology, such as videos of teachers presenting various progressive lessons on mathematics concepts to students. One thing is certain, continued research and development of EMS programs across the country are needed to improve student achievement in mathematics.

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APPENDIX A - IRB APPROVAL LETTERS

MARSHALL UNIVERSITY
www.marshall.edu

Office of Research Integrity
Institutional Review Board
One John Marshall Drive
Huntington, WV 25755

FWA 00002704

IRB1 #00002205
IRB2 #00003206

April 21, 2019

Edna Meisel, Ed.D.
Curriculum and Instruction Department

RE: IRBNet ID# 1426813-1
At: Marshall University Institutional Review Board #2 (Social/Behavioral)

Dear Dr. Meisel:

Protocol Title:	[1426813-1] The Education of Elementary Mathematics Specialists	
Site Location:	MUGC	
Submission Type:	New Project	APPROVED
Review Type:	Expedited Review	

In accordance with 45CFR46.110(a)(6)(7), the above study was granted Expedited approval today by the Marshall University Institutional Review Board #2 (Social/Behavioral) Chair. An annual update will be required on April 21, 2020 for administrative review and approval. The update must include the Annual Update Form and current educational certificates for all investigators involved in the study. All amendments must be submitted for approval by the IRB Chair prior to implementation and a closure request is required upon completion of the study.

This study is for student Lee Ann Vecellio.

If you have any questions, please contact the Marshall University Institutional Review Board #2 (Social/ Behavioral) Coordinator Anna Robinson at (304) 696-2477 or robinsonn1@marshall.edu. Please include your study title and reference number in all correspondence with this office.

Sincerely,

Bruce F. Day

Bruce F. Day, ThD, CIP
Director, Office of Research Integrity

MARSHALL UNIVERSITY
www.marshall.edu

Office of Research Integrity
Institutional Review Board
One John Marshall Drive
Huntington, WV 25755

FWA 00002704

IRB1 #00002205
IRB2 #00003206

June 25, 2019

Edna Meisel, Ed.D.
Curriculum and Instruction Department, MUGC

RE: IRBNet ID# 1426813-2
At: Marshall University Institutional Review Board #2 (Social/Behavioral)

Dear Dr. Meisel:

Protocol Title:	[1426813-2] The Education of Elementary Mathematics Specialists	
Site Location:	MUGC	
Submission Type:	Amendment/Modification	APPROVED
Review Type:	Expedited Review	

The amendment to the above listed study was approved today by the Marshall University Institutional Review Board #2 (Social/Behavioral) Vice-Chair. This amendment is to add a phone interview guide and verbal consent to the study.

This study is for student Lee Ann Vecellio.

If you have any questions, please contact the Marshall University Institutional Review Board #2 (Social/ Behavioral) Coordinator Anna Robinson at (304) 696-2477 or robinsonn1@marshall.edu. Please include your study title and reference number in all correspondence with this office.

Sincerely,

Bruce F. Day

Bruce F. Day, ThD, CIP
Director, Office of Research Integrity

APPENDIX B - IRB APPROVED CONSENT FORMS

1. Online Survey Consent Form:

Anonymous Survey Consent

You are invited to participate in a research project entitled The Education of the Elementary Mathematics Specialist designed to analyze the effectiveness of the Elementary Mathematics Specialist program on the confidence and mathematics content knowledge of its teacher candidates. The study is being conducted by Dr. Edna Meisel and Lee Ann Vecellio, doctoral candidate from Marshall University and has been approved by the Marshall University Institutional Review Board (IRB). This research is being conducted as part of the dissertation requirements for Lee Ann Vecellio; and has been approved by the Marshall University Institutional Review Board (IRB).

This survey is comprised of the Elementary Mathematics Specialist survey that should take participants no longer than 40 minutes to complete. Your replies will be anonymous, so do not type your name anywhere on the form. We hope to have15-20 participants from this group complete the survey. There are no known risks involved with this study. Participation is completely voluntary and there will be no penalty or loss of benefits if you choose to not participate in this research study or to withdraw. If you choose not to participate you can leave the survey site. You may choose to not answer any question by simply leaving it blank. Once you complete the survey you can delete your browsing history for added security. The IP addresses of these individuals will not be recorded. Completing the on-line survey indicates your consent for use of the answers you supply. If you have any questions about the study you may contact Dr. Edna Meisel at 304-746-8983, Lee Ann Vecellio at 304-881-7973.

If you have any questions concerning your rights as a research participant, you may contact the Marshall University Office of Research Integrity at (304) 696-4303.

By completing this survey you are also confirming that you are **18** years of age or older.

Please print this page for your records.

2. In-Person Survey Consent Form:

Anonymous Survey Consent (In-Person)

You are invited to participate in a research project entitled The Education of the Elementary Mathematics Specialist designed to analyze the effectiveness of the Elementary Mathematics Specialist program on the confidence and mathematics content knowledge of its teacher candidates. The study is being conducted by Dr. Edna Meisel and Lee Ann Vecellio, doctoral candidate from Marshall University and has been approved by the Marshall University Institutional Review Board (IRB). This research is being conducted as part of the dissertation requirements for Lee Ann Vecellio and has been approved by the Marshall University Institutional Review Board (IRB).

The In-Person group consists of 40 individuals located in one county in the northern part of West Virginia. Complete the survey and give it to Norma Gains. Mrs. Gains will then give you a paper asking if you would like to participate in a focus group. If you would like to participate write your name, email address, and phone number. Otherwise, you can decline to participate and leave the Center. The survey's will be placed in a separate envelop and mailed back to the principal investigator. The focus group participant information will be placed in a separate envelop and also mailed back to the principle investigator.

Your replies will be anonymous, so do not type your name anywhere on the form. There are no known risks involved with this study. Participation is completely voluntary and there will be no penalty or loss of benefits if you choose to not participate in this research study or to withdraw. If you choose not to participate you may either return the blank survey or you may discard it. You may choose to not answer any question by simply leaving it blank.

Returning the survey to Norma Gaines, Director of Elementary Curriculum, 304.291.9210, indicates your consent for use of the answers you supply.

If you have any questions about the study you may contact Dr. Edna Meisel at 304-746-8983, Lee Ann Vecellio at 304-881-7973.

If you have any questions concerning your rights as a research participant, you may contact the Marshall University Office of Research Integrity at (304) 696-4303.

Please keep this page for your records.

3. Focus Group Consent Form:

Marshall University
Informed Consent to Participate in a Research Study

KEY INFORMATION FOR The Education of the Elementary Mathematics Specialist

You are being invited to take part in a research study about the Marshall University Elementary Mathematics Specialist program.

By doing this study, we hope to learn about the effectiveness of the Elementary Mathematics Specialist program on the confidence and mathematics content knowledge of its teacher candidate graduates. Your participation in this research will be for a focus group that should not last more than 1.5 hours. It will involve asking questions and having discussions about your opinions regarding the program overall effectiveness and coursework.

The purpose of this research is to examine the effectiveness of the Elementary Mathematics Specialist program. on the confidence and mathematics content knowledge of its teacher candidates in order to improve the program.

