Mathematics Instruction In Pre-Service Undergraduate Programs
In The State of Maine

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MATHEMATICS INSTRUCTION IN PRE-SERVICE UNDERGRADUATE PROGRAMS

IN THE STATE OF MAINE

By

Jessica Cefalo Osich

A DISSERTATION

Presented to the Affiliated Faculty

Of the College of Graduate and Professional Studies at the University of New England

In Partial Fulfillment of Requirements

For the degree of Doctor of Education

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2018
Abstract

The purpose of this study was to investigate elementary pre-service teacher preparation in mathematics offered in undergraduate education programs in the state of Maine. The research questions were: How many mathematics courses are undergraduate programs requiring pre-service teachers to take for their baccalaureate education? Within the courses that are required, how many are mathematical content courses, and how many are mathematical pedagogical courses? How does a knowledgeable informant characterize the quality of elementary pre-service teacher preparation in mathematics at their institutions? And, how do faculty evaluate student-teacher competence in math preparation? The conceptual framework was based on three core ideas: pre-service teacher preparation programs, mathematical content knowledge and teacher quality. Data was collected through an online data collection process and indepth phone interviews with representatives from eight colleges and universities in the state of Maine. Analysis of each college’s preparation programs showed that mathematics is a key component in teacher preparation. However, findings indicate the following:

Participants noted that many of their programs required more credits than the state of Maine requires pre-service teachers to take. Maine colleges provide structured expectations and at least a B-average in their education courses to provide rigor for their pre-service teachers. Passing Praxis I is normally required before the students reach their sophomore year in the program, and the passing of Praxis II needs to occur before students start their student-teaching senior year. While Praxis exams present an academic roadblock, their use has raised the level of
mathematics preparation. The Teacher Education Alliance of Maine (TEAMe) was developed by math educators to share and strengthen practices of preparing teachers in higher learning (Department of Maine, 2017). Most programs use of school-wide rubrics to provide consistency in their grading systems. Classroom-based observations provide a final opportunity to review student teacher content knowledge.

Informants expressed concerns about and opportunities for the addition of more mathematics courses into programs and their goals to provide strong foundational knowledge for pre-service teachers. Implications from this research are the following: Although the state has established rather low standards for mathematical preparation, many colleges and universities require more than that minimum. While the schools have a unique way of presenting their curriculum and courses, overall the schools’ purposes are aligned. Program leaders should continue adding to their mathematics curriculum to manage the many mathematical needs for their future teachers while still targeting requirements of the Praxis I test.

*Keywords:* Maine, pre-service teachers, preparation programs, mathematical content knowledge, teacher quality.
University of New England

Doctor of Education
Educational Leadership

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I’d like to acknowledge my parents, who instilled a need for educational excellence in me from the very beginning; who always ensured me that a top education would be my greatest tool and could never be taken away from me, and for being exceptionally more proud of me, then I could ever be for myself.

Also, I’d like to acknowledge my husband. For when he achieved his lifelong dream on July 3, 2015, it inspired me to go out and do exactly the same thing.
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Participants

College of the Atlantic
Husson University
University of Maine, Farmington
University of Maine, Fort Kent
University of Maine
University of Maine, Presque Isle
University of New England
University of Southern Maine

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Chapter I: Introduction

Teacher proficiency is the single greatest factor determining the quality in a child’s formal education (Bertram, 2014). In the past, top graduates from universities entered the teaching profession; in fact, “90% of new American teachers in the early to mid-20th century came from the upper third of their graduating classes. Through the 2010’s, the percentage is just 23%” (Bertram, 2014, p. 29). Some researchers suggest that improving teacher quality would directly influence student achievement.

Stanford economist, Eric Hanushek, recommended that if school districts replaced the lowest performing teachers in the U.S. with average performing teachers, student achievement would not only increase, but would rise to a Top 10 ranking among other countries (Bertram, 2014). Hanushek (2011) found that the teacher quality in American schools is vital, as there is not another influence as important in determining student achievement. This study sought to explore how undergraduate programs utilize mathematics in pre-service teaching programs, and if such programs were placing an emphasis on increasing a teacher’s mathematical content knowledge.

The chapter begins with a discussion regarding the background of teacher preparation programs and the absence of mathematics in many programs across the U.S.. The statement of the problem, purpose of the study, and research questions that guide the focus of the study follow. Possible assumptions, and definitions of key terminology conclude the chapter.