The most important reason a person may want to volunteer to participate in this study is to reflect on their experiences in the Elementary Mathematics Specialist program. There are minimal risks involved in this study, as others in a focus group interview will hear your opinions of the program. Though the information communicated in this group will not be confidential and others in the group will hear your opinions, it should be reminded that group members could relay information outside of the group discussion to others not involved in the focus group. We are hoping the group will consist of 10-15 participants gathered from the In-Person group surveyed earlier in the month. Your responses will be audio recorded without any names said out loud. Once the responses are transcribed over the next two weeks, the recordings will be deleted. The transcription will be stored in Dr. Edna Meisel's file cabinet in her Marshall University office 100 Angus E. Peyton Drive, South Charleston, WV 25303.

If you decide to take part in the study, it should be because you really want to volunteer. You will not lose any services, benefits or rights you would normally have if you choose not to volunteer.

For questions about the study or in the event of a research-related injury, contact the study investigator, *Dr. Edna Meisel* at *304-746.8983*, *Lee Ann Vecellio* at *304-881-7973*. You should also call the investigator if you have a concern or complaint about the research.

For questions about your rights as a research participant, contact the Marshall University Office of Research Integrity at (304) 696-4303.

You will be given a signed and dated copy of this consent form.

SIGNATURES

You agree to take part in this study and confirm that you are 18 years of age or older. You have had a chance to ask questions about being in this study and have had those questions answered. By signing this consent form you are not giving up any legal rights to which you are entitled.

____

Subject Name (Printed)

____ ________________

Subject Signature Date

____

Person Obtaining Consent (Printed)

____ ________________

Person Obtaining Consent Signature Date

Are There Reasons Why You Would Not Qualify for This Study?

The only reason a person would not qualify for the study is if they did not complete and graduate from the Marshall University Elementary Mathematics Specialist Program.

How Many People Will Take Part In The Study?

About 15 people will take part in this study. A total of 40 subjects are the most that would be able to enter the focus group.

What Is Involved In This Research Study?

The Focus groups will be employed to collect qualitative data. We are hoping the group will consist of 10-15 participants gathered from the In-Person group surveyed earlier in the month. This group will meet at Suncrest Center, 523 Junior Ave., Morgantown, WV 26505. There responses will be audio recorded without any names said out loud. Once the responses are transcribed over the next two weeks, the recordings will be deleted. The transcription will be stored in Dr. Edna Meisel's file cabinet in her Marshall University office 100 Angus E. Peyton Drive, South Charleston, WV 25303.

What about Alternative Procedures?

The focus group could be beneficial to participants because they may find common ground with others in the benefits the program has provided them in their professional careers.

How Long Will You Be In The Study?

You will be in the study for about 12 months.

You can decide to stop participating at any time. If you decide to stop participating in the study we encourage you to talk to the study investigator or study staff as soon as possible.

The study investigator may stop you from taking part in this study at any time if he/she believes it is in your best interest; if you do not follow the study rules; or if the study is stopped.

What Are The Risks Of The Study?

The only risk to participating in the study is the focus group members could relay information outside of the group discussion to others not involved in the focus group.

There are no known risks to those who take part in this study.

Are There Benefits To Taking Part In The Study?

If you agree to take part in this study, there may or may not be direct benefit to you. We hope the information learned from this study will benefit other people in the future. The benefits of participating in this study may be: By participating, themes of strengths and benefits of graduating in the program may be identified by the graduates.

What About Confidentiality?

We will do our best to make sure that your personal information is kept confidential. However, we cannot guarantee absolute confidentiality. Federal law says we must keep your study records private. Nevertheless, under unforeseen and rare circumstances, we may be required by law to allow certain agencies to view your records. Those agencies would include the Marshall University IRB, Office of Research Integrity (ORI) and the federal Office of Human Research Protection (OHRP). This is to make sure that we are protecting your rights and your safety. If we publish the information we learn from this study, you will not be identified by name or in any other way.

<u>What Are The Costs Of Taking Part In This Study?</u>
There are no costs to you for taking part in this study. All the study costs, including any study tests, supplies and procedures related directly to the study, will be paid for by the study.

<u>Will You Be Paid For Participating?</u>
You will receive no payment or other compensation for taking part in this study.

<u>Who Is Sponsoring This Study?</u>
There is no sponsor for this study.

<u>What Are Your Rights As A Research Study Participant?</u>
Taking part in this study is voluntary. You may choose not to take part or you may leave the study at any time. Refusing to participate or leaving the study will not result in any penalty or loss of benefits to which you are entitled. If you decide to stop participating in the study we encourage you to talk to the investigators or study staff first.

4. Telephone Interview Consent Form

Consent to Participate in the Education of the Elementary Mathematics Specialist

Hello, my name is Lee Ann Vecellio. You have been chosen at random to be in a study about the Elementary Mathematics Specialist program. This study involves research. The purpose of this research study is to determine the perceptions of graduates relating to the program. This will take 20 minutes of your time. If you choose to be in the study, I will conduct a phone interview and record our interview and you will be expected to answer 10 questions.

There are no foreseeable risks or benefits to you for participating in this study. There is no cost or payment to you. If you have questions while taking part, please stop me and ask. You will remain anonymous through the deletion of the recording once transcribed, no name will be associated with the transcription. Your participation is confidential. There will be no link to your answers to you once transcribed.

If you have questions about this research study you may call Lee Ann Vecellio at 304-881-7973 and they will answer your questions. If you feel as if you were not treated well during this study, or have questions concerning your rights as a research participant call the Marshall University Office of Research Integrity (ORI) at (304) 696-4303.

Your participation in this research is voluntary, and you will not be penalized or lose benefits if you refuse to participate or decide to stop.

APPENDIX C – SURVEY

Candidate Perceptions of Confidence due to Participation in the Marshall University Elementary Mathematics Specialist Program

Respond to each question concerning your confidence related to the goals of the Elementary Mathematics Specialist Program. Please circle only one answer for each question.

Standard One Content Knowledge

1. My personal knowledge of Number & Operations
Not Confident Somewhat Confident Confident Very Confident

2. My personal knowledge of Algebra
Not Confident Somewhat Confident Confident Very Confident

3. My personal knowledge of Geometry
Not Confident Somewhat Confident Confident Very Confident

4. My personal knowledge of Measurement
Not Confident Somewhat Confident Confident Very Confident

5. My personal knowledge of Data Analysis & Probability.
Not Confident Somewhat Confident Confident Very Confident

6. My personal knowledge of modeling mathematics standards-based instruction.
Not Confident Somewhat Confident Confident Very Confident

Standard Two Mathematical Practices

7. My ability to create interdisciplinary learning experiences to integrate problem-solving techniques with math.
Not Confident Somewhat Confident Confident Very Confident

8. My ability to develop methods that encourage students to approach mathematics problems from different perspectives.
Not Confident Somewhat Confident Confident Very Confident

9. My ability to encourage student reflection.
Not Confident Somewhat Confident Confident Very Confident

10. My ability to help students to link new mathematics information to previously learned material.
Not Confident Somewhat Confident Confident Very Confident

11. My ability to encourage students to be independent learners.
Not Confident Somewhat Confident Confident Very Confident

12. My ability to encourage students to attempt challenging problems.
Not Confident Somewhat Confident Confident Very Confident

13. My ability to evaluate students' thinking using multiple modes of communication.
Not Confident Somewhat Confident Confident Very Confident

Standard Three Content Teaching

14. My ability to teach mathematics instruction appropriate to individual students' stages of development.
Not Confident Somewhat Confident Confident Very Confident

15. My ability to teach mathematics instruction appropriate to individual students' learning styles.
Not Confident Somewhat Confident Confident Very Confident

16. My ability to teach mathematics instruction appropriate to individual students' strengths.
Not Confident Somewhat Confident Confident Very Confident

17. My ability to teach mathematics instruction appropriate to individual students' needs.
Not Confident Somewhat Confident Confident Very Confident

18. My ability to evaluate and use various mathematical teaching strategies, manipulatives, and materials, including technology, to achieve different instructional goals.
Not Confident Somewhat Confident Confident Very Confident

19. My ability to use different active learning opportunities, such as research-based inductive teaching models, direct instruction, collaborative groups, cooperative learning, peer teachings, inquiry, and classroom discussion to promote critical thinking and problem-solving.
Not Confident Somewhat Confident Confident Very Confident

20. My ability to help students identify which active learning opportunities work well for them.
Not Confident Somewhat Confident Confident Very Confident

21. My ability to monitor student learning and adjust strategies accordingly.
Not Confident Somewhat Confident Confident Very Confident

Standard Four Mathematical Learning Environment

22. My ability to assess appropriate services/resources for special needs students.
Not Confident Somewhat Confident Confident Very Confident

23. My ability to create a classroom climate that is a safe and open environment for students and student learning.
Not Confident Somewhat Confident Confident Very Confident

24. My ability to make appropriate provisions for students who use English as a second language.
Not Confident Somewhat Confident Confident Very Confident

25. My ability to create a learning community in which students work collaboratively in a climate of inquiry.
Not Confident Somewhat Confident Confident Very Confident

26. My ability to create a learning community in which students work independently in a climate of inquiry.
Not Confident Somewhat Confident Confident Very Confident

27. My ability to demonstrate sensitivity to cultural and gender differences.
Not Confident Somewhat Confident Confident Very Confident

28. My ability to model effective communication strategies.
Not Confident Somewhat Confident Confident Very Confident

Standard Five Impact on Student Learning

29. My ability to collect student data for analysis and improvement of instruction.
Not Confident Somewhat Confident Confident Very Confident

30. My ability to maintain records of student work and performance in such a manner that student progress can be documented.
Not Confident Somewhat Confident Confident Very Confident

31. My ability to solicit information about students from parents.
Not Confident Somewhat Confident Confident Very Confident

32. My ability to solicit information about students from other colleagues.
Not Confident Somewhat Confident Confident Very Confident

33. My ability to utilize reflection of students' characteristics, their community, and the school environment to improve and personalize teaching for students.
Not Confident Somewhat Confident Confident Very Confident

Standard Seven Elementary Mathematics Specialist Leadership

34. My ability to collaborate with school interdisciplinary teams to create interdependent, relevant learning activities.
Not Confident Somewhat Confident Confident Very Confident

35. My ability to collaborate with colleagues to improve teaching, learning, and the school environment.
Not Confident Somewhat Confident Confident Very Confident

36. My ability to use leadership skills to improve mathematics programs at the school level.
Not Confident Somewhat Confident Confident Very Confident

37. My ability to coach and mentor new and experienced teachers to better serve students.
Not Confident Somewhat Confident Confident Very Confident

38. My ability to conduct teacher meetings to discuss critical issues, policy initiatives, and curriculum trends related to mathematics teaching.
Not Confident Somewhat Confident Confident Very Confident

39. My ability to collaborate with teachers to create a shared vision to improve each student's achievement.
Not Confident Somewhat Confident Confident Very Confident

40. My ability to partner with other school-based professionals to create a shared vision to improve each student's achievement.
Not Confident Somewhat Confident Confident Very Confident

41. My ability to partner with other school-based professionals to develop an action plan for school improvement.
Not Confident Somewhat Confident Confident Very Confident

DEMOGRAPHICS

What is your gender?
___Male ____Female _____N/A

How long have you been working in the public school system?
____1-5 years ____6-10 years
____11-15 years ____16-20 years
____21-25 years ____More than 25 years

Grade level where you are currently teaching?
___K ___1st ___2nd
___3rd ___4th ____5th ____6th

In what school level do you teach?
___Elementary
___Middle School

Does your school district have a specific position for an Elementary Mathematics Specialist?
___ Yes
___ No

Has your school identified and utilized you as an Elementary Mathematics Specialist?
___ Yes
___ No

Standard Six Professional Knowledge and Skills

42. I conduct mathematics professional development training to improve teaching.
Rarely Sometimes Often Very Often

43. I participate in mathematics professional development training to improve teaching.
Rarely Sometimes Often Very Often

44. I participate in mathematics professional organizations and/or use mathematics professional organization resources to improve teaching.
Rarely Sometimes Often Very Often

APPENDIX D - FOCUS GROUP AND TELEPHONE INTERVIEW GUIDE

FOCUS GROUP AND PHONE INTERVIEW GUIDE FOR ELEMENTARY MATHEMATICS SPECIALIST

1. After experiencing the Elementary Mathematics Specialist program, discuss how your teaching fosters deep mathematical understanding among your students.
2. After experiencing the Elementary Mathematics Specialist program, discuss your confidence in organizing a school-wide training for staff development in mathematics.
3. After experiencing the Elementary Mathematics Specialist program, discuss your confidence in organizing a district-wide training for staff development in mathematics.
4. After experiencing the Elementary Mathematics Specialist program, discuss your confidence in teaching mathematics to all grade levels K-6.
5. After experiencing the Elementary Mathematics Specialist program, discuss your confidence in organizing information sessions for parents concerning K-6 mathematics instruction? For example, during parent-teacher conferences.
6. Discuss your experience since you have completed the Elementary Mathematics Specialist program, how your district gives you greater autonomy in teaching mathematics.
7. Prior to the completion of Elementary Mathematics Specialist program what obstacles did you face in covering the mathematics curriculum in the allotted time to teach mathematics each day?

OPEN ENDED QUESTIONS

Prior to the completion of Elementary Mathematics Specialist program, describe your gaps in personal knowledge and understanding of elementary mathematics?
What was it about your experiences in the Elementary Mathematics Specialist program that makes you feel stronger in math teaching and personal confidence?
How did the Elementary Mathematics Specialist program offer you in-depth knowledge of both teaching and content, and the relationships between them?
What do you consider the programs strengths? Weaknesses?