Background and Context

The measure of teacher quality comes from institutions and colleges that provide teacher preparation programs. In 2016, the National Council on Teacher Quality (NCTQ) conducted a landscape review in teacher preparation at undergraduate schools across the U.S. They
examined 875 elementary teacher preparation programs including 396 public schools and 479 private schools. Although NCTQ found that progress had been made since their earlier 2014 study, many programs were still a long way from raising standards in both the teaching of elementary mathematics and STEM-related fields (Putman & Lubell, 2016). The NCTQ rated each school with a letter grade, with the criteria of requiring specialized mathematics coursework for pre-service teachers and providing candidates with consistent exposure to essential elementary-level topics and standards. Only 13% of the schools tested received an A rating or higher, with only 1% receiving an A+. However, a surprising 37% of schools received an F rating for providing no elementary math courses at all in their teacher preparation programs. Future elementary teachers need to be challenged with college-level mathematical comprehension of advanced topics (Putman & Lubell, 2016). If their understandings are strong, their explanations will assist students in not just memorizing formulas and algorithms, but in truly understanding the concepts of mathematics.

**Statement of Problem**

College teacher preparation programs are not providing pre-service teachers sufficient amounts of mathematics practice. Teachers are not being prepared sufficiently for teaching mathematics education in the elementary classroom (Matthews, Rech, & Grandgenett, 2010). Researchers have pointed out that the expertise of mathematic educators is nested in different roles they play: learning mathematics as a student, learning to teach mathematics as a teacher, learning to teach mathematics teachers as a teacher preparatron educator, and learning to teach mathematics teacher educators as a mentor (Yang, Hsu, Lin, Chen, & Cheng, 2015). Being a strong math student is an essential part of being an effective math educator. Not having an opportunity to develop current mathematic strategies and tools can lessen the expertise of young
professionals. Part of the problem rests in teacher education programs are not training teachers thoroughly to teach mathematics at an enriching level. The problem not only rests in the lack of formal math preparation at the college level, but also the type of math classes being required, or even offered, for teachers in training to take.

**Purpose of Study**

The purpose of this study was to investigate one aspect of the quality of pre-service education programs for elementary teachers. The researcher focused on documenting current math requirements at all Maine teacher preparation programs. One measure of quality teacher preparation was evident in the amount and type of mathematics courses required during the teacher in training baccalaureate education and their major preparation (Leitzel, 1991; Harris & Sass, 2011). Documentation of program requirements at all Maine colleges offering elementary teaching credential preparation was the first stage of the study. According to The Conference Board of the Mathematic Sciences and the American Mathematical Society, prospective elementary school teachers should be required to take 12 semester hours on fundamental elementary mathematics from a teacher’s perspective (Greenberg, Walsh, McKee, A., & National Council on Teacher Quality, 2015; Leitzel, 1991). The second stage of the research addressed teacher educators’ perspectives on math preparation for elementary pre-service teachers. Administrators of college undergraduate programs specializing in elementary education were interviewed to document their perceptions on both the quantity and quality of math courses required for those seeking to become teachers.

Approximately 16 undergraduate programs were to be evaluated to assess their strengths in math preparation for teachers. The study sites were major colleges and universities in the state of Maine. The Maine Department of Education (MDE) acknowledged that 16 of the state’s 20
bachelor’s degree programs are “approved educator preparation programs” (MDE, 2015). A list of these approved programs are listed in Appendix A. The criteria for these schools included in this study were being a four-year collegiate institution with an education major or minor that leads to teacher certification.

Research Questions

Teachers need stronger formalized mathematical preparation. Such preparation can occur in college during teacher preparation and in professional environments. Some research suggests pre-service baccalaureate programs are not providing sufficient mathematics practice for student-teachers who are working toward an Elementary Education Certification. This researcher sought to answer the following questions:

RQ1: How many mathematics courses are undergraduate programs requiring pre-service teachers to take for their baccalaureate education? Within the courses that are required, how many are mathematical content courses, and how many are mathematical pedagogical courses?

RQ2: How does a knowledgeable informant characterize the quality of elementary pre-service teacher preparation in mathematics at their institutions?

RQ3: How do faculty evaluate student-teacher competence in math preparation?

Research Approach

With the authorization of the institutional review board, the researcher planned to document the education major curriculum requirements for each undergraduate program chosen for the study. The National Council of Teacher Quality (NCTQ) produces a National Teacher Preparation Yearbook every two years since 2009. This yearbook evaluates thousands of undergraduate programs in the U.S. to determine strengths and weaknesses of their teacher
preparation programs. The state of Maine has received overall grades each year for their teacher preparation as follows: 2009 F, 2011 D-, 2013 C-, 2015 C-, and 2017 D. However, when it comes to the elementary teacher preparation in mathematics, the state of Maine has met its goals the past two evaluations (2015 and 2017). The researcher approached this study with the NCTQ’s research as a guideline to understand how Maine colleges continue to meet their goals in preparing their pre-service teachers.

**Conceptual Framework**

The study was guided largely by theories of how teachers learn mathematical content knowledge through their collegiate teacher preparation programs. For the purpose of this study, mathematical content knowledge refers to a substantive and syntactic education, which suggests teachers have a strong conceptual idea of the specific subject matter (Jaworski & Gellert, 2003). Collegiate teacher preparation programs refer to the required baccalaureate classes and major-specific classes for pre-service teachers to take during their undergraduate educations before certification.

The focus of this study was based on research conducted by the American Mathematical Society in the 17th volume of their research, The Mathematical Education of Teachers II (American Mathematical Society, 2013). The study recommended that teachers ought to have a strong understanding of not only elementary mathematics, but early childhood and middle school mathematics as well, to further enhance their students’ educations. Along with the fundamentals of mathematics, teachers need to connect the mathematics for students to what they have learned in the past, to what they will learn in the future (Greenberg et al., 2015). This recommendation stems from the need for institutions of higher education to produce high-quality math educators by providing a stronger pre-service foundation from which they can build skills.
Assumptions

Assumptions are pre-existing situations researchers must accept, but which they cannot verify due to limited statistical support (Nkwake, 2013). Establishing the assumptions allows the researcher to focus on a specific dimension of a problem and then to facilitate and conduct the study (Simon & Goes, 2013). Three assumptions were made during this study. First, collegiate mathematics courses affect a pre-service teacher’s ability to teach mathematics. It is not confirmed that more mathematics courses taken in college result in a direct increase in mathematics content knowledge for pre-service elementary educators. Second, many teachers feel unprepared and uncomfortable teaching mathematics to their students (Gerstenschlager & Tassell, 2017). The overall anxiety and helplessness many of those teachers feel regarding mathematics is possibly related to reported levels of decreased self-efficacy within their mathematical content knowledge (Gerstenschlager & Tassell, 2017). Nonetheless, the amount of mathematics courses those teachers have completed will influence their foundational knowledge base in number sense and basic mathematical equating.

Lastly, mathematics anxiety has been documented in pre-service teachers, contracted teachers and many other university students (Malinsky, Ross, Pannells, McJunkin, 2006). However, pre-service teachers have the weakest attitudes towards mathematics, more so than the general college population (Gresham, 2006). Mathematical anxiety has been tied to poor academic performance of students as well as to the effectiveness of elementary school teachers (Malinsky, et al., 2006). Gresham (2006) suggests that many of these teachers are going into the profession with severe anxiety about the subject before they even start teaching it. Researchers have found that a teacher’s anxiety and distress from teaching mathematics can easily be
transmitted onto the students they are teaching by unintentionally passing on negative feelings and attitudes about mathematics (Gresham, 2006).

Studies have shown that too many students in America have modest levels of mathematics knowledge and an even lower level of conceptual knowledge (Bertram, 2014; Vinson, 2001). However, pre-service teachers are in the highest percentage of students having mathematics anxiety (Gresham, 2006). Gresham (2006) suggests that a likely solution for this problem could lie in how teachers are prepared. Understanding how these teachers were taught, and how they are currently teaching, can inform and lead to improvement in the field.

**Rationale**

The rationale for this study stemmed from a conversation overheard early in the researcher’s master’s degree studies. Several pre-service teachers were discussing their desire to only teach 2nd grade and lower, because they were anxious about teaching math to students in any grade higher than that. Many researchers have strived to uncover ways to change this attitude in young teachers. Thus, the common denominator in these prospective teachers’ academics began to emerge: a lack of both providing a foundational understanding of mathematics and a mitigation of their anxieties toward the subject.