APPENDIX E - MANN-WHITNEY U DATA ANALYSIS

EMS Position (N=21)				
Standard 1				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes(n=2)	No(n=19)		
1	10.25	11.08	20.5	.857
2	13.75	10.71	13.5	.533
3	14.25	10.66	12.5	.467
4	10.25	11.08	20.50	.857
5	13.00	10.79	15.00	.686
6	9.00	11.21	23.00	.686

* Significance attained at $p<0.05$

EMS Position (N=21)				
Standard 2				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes (n=2)	No (=19)		
7	7.50	11.37	26.00	.467
8	13.25	10.76	14.50	.610
9	15.50	10.53	10.00	.343
10	14.00	10.68	13.00	.533
11	13.75	10.71	13.50	.533
12	9.50	11.16	22.00	.771
13	10.50	11.05	20.00	1.000

* Significance attained at $p<0.05$

EMS Position (N=21)				
Standard 3				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes	No		
14	14.25	10.66	12.50	.467
15	14.25	10.66	12.50	.467
16	10.50	11.05	20.00	1.000
17	14.50	10.63	12.00	.467
18	9.00	11.21	23.00	.686
19	10.50	11.05	20.00	1.000
20	11.50	10.95	18.00	.952
21	10.50	11.05	20.00	1.000

* Significance attained at $p<0.05$

EMS Position (N=21)				
Standard 4				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes	No		
22	8.75	11.24	23.50	.610
23	12.50	10.84	16.00	.771
24	8.00	11.32	25.00	.533
25	14.00	10.68	13.00	.533
26	14.25	10.66	12.50	.467
27	14.00	10.68	13.00	.533
28	13.25	10.76	14.50	.610

* Significance attained at p<0.05

EMS Position (N=21)				
Standard 5				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes	No		
29	8.00	11.32	25.00	.533
30	13.25	10.76	14.50	.610
31	11.00	11.00	19.00	1.000
32	9.00	11.21	23.00	.686
33	11.50	10.95	18.00	.952

* Significance attained at p<0.05

EMS Position (N=21)				
Standard 6				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes	No		
42	9.25	11.18	22.50	.686
43	12.50	10.84	16.00	.771
44	10.75	11.03	19.50	1.000

* Significance attained at p<0.05

EMS Position (N=21)				
Standard 7				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes	No		
34	7.25	11.39	26.50	.400
35	13.25	10.76	14.50	.610
36	14.50	10.63	12.00	.467
37	10.50	11.05	20.00	1.000
38	13.50	10.74	14.00	.610
39	1350	10.74	14.00	.610
40	10.50	11.05	20.00	1.000
41	12.50	10.84	16.00	.771

* Significance attained at p<0.05

Working as EMS (N=21)				
Standard 1				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes (n=5)	No (n=16)		
1	9.20	11.56	49.0	.495
2	8.10	11.91	54.50	.240
3	10.00	11.31	45.00	.719
4	8.60	11.75	52.00	.354
5	9.20	11.56	49.00	.495
6	10.80	11.06	41.00	1.000

* Significance attained at p<0.05

Working as EMS (N=21)				
Standard 2				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes (n=5)	No (n=16)		
7	10.20	11.25	44.00	.780
8	9.00	11.62	50.00	.445
9	11.50	10.84	37.50	.842
10	9.50	11.47	47.50	.548
11	9.00	11.62	50.00	.445
12	9.50	11.47	47.50	.548
13	8.90	11.66	50.50	.398

* Significance attained at p<0.05

Working as EMS (N=21)				
Standard 3				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes (n=5)	No (n=16)		
14	9.20	11.56	49.00	.495
15	10.00	11.31	45.00	.719
16	10.50	11.16	42.50	.842
17	9.00	11.62	50.00	.445
18	10.90	11.03	40.50	1.000
19	8.10	11.91	54.50	.240
20	8.60	11.75	52.00	.354
21	10.50	11.16	42.50	.842

* Significance attained at p<0.05

Working as EMS (N=21)				
Standard 4				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes (n=5)	No (n=16)		
22	7.90	11.97	55.50	.208
23	7.50	12.09	57.50	.153
24	8.40	11.81	53.00	.313
25	9.50	11.47	47.50	.548
26	9.50	11.47	47.50	.548
27	10.00	11.31	45.00	.719
28	8.00	11.94	55.00	.240

* Significance attained at $p<0.05$

Working as EMS (N=21)				
Standard 5				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes (n=5)	No (n=16)		
29	10.00	11.31	45.00	.719
30	10.40	11.19	43.00	.842
31	11.20	10.94	39.00	.968
32	12.80	10.44	31.00	.495
33	13.10	10.34	29.50	.398

* Significance attained at $p<0.05$

Working as EMS (N=21)				
Standard 6				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes (n=5)	No (n=16)		
42	10.20	11.25	44.00	.780
43	11.70	10.78	36.50	.780
44	9.50	11.47	47.50	.548

* Significance attained at $p<0.05$

Working as EMS (N=21)				
Standard 7				
	Mean Ranks		Mann Whitney U	P value attained
Question	Yes (n=5)	No (n=16)		
34	10.70	11.09	41.50	.905
35	10.40	11.19	43.00	.842
36	8.50	11.78	52.50	.313
37	10.50	11.16	42.50	.842
38	11.70	10.78	36.50	.780
39	9.00	11.62	50.00	.445
40	10.50	11.16	42.50	.842
41	10.90	11.03	40.50	1.000

* Significance attained at $p<0.05$

APPENDIX F - KRUSKAL-WALLIS DATA ANALYSIS

Grade Level Taught (N=21)					
Standard 1					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	K-2	3-5	Out of Classroom		
1	11.56	11.56	9.20	.750	.687
2	11.81	12.69	7.00	3.302	.192
3	10.25	13.19	8.70	2.172	.338
4	10.81	11.75	10.10	.262	.877
5	10.62	14.88	5.40	9.756	.008
6	9.25	14.62	8.00	5.544	.063

* Significance attained at p<0.05

Grade Level Taught (N=21)					
Standard 2					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	K-2	3-5	Out of Classroom		
7	9.75	12.88	10.00	1.584	.453
8	10.56	13.25	8.10	2.536	.281
9	9.31	14.50	8.10	5.321	.070
10	8.75	12.88	11.60	2.319	.314
11	10.44	13.75	7.50	4.361	.113
12	9.69	14.25	7.90	5.501	.064
13	9.62	13.69	8.90	3.103	.212

* Significance attained at p<0.05

Grade Level Taught (N=21)					
Standard 3					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	K-2	3-5	Out of Classroom		
14	9.56	14.25	8.10	4.147	.126
15	11.31	12.12	8.70	1.172	.557
16	10.62	12.62	9.00	1.381	.501
17	11.62	12.50	7.60	2.392	.302
18	9.25	13.75	9.40	3.432	.180
19	11.81	10.88	9.90	.376	.829
20	10.81	13.75	6.90	4.544	.103
21	9.50	12.75	10.60	1.617	.445

* Significance attained at p<0.05

Grade Level Taught (N=21)					
Standard 4					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	K-2	3-5	Out of Classroom		
22	10.25	11.56	11.30	.234	.890
23	10.44	12.50	9.50	1.087	.581
24	11.44	10.31	11.40	.191	.909
25	9.81	12.00	11.30	.648	.723
26	9.69	12.06	11.40	.888	.642
27	11.06	10.38	11.90	.213	.899
28	11.94	10.62	10.10	.517	.772

* Significance attained at $p<0.05$

Grade Level Taught (N=21)					
Standard 5					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	K-2	3-5	Out of Classroom		
29	8.38	13.00	12.00	3.290	.193
30	9.94	12.44	10.40	.914	.633
31	8.88	11.00	14.40	3.228	.199
32	9.19	12.56	11.40	1.634	.442
33	10.19	11.50	11.50	.277	.871

* Significance attained at $p<0.05$

Grade Level Taught (N=21)					
Standard 6					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	K-2	3-5	Out of Classroom		
42	10.00	10.12	14.00	1.913	.384
43	9.38	11.81	12.30	1.065	.587
44	8.25	11.31	14.90	4.066	.131

* Significance attained at $p<0.05$

Grade Level Taught (N=21)					
Standard 7					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	K-2	3-5	Out of Classroom		
34	12.12	10.06	10.70	.510	.775
35	12.31	10.88	9.10	1.067	.587
36	10.38	12.25	10.00	.714	.700
37	9.56	11.69	12.20	.895	.639
38	8.56	13.00	11.70	2.692	.260
39	11.38	11.56	9.50	.472	.790
40	11.56	11.75	8.90	1.083	.582
41	9.81	12.25	10.90	.717	.699