As a professional educator, the researcher was able to serve on the mathematics coaching board at my school. There, she was in charge of providing professional development regarding the math curriculum for 4th and 5th grade teachers. Although many were years away from having achieved their undergraduate education, the same mentality was prevalent. Many of these teachers openly admitted that they spend hours each night reviewing the math content for the next day’s lesson. Some even suggested that their day would be much easier if someone else could teach their math class. However, what came up multiple times, but was not surprise to the
researcher, was the number of teachers who admitted getting nervous that their students were going to ask them a math question that they could not answer. So not only are many of these teachers insecure in their knowledge of mathematics, many of them have severe math anxiety, adding another limitation to their teaching.

Increasing the quantity of mathematics courses in pre-service education programs may discourage certain individuals from entering the teaching profession due to math insecurity; however, it might reduce those observed conversations regarding teacher anxiety and student achievement. Experiencing more mathematics in undergraduate education programs may result in teachers becoming more confident in their own teaching and more willing to naturally include math enrichment into their daily lessons.

**Definition of Terms**

*Highly-Qualified Teacher:* was described as “three or more years’ experience, full certification and a college major in an educational subject area (Hanushek, 2011).

*Content Math Course:* An undergraduate course that offers fundamental and foundational mathematical knowledge and practice for pre-service teachers.

*Mathematical Content Knowledge (MCK):* A comprehensive understanding of mathematics which has breadth, depth, connectedness, and thoroughness (Liping, 1999).

*Pedagogical Math Course:* An undergraduate course that is designed to teach teachers how to teach mathematics to students.

*Practicum:* Education classes under an “Education Major” in undergraduate schools, including in-classroom student-teaching

*Pre-Service Teachers:* are candidates working within a teacher education program (Even & Ball, 2009).
**Professional Development:** A wide variety of specialized training, formal education, and advance learning intended to help teachers and educators to improve professional knowledge, competence, and skill (Gulamhussein, 2013).

**Proficiency:** A high degree of competence, skill, or expertise.

**Prospective Teachers:** Are individuals who have decided that they would like to become teachers and have begun the process of acquiring prerequisite knowledge and/or experiences to be accepted into a teacher education program (Even & Ball, 2009).

**Substantive Knowledge:** Referring to the explanatory structures or paradigms of a subject-matter field (Rollnick & Mavhunga, 2016).

**Syntactic Knowledge:** Referring to the facts and concepts of a subject-matter field (Rollnick & Mavhunga, 2016).

**Summary**

Learning to teach mathematics, especially for teachers at the pre-service level, can be an intimidating task. It requires balance between theoretical and practical knowledge, a diverse skill set of foundational mathematics, as well as a thorough knowledge of math and its pedagogy (Even & Ball, 2009). This preparation and knowledge is part of a continuum of experiences that contribute to the process of learning to teach (National Research Council, 1996). When teachers learn mathematics, they improve their understanding of the content they teach, while at the same time develop subject knowledge for math levels beyond that which they instruct (Rubenstein, 2015). In order to acquire competency and knowledge in the education profession, schools, colleges, and departments of education ought to maintain high admission standards and effective instruction to all pre-service teachers, potentially creating a supportive environment for teachers-in-training to develop their skills.
Chapter II: Review of the Literature

Through American educational settings, concern regarding students’ mathematics achievement has grown (Ball, Hill, & Bass, 2005; Kitsantas, Cheema, & Ware, 2010). Although the use of strong standards and quality curriculum is imperative in raising students’ mathematical achievement, the depth and quality of mathematics instruction is contingent upon the subject matter knowledge of the teachers (Ball et al., 2005). The Mathematical Association of America found that adequate preparation for teachers to be weakest portion of the nation’s system of mathematics education (Hungerford, 1994; Conference Board of Mathematical Sciences, 2012). Hanushek (2011) noted “the quality of the teachers in our schools is paramount; no other measured aspect of schools is nearly as important in determining student achievement” (p. 40). Teacher quality reflects undergraduate preparation programs and content courses to a great degree.

Matthews et al. (2010) studied a random sampling of 48 higher education teaching programs and discovered that only 14 colleges or universities required a general mathematics course during their teacher preparation programs with no specific connection to elementary mathematics. Furthermore, they identified that grooming teachers to successfully teach math “is one of the most urgent problems facing those who wish to improve student learning” (Matthews et al., 2010, p. 1). Moreover, the National Council on Teacher Quality (NCTQ), discovered that teacher preparation programs in the U.S. had many inconsistencies regarding the required mathematics content for pre-service teachers (Greenberg & Walsh, 2008). Improving the overall training and course content in schools and colleges of education will strengthen the teacher candidates for the future (Hanushek, 2011). Ultimately, through robust preparation programs
and content-focused professional development, student achievement will see improvements due to a better quality and superior knowledge of the teachers.