* Significance attained at $p<0.05$

Years of teaching experience (N=21)					
Standard 1					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	1-5 years (n=1)	6-15 years (n=10)	Greater than 15 years (n=10)		
1	5.00	10.25	12.35	2.1	.348
2	9.50	12.20	9.50	.846	.655
3	10.00	11.05	11.05	.033	.984
4	9.50	10.10	12.05	.633	.729
5	13.00	10.90	10.90	.147	.929
6	9.00	11.90	10.30	.540	.764

* Significance attained at $p<0.05$

Years of teaching experience (N=21)					
Standard 2					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	1-5 years (n=1)	6-15 years (n=10)	Greater than 15 years (n=10)		
7	12.00	10.90	11.00	.038	.981
8	17.50	11.75	9.60	2.035	.361
9	11.50	10.60	11.35	.100	.951
10	9.50	12.20	9.95	.911	.634
11	18.50	10.15	11.10	2.231	.328
12	19.00	10.60	10.60	2.526	.283
13	10.50	12.25	9.80	.989	.610

* Significance attained at $p<0.05$

Years of teaching experience (N=21)					
Standard 3					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	1-5 years (n=1)	6-15 years (n=10)	Greater than 15 years (n=10)		
14	10.50	10.80	11.25	.037	.982
15	10.00	12.65	9.45	1.639	.441
16	10.50	13.10	8.95	2.823	.244
17	10.50	12.20	9.85	.845	.656
18	9.00	12.05	10.15	.781	.677
19	9.50	11.70	10.45	.334	.846
20	12.00	10.20	11.70	.386	.825
21	10.50	12.35	9.70	1.321	.517

* Significance attained at $p<0.05$

Years of teaching experience (N=21)					
Standard 4					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	1-5 years (n=1)	6-15 years (n=10)	Greater than 15 years (n=10)		
22	4.50	12.70	9.95	2.566	.277
23	17.50	11.50	9.85	1.982	.371
24	8.00	12.85	9.45	2.097	.351
25	18.50	12.20	9.05	3.569	.168
26	19.00	11.40	9.80	3.008	.222
27	3.50	12.55	10.20	2.561	.278
28	8.00	12.20	10.10	1.333	.513

* Significance attained at $p<0.05$

Years of teaching experience (N=21)					
Standard 5					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	1-5 years (n=1)	6-15 years (n=10)	Greater than 15 years (n=10)		
29	8.00	11.00	11.30	.354	.838
30	2.00	10.40	12.50	3.576	.167
31	1.50	12.70	10.25	4.288	.117
32	9.00	12.80	9.40	2.174	.337
33	3.50	12.30	10.45	2.469	.291

* Significance attained at $p<0.05$

Years of teaching experience (N=21)					
Standard 6					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	1-5 years (n=1)	6-15 years (n=10)	Greater than 15 years (n=10)		
42	14.00	11.50	10.20	.579	.749
43	5.50	10.85	11.70	1.081	.582
44	8.50	11.85	10.40	.506	.777

* Significance attained at p<0.05

Years of teaching experience (N=21)					
Standard 7					
	Mean Ranks			Kruskal-Wallis	P value attained
Question	1-5 years (n=1)	6-15 years (n=10)	Greater than 15 years (n=10)		
34	4.00	12.10	10.60	1.817	.403
35	8.50	11.35	10.90	.253	.881
36	10.00	11.95	10.15	.597	.742
37	10.50	13.15	8.90	2.946	.229
38	13.50	13.30	8.45	4.078	.130
39	18.00	12.60	8.70	4.038	.133
40	10.50	13.20	8.85	3.534	.171
41	12.50	13.80	8.05	5.043	.080

* Significance attained at p<0.05

APPENDIX G - SUMMARY OF ELEMENTARY MATHEMATICS SPECIALIST PROGRAM

Course Content and Syllabi Descriptions

CIME 500 Mathematics for Elementary Teachers I: This is the first mathematics course in a series of content courses for elementary teachers that starts with more familiar concrete problems and transition the students to complex, novel and abstract problems. Very important tools such as number sense, pattern making, estimation, working backward and multiple representations of problems are integrated with an emphasis on mathematical practices. Mathematics pedagogy for teaching course concepts is also emphasized. Candidates examine several inductive teaching models and prepare lesson plans and activities based on the inductive models. Candidates plan lessons appropriate for child, or pre-adolescents, or adolescents based on activities and topics that are of interest to elementary students. The lesson plan integrates mathematics content with other content areas for a more realistic approach to how students learn in everyday life. The lesson plan uses research-based information concerning inductive teaching models that are student-oriented for inquiry and/or discovery approaches to teaching and uses research-based information concerning the integration of content areas for teaching mathematics content with other content areas for a more realistic approach to how students learn in everyday life. Candidates present lesson plans that include consideration of Gardner's Multiple Intelligences to differentiate teaching according to students' strengths and interests. This course includes a study of place value, comparing numbers, arithmetic operations, number theory, applications of math, and historical development of number systems in cultures. The course also includes an introduction to integration of mathematical practices, content pedagogy, the mathematical learning environment, impact on student learning, and professional knowledge and skills. The curriculum of this course is developed under the guidance of the standards of the National Council of Teachers of Mathematics (NCTM) Elementary Mathematics Specialist Standard 1 Content Knowledge and Standard 2 Mathematical Practices, and the International Society for Technology in Education (ISTE). Goals for this course are to deliver the content objectives and methods needed by prospective teachers for mathematics instruction for students in elementary grades. Emphasis will be on communication, expression, and problem-solving from a mathematical perspective. Activities and assignments include the following:

1. Examination of one's own philosophy of education.
2. Exploration of the history of mathematical concepts; digital poster for the elementary classroom of a mathematical concept.
3. Place value; creating a place value activity for the elementary classroom.
4. Comparing numbers; exploring and critiquing the effectiveness of on-line activities for comparing numbers for the elementary classroom.
5. Teaching arithmetic operations; creating a social growth activity involving arithmetic operations for the elementary classroom including Vygotsky social learning theory and zone of proximal development.

6. Examination of objective domains (cognitive, psychomotor, and affective); examination of state mathematics objectives; creation of "I Am Learning About…" statements based on objectives for elementary mathematics.
7. Inductive teaching methods (teaching models where students make generalizations from specifics); creation of lesson plan based on inductive teaching models.