**Historical Perspective**

When elementary teaching emerged in the U.S., it began as a job, rather than a profession (Altenbaugh & Underwood, 1990; Borrowman, 1965). Men normally started off in teaching before assuming their long-term careers as white-collar workers. Women might have taught before moving onto marriage and housekeeping (Holmes Group, 2007). The nature of the job attracted talented part-timers and bright workers who were just passing through to another phase of life. The quality of preparation required in teaching was so weak that it did little to encourage individuals to make a serious commitment to teaching (Holmes Group, 2007). As mass education began to grow and more children were being schooled on a daily basis, standards were set in place to strengthen teacher quality, however the amount and degree of difficulty of preparation remained low (Altenbaugh & Underwood, 1990; Borrowman, 1965; Tyack, 1967).

In 1986, Lee Shulman, a researcher from Stanford University, presented an address on knowledge growth in teaching. Shulman (1986) described that, dating back decades, teachers had been tested on their competencies in elementary subject knowledge and pedagogical skills in order to be licensed to teach. As far back as 1875, Shulman reported an examination for school teachers which covered subject matter questions, including those in both written and mental arithmetic (Shulman, 1986). Shulman’s investigations showed that, during the educational curriculum changes in the 1980s, many states began shifting what teachers needed to know in order to be licensed and tenured. However, these examinations merely tested basic abilities to read, write, and calculate, which were not sufficient as prerequisites for teaching elementary
school (Shulman, 1986). Shulman argued that there was a need for more stringent requirements when preparing teachers to be suitable educators for elementary school students.

**Pre-Service Preparation Programs**

Educational research about elementary school mathematics teaching and learning and about the preparation and continuing education of teachers, are both critical components in the improvement of mathematics teacher proficiencies. There is an increasingly comprehensive body of research about the teaching and learning of mathematics (Dževad, Minela, & Dina, 2017; Grouws, 2009; Satsope, Kwena, & Kgaladi, 2016; Tella, 2013), as well as about the preparation and development of teachers of mathematics (National Research Council, 1996; Mrayyan, 2016; Yopp, Ellis, Bonsangue, Duarte, & Meza, 2014). Teacher preparation programs differ substantially depending on whether they are for the generalist teacher in the elementary school, or for the specialists in middle and secondary schools (National Research Council, 1996). This is partly due to the organization of schools and universities, and partly due to the structure of state-level educator certification programs.

Undergraduate pre-service programs are expected to provide teachers a broad, yet solid education, comprised of a substantial understanding of each subject they plan to instruct (Carnegie Foundation for the Advancement of Teaching, 2008). However, the U.S. mathematics curriculum for upcoming teachers is often fragmented and does not provide pre-service teachers with a foundational knowledge of mathematics (Liping, 1999; Livy, Vale, & Herbert, 2016). Mathematical college courses for teachers should model and represent the actual curriculum and pedagogy that teachers need to instruct their students.

The *Second International Handbook of Mathematics Education* suggests that elementary teachers tend to lack certain mathematical sophistication which, if engaged in the classroom,
would transform a student’s learning beyond memorization and procedure toward an in depth understanding of the concepts of Math (Cooney & Wiegel, 2003). This literature advocates that teacher training should promote the idea that teachers “see the mathematics that is in the minds of their students by first exploring the mathematics in their own minds” (Cooney & Wiegel, 2003, p. 799). Ball (2002) explained that, for teachers-in-training, learning a foundational and broad knowledge of mathematics is the goal. A major concern with such teachers is that when they learned the mathematics themselves during their compulsory education, it was often with little “connective tissue” (Ball, 2002, p. 7), or true meaning, leading to a disconnect when attempting to teach the material.

In 2004, the National Council of Teachers of Mathematics released a yearbook discussing the enhancements of mathematical understanding of prospective teachers. The yearbook described in depth of the courses being taken during undergraduate studies. These courses, as described in the handbook, are not challenging pre-service teachers to apply mathematics from their K-12 education background. Thus, new teachers need to make mathematical connections on their own in order to relay strategies to their students, so they can make those same connections. Although teachers are required to take the mathematics courses assigned within the education major, such courses, along with the associated work, tend to be aimed at a lower academic level due to the average academic levels of most students in the programs (Steiner & Rozen, 2004, p. 224). Pre-service learning at the undergraduate level must be coordinated, in both a practical and theoretical sense, with teachers’ initiation into their upcoming profession, as well as with their continuing education.

In 2007, The Holmes Group, a collection of education deans and academic officials from major research universities in each of the 50 states, came together and discussed student
performance and teacher quality. They concluded that the performance of the nation’s students would not improve if the quality of the teachers did not rise; and that the quality of the teachers would not rise unless there were dramatic improvements in teacher education (Holmes Group, 2007). Together, the group devised goals in order to see progress in their study. Three of the goals were:

1. To make the education of teachers intellectually more solid. To demand a greater command of academic subjects.
   a. Sharply revise the undergrad curriculum.
      i. Methods courses need to be replaced with subject-matter specific studies.
      ii. Focus more on teachers’ learning, not teaching student learning.
   b. Organize academic course requirements and courses so that students can gain a sense of the intellectual structure and boundaries of their discipline. (If teachers are to know a subject so that they can teach it well, they need to be taught it well.)
   c. Schools and departments of education need to devise coherent programs that will support the advanced studies for a solid professional education.

2. To recognize differences in teachers’ knowledge, skill and commitment in their education, certification, and work. (Distinguish between novice and distinguished members of the profession.)

3. To create standards of entry to the profession--examinations and education requirements that are professionally relevant and intellectually defensible.
The group’s overall goal was to regain rigor within an intellectually weak profession (Holmes Group, 2007). “Tomorrow’s Teachers,” a report performed by The Holmes Group stated:

The undergraduate education major must be abolished in our universities. For
Elementary Education teachers, this degree has too often become a substitute for learning
any academic subject deeply enough to teach it well. These teachers are certified to teach
all things to all children. But few of them known much about anything because they are
required to know a little of everything. (p. 18)

American educational schools have set such low expectations for admissions to their
programs that admission is almost guaranteed (Greenberg & Walsh, 2008). Furthermore, once
accepted, these teachers in training find that the mathematics content courses are not demanding
or challenging, and consequently provide little rigor for pre-service teachers (Greenberg &
Walsh, 2008). Ball, Lubienski, and Mewborn (2001) added findings that undergraduate
education programs often have inadequate effects on teachers’ mathematics skills, while
furthermore, not having a lasting influence. Many of the students admitted to undergraduate
elementary education programs have insubstantial mathematical skills combined with high levels
of math anxiety, neither of which provokes their universities to challenge these teachers-in-
training to have even slightly more stringent mathematical requirements placed upon them
(Hungerford, 1994). Hungerford (1994) stated that the mathematical preparation of elementary
school teachers is the perhaps “the weakest link in our nations’ entire education system” (p. 13).

Elementary educators, as “accomplished early childhood generalists” (Even & Ball,
2009, p. 14) are more committed to the holistic education of the child, but less committed to
particular content areas, such as mathematics, specialties which might deter those teachers from
pursuing a career in secondary education and specific subject-matter learning (National Research
Council, 1996). Because of this situation, pre-service preparation programs are crowded with many generalist courses and allow very little time for mathematics (National Research Council, 1996). When mathematics classes are offered within an education major they tend to be focused on the teachers in general, for example “Geometry for Educators,” or “Number Sense for Teachers” (National Research Council, 1996). This approach teaches the content at an elementary level, while also modeling instructional methods that are appropriate for the classroom. It does not, in fact, help teachers understand the mathematics or enlighten their mathematical inquiry and practice (National Research Council, 1996).

**Praxis Test.** In the state of Maine, teacher candidates who want to become certified teachers must take the Praxis exams. The Praxis I test, also known as the Pre-Professional Skills Test, must be taken prior to entering an educator preparation program. This test consists of the core academic skills for educators and principles of learning and teaching test, as well as the multiple subject tests which include reading, math, social studies and science (Educational Testing Service, 2018).

As of May 2018, the state of Maine expects a passing score of 157 on the Elementary Education Mathematics subtest. Of the 23 states that require this test, 21 require a passing score of 157, while Alabama requires a 143 and South Dakota requires a 146 (Educational Testing Service, 2018). Before the pre-service teacher starts their student-teaching, they need to pass the Praxis II which tests content knowledge and pedagogy.