CIME 501 Mathematics for Elementary Teachers II: This mathematics course is a course for elementary teachers that start with more familiar concrete problems and transition the students to complex, novel and abstract problems involving fractions, decimals, and percent. Very important tools such as number sense, pattern making, estimation, working backward and multiple representations of problems are integrated with an emphasis on mathematical practices. Mathematics pedagogy for teaching course concepts is also emphasized. Topics include: Arithmetic operations (addition, subtraction, multiplication, and division) of fractions and decimals, with emphasis on ratios and proportions with regards to percentages, and historical development of number systems in cultures. This course also includes an integration of mathematical practices, content pedagogy, the mathematical learning environment, impact on student learning, and professional knowledge and skills. The curriculum of this course is developed under the guidance of the standards of the National Council of Teachers of Mathematics (NCTM) Elementary Mathematics Specialist Standard 1 Content Knowledge and Standard 2 Mathematical Practices, and the International Society for Technology in Education (ISTE). Goals for this course are to deliver the content objectives and methods needed by prospective teachers for mathematics instruction for students in elementary grades. Emphasis will be on communication, expression, and problem-solving from a mathematical perspective. Activities and assignments include the following:
1. Fractions as parts of a whole; vocabulary of fractions
2. Equivalent fractions and fractions on the number line; exploration of online fraction game for the elementary classroom; vocabulary of fractions.
3. Addition and Subtraction of fractions; creating concrete visuals for adding and subtracting fractions for the elementary classroom; exploring and critiquing fraction tool on the graphing calculator to add and subtract fractions; vocabulary of adding and subtracting fractions.
4. Multiplying fractions; using and creating grids to concretely demonstrate fraction multiplications; exploring and critiquing fraction tool on the graphing calculator to multiply fractions; vocabulary of multiplying fractions.
5. Dividing fractions; exploration of what division represents (partitive or measurement); exploration of the process "invert and multiply;" using and creating concrete visuals of division of fractions; exploring and critiquing fraction tool on the graphing calculator to divide fractions; vocabulary of dividing fractions.
6. Fractions to decimals exploration (noting patterns, repitend, etc); number systems and fractions as rational numbers; fraction vocabulary and summary of types of fractions; Age of Trees activity that calculates age of trees using fractions.
7. Incorporates the *Connected Mathematics* series and *Mathematical Excursions* texts problems containing problem solving of real-world connections to mathematical concepts.

CIME 555 Technical Mathematics for Mathematics Educators: This course includes the study of specialized mathematical knowledge for teaching; an in-depth analysis of the foundations of mathematics: numbers and operations, ratio and proportion, and numbering systems; geometry applications; and linear, pie, and bar graphs, probability and statistical analysis using mean, median, mode, and range, with an emphasis on workplace applications and mathematical tools. Candidates are instructed in the use of several technology tools that include the TI-73 or TI83 Graphing calculator and the Microsoft Excel spreadsheet program, Internet resources such as online protractor, online isometric drawing tool to create 3-D figure drawings, and digital journaling tool through assignments and projects. Assignments also include the study of NCTM standards and dispositions such as the use of graphing calculators in the mathematics classroom through electronic journal articles. Candidates use journaling to reflect on their mathematics learning. Candidates study the contributions of mathematics in art such as creations by M. C. Escher. The curriculum of this course is developed under the guidance of the standards of the National Council of Teachers of Mathematics (NCTM) Elementary Mathematics Specialist Standards, NCTM Middle School Standards, and the International Society for Technology in Education (ISTE). Goals for this course are to deliver the content objectives and methods needed by prospective teachers for mathematics instruction for students in elementary grades. Emphasis will be on communication, expression, and problem-solving from a mathematical perspective. Activities and assignments include the following:

1. Exploration of NCTM position statements on calculator use and teaching mathematics in the elementary classroom.
2. Percent and relationship of percent to fractions and decimals; Summer Daze activity where time spent on daily activities data is collected and analyzed as fraction of a day, decimal, and percent, and then displayed as a pie graph (including data represented as angles as proper percent of a circle).
3. Comparing and scaling; construct scale drawings; interpret and apply concepts of ratio, proportion, and percent in real-world context; calculate with appropriate accuracy according to the problem being solved;
draw conclusions from information contained in simple diagrams, flowcharts, paths, circuits, networks, or algorithms; use inductive or deductive reasoning to solve problems; read and analyze data presented in various forms such as charts and tables from real-world contexts; draw conclusions from data in real world contexts.
4. Geometry concepts; protractor use; identify angles (acute, obtuse, right) and their parts; recognize and label rays, lines, and segments and demonstrate knowledge of their properties; measure angles; create angles of certain measures; apply properties of tiling and tessellations; use of online tessellation tool; exploration of M. C. Escher designs.
5. Area and perimeter; use measuring instruments such as rulers, protractors, and scales; solve problems involving measurement in both metric and traditional systems; compute perimeter and area; compute surface area and volume of simple geometric figures; solve problems using the properties of squares and rectangles; create a method to estimate the area of a region; measure and/or state the dimensions of a given drawing; relate technical drawings to a drawing of an object; measurement in real-world context.

6. Variables and patterns; solve simple problems involving rates and speed; use estimation and test reasonableness of results; work with algebraic expressions and formulas; begin to understand the connection between mathematical models and the situations they can represent in real-world contexts; translate verbal expressions and relationships into algebraic expressions; provide and interpret geometric representations of numeric and algebraic concepts; read and analyze data presented in various forms such as charts and tables and graphs such as box-and-whisker plots; draw conclusions from data in real-world contexts.
7. Linear functions; identify whether a graph in a plane is that of a function; identify other characteristics of a function; given an equation, understand the relationship between the equation and its graph; determine the graphical properties of a linear equation.
8. Perform and analyze data collected from a coin flip experiment; analyze data using mode, median, mean, bar graph, box-and-whisker plots, and probability.
9. Incorporates the *Connected Mathematics* series and *Mathematical Excursions* texts problems containing problem solving of real-world connections to mathematical concepts.

CIME 650 Algebra for Mathematics Educators: This course includes the study of specialized mathematical knowledge for teaching with an in-depth study of topics typically found in a college algebra course, integer arithmetic, linear regression techniques, and scatter plots. Candidates are instructed in the use of technology for mathematics through assignments that require the use of the TI-73 or TI83 Graphing calculator. Candidates are also required to read and reflect on articles originating from NCTM concerning issues related to the teaching of Algebra in the K-12 classroom. Candidates use journaling to reflect on mathematics learning. Candidates examine the history of Algebra through the study of prominent mathematicians and the origins of Algebra vocabulary. The curriculum of this course is developed under the guidance of the standards of the National Council of Teachers of Mathematics (NCTM) Elementary Mathematics Specialist Standards, NCTM Middle School Standards, and the International Society for Technology in Education (ISTE). Goals for this course are to deliver the content objectives and methods needed by prospective teachers for mathematics instruction for students in elementary grades. Emphasis will be on communication, expression, and problem-solving from a mathematical perspective. Activities and assignments include the following:
1. Exploration of the history of algebra concepts.
2. Integer arithmetic; use and creation of concrete visuals using chip boards to demonstrate integer arithmetic; develop strategies for adding, subtracting, multiplying, and dividing integers; determine whether one integer is greater than, less than, or equal to another integer; represent integers on a number line; model situations with integers; use integers to solve problems in real-world contexts; explore the use of integers in real-world applications; compare integers using the symbols =, >, and <; understand that an integer and its inverse are called opposites; rewrite expressions using the distributive property; use the order of operations to solve expressions involving integers
3. Mathematical models; develop skills in collecting data from experiments and systematically recording data in tables; construct coordinate graphs to represent data; make predictions from data tables or graph models;