**Mathematical Content Knowledge**

Mathematical content knowledge (MCK) is having a thorough understanding of mathematics while possessing a computational fluency and quantitative literacy (Hine, 2015). Evidence shows that there is a clear relationship between teachers’ MCK and their ability to
instruct successfully in the classroom (Hine, 2015). Teachers must not only know the content, but they must be able to explain why the content is important, and how it relates to previous and upcoming concepts that students will learn (Shirvani, 2015). A teacher’s subject matter knowledge (SMK) requires both a substantive and syntactic knowledge base, meaning that teachers need knowledge both of math and about math (Brown & Borko, 1992). In addition, teachers need to know how to teach both these kinds of SMK effectively (Anderson & Clark, 2012). See Figure 1, which displays domains of mathematical knowledge for teaching, subject matter knowledge and pedagogical content knowledge.

![Domains of Mathematical Knowledge for Teaching](image)

Figure 1. Domains of Mathematical Knowledge for Teaching (Ball, Thames, & Phelps, 2008).

Because of some teachers inhibited confidence and attitudes with their own mathematical content knowledge, they take comfort by opting to teach a younger grade level, where the math demands are less challenging (Goulding, Rowland, & Barber, 2002; Association of Mathematics Teacher Educators, 2017). Goulding et al. (2002) also found that this deficiency may cause
According to Liping, teachers should have “PUFM,” or “a profound understanding of fundamental mathematics” (1999). This would include an awareness of the conceptual organization and basic attitudes of mathematics, and the ability to disseminate those concepts to their students. During her studies, Liping (1999) focused on the preparation differences between Chinese and American pre-service teachers. What she discovered was that 85% of the pre-service Chinese teachers could create a conceptually compelling math story problem for their students, while only 4% of the US teachers could do the same. Liping revealed that low-quality teacher knowledge in the U.S. is a result of teachers not acquiring mathematical competency during their own elementary and secondary education years (1999).

Bambico (2003) researched that teachers are the primary change agents in the classroom with various types of learners present. It is the teacher’s duty to continuously update and enhance their mathematical content knowledge and skills (Bloom, 2010). If teachers are not suited to teach mathematics properly, students will not be prepared to learn mathematics. Bambico (2003) further states that if teachers’ content knowledge is poor, their classroom practice would be limited to lectures taken directly from texts and not from true content knowledge. When lectures are not original, students run the risk of not being engaged in the lesson, which may then be reflected in a lack of understanding of the content (Bambico, 2003).

Ball et al. (2001) discuss the necessity for teachers to have strong mathematical knowledge. Without this knowledge, teachers suffer from an insufficient amount of resources that are necessary for them to be successful at work. This fact alone suggests that the potential weaknesses seen in the U.S. elementary education programs stem from the U.S. teachers’ lack of
content knowledge of mathematics (Ball et al., 2001) Developing new curriculum materials, endorsing new programs, and teaching new content all depend on the knowledge of the classroom teacher and the overall attitude he/she has regarding mathematics. One challenge however, is that there is no consensus about, or general guidelines for what mathematical knowledge is required to teach at the generalist level of an elementary teacher. Studies over the past 15 years have revealed that the mathematics knowledge base of many teachers is “dismaying thin” (Ball et al., 2005). Ball et al. (2005) recommend that teachers be required to study and receive more mathematics, whether it be by adding additional coursework to college programs, or rejuvenating preparation programs to be solely subject-matter focused.

**Scholarly Significance**

Undergraduate education is the foundational block of academic preparation to become an elementary school teacher, as there is little or no post-graduate work necessary in most states to qualify in this profession. Because of this limited formal preparation, undergraduate programs need to make sure they are fulfilling all the requirements that will ensure each teacher graduates with the skills and confidence required for effective teaching. This includes a stronger mathematical foundation provided during core knowledge classes.

While many pre-service teachers have strengths in reading and language arts, almost half of elementary teachers do not have strong math backgrounds (Hine, 2015). Teachers who instruct children in mathematics must have the background necessary to tender challenging programs and higher-order thinking questions. Teachers must be competent, confident, and comfortable when instructing mathematics (Hine, 2015). Pedagogical content knowledge (PCK) represents the most useful ways of expressing and teaching math so that it is more comprehensive to others (Hine, 2015). PCK is a necessary attribute for teachers as it gives them
the ability to understand students’ inconsistencies and helps teachers adjust lessons to cater to all learners. Schmidt, Burroughs, Cogan, and Houang (2017) remarked on the necessary role of pedagogical understanding for teachers.