use patterns in data to find equations that model relationships between variables; use tables, graphs, and equations to model linear and nonlinear relationships between variables; distinguish between linear and nonlinear relationships; identify inverse relationships and describe their characteristics; use a graphing calculator to find and study graph models and equation models of relationships between variables; use intuitive ideas about rates of change to sketch graphs for, and to match graphs to given situations, in real world-contexts.
4. Solving linear equations; build understanding of the conventional order of operation rules in the context of practical problems; evaluate expressions by applying the rules of order of operations; write symbolic sentences that communicate their reasoning; develop tools for manipulating symbolic expressions in ways that are both connected to and independent from tabular, graphical, and contextualized reasoning; recognize applications of the distributive and commutative properties; recognize and interpret equivalent expressions;
judge the equivalency of two or more expressions by examining the underlying reasoning and the related tables and graphs; apply the properties for manipulating expressions to solving linear equations; create algebraic expressions that model real-world contexts.
5. Quadratic functions; make connections among coordinates, slope, distance, and area; develop an awareness of quadratic relationships and how they can be recognized from patterns in tables, graphs, and equations; describe patterns in tables of quadratic functions and predict subsequent entries; recognize the characteristic shape of the graph of a quadratic function and identify its line of symmetry, vertex, and intercepts; detect quadratic relationships from the pattern of differences in tables; match quadratic equations to patterns in tables and graphs; find the maximum and minimum values of quadratic functions from tables and graphs; develop an understanding of equivalent expressions, that is, of two expressions that model the same relationship; recognize a quadratic function from an equation written as a product of two linear factors or in expanded form as $y = ax^2 + bx + c$; recognize that the same equation can model more than one situation; predict from tables, graphs, and equations whether quadratic functions have a maximum or minimum values; interpret maximum and minimum points and intercepts in projectile-motion problems; develop a deeper sense of the properties that characterize quadratic relationships by comparing quadratic relationships to linear relationships.
6. Exponential functions; represents, recognize and use tables, graphs, and equations to solve problems involving exponential growth and decay; describe the effects of varying the values of a and b in the exponential equation on the graph of that equation.
7. Incorporates the *Connected Mathematics* series and *Mathematical Excursions* texts problems containing problem solving of real-world connections to mathematical concepts.

CIME 658 Geometry for Mathematics Educators: This course includes the study of specialized mathematical knowledge for teaching; angle relationships, parallel and perpendicular lines, quadrilaterals, circles, polygons, solids, triangles, and elementary trigonometry. Candidates are instructed in the use of technology for mathematics through assignments that require the use of the Geometer’s Sketchpad software. Candidates explore the origins and histories of geometry concepts. Candidates explore science and mathematics content integration through a moon journal project. Consider geometry in advertising through dilation projects and drawing regular polygons and using these for advertising poster. Candidates investigate the history of geometry through the study of solid figures, axiomatic systems and proofs, and origins of geometry vocabulary and concepts. The curriculum of this course is developed under the guidance of the standards of the National Council of Teachers of Mathematics (NCTM) Elementary Mathematics Specialist Standards, NCTM Middle School Standards, and the International Society for Technology in Education (ISTE). Goals for this course are to deliver the content objectives and methods needed by prospective teachers for mathematics instruction for students in elementary grades. Emphasis will be on communication, expression, and problem-solving from a mathematical perspective. Activities and assignments include the following:

1. Exploration and use of *Geometer's Sketchpad* to explore geometry concepts and how this program can be used in the elementary classroom.
2. Foundations of Geometry; exploration of axioms, postulates, and theory; inductive and deductive reasoning
3. Triangles; use relationships such as congruency and similarity to solve problems involving two-dimensional figures; solve problems using the relationships among the parts of triangles, such as sides, angles, medians, midpoints, and altitudes; apply the Pythagorean Theorem to solve problems; Measuring Tall Objects activity using right triangle properties.
4. Quadrilaterals and Polygons; solve problems involving perimeter of quadrilaterals; solve problems involving area of quadrilaterals; solving quadrilateral problems in real-world contexts; solve problems that involve measurement in both the metric and traditional systems; compute perimeter and area of triangles, quadrilaterals, and regions that are combinations of these; solve area and perimeter problems of special polygons.
5. Circles; solve problems that involve measurement in both the metric and traditional systems; solve problems involving angles, arcs, chords, secants, and tangents of circles; compute perimeter and area of triangles, quadrilaterals, circles, and regions that are combinations of these; solve circle problems in real-world contexts.
6. Moon Observation Journal; construction and measurement of angles depicting the Earth-Moon-Sun configuration to explain moon phases; collection of moon observation data.
7. Basic construction techniques using a compass and straight edge; constructing regular polygons using construction techniques
8. Dilation techniques; creating illustrations using dilation techniques.
9. Analytical geometry techniques; distance and mid-point formulas
10. Incorporates the *Mathematical Excursions* text problems containing problem solving of real-world connections to mathematical concepts.

CIME 673 Elementary Mathematics Methods and Supervised Field Experience, K-6: This is the practicum culmination course that provides a setting for candidates to examine research- based elementary math methods and leadership, and a supervised practicum teaching experience in an educational field-based environment. In the practicum experience, candidates also demonstrate problem solving skills as well as help students use problem solving attain mathematical content knowledge and skills. Teacher candidates work with the MU College of Education program coordinator for the Elementary Mathematics Specialist Program to locate the school in which to perform the practicum, receive approval from the appropriate administrator of the schools, and choose the School Based Professional. The West Virginia

Department of Education (WVDE) requires that this placement be in an inclusive, regular education, elementary classroom located in a state public school, in any of Grades K-6. The Practicum Candidate is required to participate in the practicum for a total of 75 hours throughout the semester. These hours can be accomplished through activities such as: planning for teaching, teaching, reflection, action research in this classroom, classroom observation, discussions with the School Based Professional, grading student assignments, assisting the School Based Professional during class instruction, tutoring students in math, and other activities in direct contact with the students of the practicum classroom. Also hours can be spent in other school activities such as: observing other math teachers in the school, participating in overall school events that involve math (i.e. Math Field day), conferences with parents of the practicum math students, etc. Projects and assessments include: Lesson Planning, Teaching, and Reflection - these projects address the EMS professional's need of deep and broad understanding of mathematical content, including the specialized knowledge needed for teaching, and the planning, teaching, and reflection of lessons for students. Candidates plan, teach, and reflect on lesson plans that incorporate research-based information concerning inductive teaching models that are student-oriented for inquiry and/or discovery approaches to teaching and incorporate research-based information concerning the integration of content areas for teaching mathematics content with other content areas for a more realistic approach to how students learn in everyday life. Candidates present lesson plans that include consideration of Gardner's Multiple Intelligences to differentiate teaching according to students' strengths and interests.

Teacher as Leader-this project addresses the EMS professional's need to have knowledge and skills for working with colleagues; and the need to develop leadership skills necessary to influence and support educational efforts from the school and community to improve the teaching and learning of mathematics.

Action Research of Student Learning Project-in the practicum setting, an examination of student learning is performed using student data and statistical analysis.

APPENDIX H - VITAE

Lee Ann Vecellio Vitae

PROFESSIONAL PROFILE:

- **Related Experience:** Skilled in working directly with students, parents, teachers, and administrators to improve student outcomes. A solid background in advising; recruitment and retention, assessment, counseling, intervention and prevention. Specializing in working with at-risk youth.
- **Communications / Presentations:** Skilled listener who asks appropriate questions, gives full attention to views of others, and conveys information effectively. Assisted in presenting in-service training to all school psychologists and school counselors for Kanawha County. Trained teachers and support staff in proper testing procedures.
- **Written Communications / Record Keeping:** Experienced with compiling reports and maintaining accurate files and reports in written or electronic formats; understand importance of maintaining confidentiality of records. Skilled writer as speech writer in State Legislature; wrote press releases, contributed articles to legislative newsletter, and prepared array of materials for use in legislative process.
- **Strong Organizational Skills:** Accustomed to maintaining accurate records for large numbers of students in multiple schools and departments. Well-developed ability to maintain calendar in order to provide needed services while remaining flexible in order to address emergency situations when necessary.

Education:

Dec 2019 Doctorate of Education/ Curriculum and Instruction (EdD), Marshall University Graduate College, Charleston, West Virginia (anticipated graduation)

May 2010 Master of Arts / Education Specialist in School Psychology (EdS), Marshall University Graduate College, Charleston, West Virginia

August 2001 Master of Arts/ Educational Psychology (MA), West Virginia University, Morgantown, West Virginia

Dec 1996 Bachelor of Arts/ Psychology (BA), West Virginia University, Morgantown, West Virginia

CERTIFICATIONS

Certified School Psychologist – West Virginia Department of Education Certificate #6878

Nationally Certified School Psychologist - National Association of School Psychologists #44930

Professional Experience

July 2016 – Present CABELL COUNTY SCHOOLS, Huntington, West Virginia

School Psychologist
Provided in-service trainings for school staff and support staff. Provided technical assistance and monitoring to Student Assistance Teams (SAT); Maintained all school-based data and data files for accuracy within the SAT process through the various programs: STAR Learning, WVEIS, Attendance records, and others; Conducted psycho-educational ssessments, complete all required reports, and meet confidentiality requirements in maintaining case reports; Consulted with parents on the evaluation and eligibility process for special education.; Developed Behavior Intervention Plans, Functional Behavioral; Conducted Psychological assessments, participated in manifestation determinations, and employed Applied Behavioral Analysis techniques. Provided a variety of behavioral and instructional strategies to effectively teach students of varying ability levels; Provide individual and group therapy with K-12 students, including those in the Alternative Learning Center; and, Participated in eligibility committee meetings, re-evaluation planning, and other meetings relating to the psychological needs of students.

August 2015 – June 2016 **GILMER COUNTY SCHOOLS,** Glenville, West Virginia

School Psychologist
Provided technical assistance and monitoring to Student Assistance Teams (SAT); Maintained all school-based data and data files for accuracy within the SAT process through the various programs: STAR Learning, WVEIS, WVDE Early Warning System, Attendance records, and others; Conducted psycho-educational assessments, complete all required reports, and meet confidentiality requirements in maintaining case reports; Consulted with parents on the evaluation and eligibility process for special education.**;** Developed Behavior Intervention Plans, Functional Behavioral; Conducted Psychological assessments, participated in manifestation determinations, and employed Applied Behavioral Analysis techniques. Provided a variety of behavioral and instructional strategies to effectively teach students of varying ability levels; Provide individual and group therapy with K-12 students, including those in the Alternative Learning Center; and, participated in eligibility committee meetings, re-evaluation planning, and other meetings relating to the psychological needs of students.

September 2013-June 2015 **RESA IIV,** Clarksburg, WV

School Psychologist Marion/Gilmer Counties
Conducted psycho-educational assessments, completed all required reports, and meet confidentiality requirements in maintaining case reports; Consulted with parents on the evaluation and eligibility process for special education.**;** Conducted Psychological assessments, Provided a variety of behavioral and instructional strategies to effectively teach students of varying ability levels; Provided individual and group therapy with K-12 students, including those in the Alternative Learning Center.; Participated in eligibility committee meetings, re-evaluation planning, and other meetings relating to the psychological needs of students; and, Conducted qualifying testing from Birth-To-Three into Marion County Schools.

January 2011 – August 2013 **RALEIGH COUNTY SCHOOL DISTRICT**, Beckley, West Virginia

Short-Term/Long-Term Substitute Teacher
Hired to serve in fill-in role for high school / middle school classes in order to provide continuity of instruction in absence of regularly assigned teacher, Title I teacher, and Reading Specialists. Charged with creating lesson plans, facilitating the learning process through classroom discussion and activities, maintaining classroom control and providing meaningful instruction during assignment. Provide feedback to regular teacher and school administration staff.

February 2007 – September 2008 **CAMC HEALTH EDUCATION RESEARCH INSTITUTE**, Charleston, West Virginia

Research Monitoring and Accreditation Coordinator
Updated policies and guidelines for Research and Grants Administration. Coordinated all meetings for Institutional Scientific Review Board (ISRB). Provided support for Institutional Review Board (IRB).

<u>ACADEMIC EXPERIENCE</u>

May 2006 – February 2007 **School of Dentistry WEST VIRGINIA UNIVERSITY**, Morgantown, WV

Program Specialist
Under a grant funded program (which concluded during tenure), recruited prospective students for School of Dentistry and maintained procurement information. Compiled conference materials and conducted presentations at conferences detailing program offerings.

January 2000 – September 2000 **Undergraduate Advising Center** WEST VIRGINIA UNIVERSITY, Morgantown, WV
Academic Advisor
Guided undergraduate students in selecting major course of study and in preparing semester schedules; assigned classes required by specific programs, and approved each schedule for program requirements. Counseling students and academic workshops.

May 1999 – December 1999 **Department of Community Medicine Office of Health Service Search,** WEST VIRGINIA UNIVERSITY, Morgantown, WV
Research Assistant
Tracked progress of medical students completing rural medical rotations in eight different disciplines. Assisted with completion of Rural Health Education Partnership Annual report.

WEST VIRGINIA LEGISLATIVE AUDITOR'S OFFICE, Charleston, West Virginia

July 2003 – April 2006 **Public Information Specialist**
Wrote articles for legislative newsletter on matters of public interest. Drafted speeches for legislators, wrote press releases, and compiled media advisories and other materials concerning legislative activities for public consumption.

November 2001 – July 2003 **Research Analyst**
Conducted performance evaluations of state agencies, boards, and commissions for Joint Committee on Government Operations. Also conducted research on special topics as requested by Legislature and/or mandated by separate legislation.

COURSES TAUGHT

- Statistics
- Business Writing

EDUCATIONAL PUBLICATION

DISSERTATION: THE EDUCATION OF THE ELEMENTARY MATH SPECIALIST: A PROGRAM EVALUATION
THESIS: FACTORS CONTRIBUTING TO COLLEGE FRESHMEN PLACED ON ACADEMIC PROBATION

PROFESSIONAL PUBLICATION & PRESENTATIONS

Campbell, E., Davidson, L, & Vecellio, L. (Spring 2018). From Hell to Hope: A Collaborative Women's Writing Project. Presented at the Appalachian Studies Association Conference

Meisel, E., Shrewsbury, J., & Vecellio, L. (Spring 2018). Elementary Mathematics Specialist Program. Presented at the Association of Teacher Educators Conference

Shoemaker, M. & Vecellio, L. (Fall 2016). Retention vs. Promotion. Presented at the Southern Regional Council on Education Administration Conference

Powell, M., & Vecellio, L. (Fall 2008). 90-minute reading block. Psych Perspectives. West Virginia School Psychology Association

PROFESSIONAL AFFILIATIONS

National Association of School Psychologists (NASP) – 2008 – Present

West Virginia School Psychology Association (WVSPA) – 2010 – Present