If we expect students to have a deep understanding of math concepts, our priority should be to have teachers with an even deeper understanding of math concepts. Teachers need to ensure that they master math concepts to be able to effectively teach students deeper level concepts. Teachers with a deep conceptual and pedagogical understanding of math will be able to recognize students’ misconceptions and better address erroneous assumptions that students make because they will understand where students are coming from with their questions. (p. 2)

In her studies on implementation practices of instruction in math classrooms, Bloom (2010) saw that when teachers possessed substantial and significant knowledge on materials and student observations, the instruction in the classroom was strengthened. Also, when teachers were offered and allowed to collaborate in order to connect educational goals to classroom experience, teacher expertise on classroom approaches and pedagogies intensified (Bloom, 2010).

**Conceptual Framework**

The study presented here is guided largely by theories of how teachers learn mathematical content knowledge through their collegiate teacher preparation programs. For the purpose of this study, mathematical content knowledge refers to a substantive and syntactic education, which suggests teachers have a strong conceptual idea of the specific subject matter (Jaworski & Gellert, 2003). Collegiate teacher preparation programs refer to the required baccalaureate classes and major-specific classes for pre-service teachers to take during their undergraduate educations before certification.
The focus of this study builds on research conducted by the American Mathematical Society in the 17th volume of their research, The Mathematical Education of Teachers II. The study recommends that teachers have a strong understanding of not only elementary mathematics, but early childhood and middle school mathematics as well, to further enhance their education. Along with the fundamentals of mathematics, teachers need to connect the mathematics for students from what they have learned in the past to what they will learn in the future (Greenberg et al., 2015). This recommendation stems from the need for institutions of higher education to produce high-quality math educators by providing a stronger foundation from which they can build skills.

**Summary**

If teachers’ mathematical content knowledge has such a vital connection to student achievement, then what do teachers actually need in order to progress and become formidable math educators? There appears to be a disconnect in current research regarding holding teachers accountable for having not been very good mathematics students themselves, while current research does not provide many solutions to remedy this situation. The answer is not to have all elementary education teachers major in mathematics (Thames & Ball, 2010). First, a teacher needs to become astute in how to teach (pedagogy), and then secondly those teachers need to be become knowledgeable with the given curriculum, while correspondingly having strong mathematical skills. Thames and Ball (2010) suggest the necessity for successful teachers of teachers is to perfect the blend of mathematical and pedagogical content knowledge. However, a common thread seems to be that instead of training teachers how to instruct math to students, just training the teachers in the pertinent math topics would suffice. It is vital that teachers need content courses that will focus on developing their own understandings of mathematics.
Thus, if teachers do not comprehend math themselves, then they are likely to overlook deficiencies within their students’ knowledge (Thames & Ball, 2010).

Within the U.S., multicultural education integrates several factors into a curriculum which encourages diversity and equality which include: instruction of students from different backgrounds, study of ethnic and cultural groups, development of critical thinking skills, and a focus on human relations (Johnson, Musial, Hall, Gollnick, & Dupuis, 2004). As educators continually attempt to incorporate multicultural education into their curriculums, the manner in which they have responded to the racial, cultural, and linguistic shifts in student demographics has not been sufficient. As a result, a lack of cultural competence has left some students less prepared to achieve than others (Brown & Borko, 1992). This has resulted in what is known as the Achievement Gap. Much research has taken place regarding this Achievement Gap (McKown, 2013) and a multitude of conclusions have arisen in an attempt to make sense of why the gap persists. Although an increased demand of new curricula and student attitudes toward math have been factors in creating and sustaining the achievement gap, teacher quality and preparation is paramount. Teachers need a stronger mathematical background in order to provide guidance and to promote basic mathematical sense to their students. Not only do teachers need to know foundational mathematics, they need to experience it for themselves. Undergraduate baccalaureate programs need to provide this experience to prospective teachers. Pre-service elementary education programs tend to be very crowded and allow little time for concrete learning, as colleges and universities of questionable quality are busy trying to churn out a high number of teachers (National Research Council, 1996; Sawchuck, 2014). The stem of these concerns is rooted in the teachers and their mathematics history. Teachers are not being
prepared in their undergraduate educations to begin to close the gap in mathematics education (Melville, Kajander, Kerr, & Holm, 2013).
Chapter III: Methodology

During the 2016-2017 school year, MDE released the test reports from the Maine Educational Assessment for Maine public schools. The reports indicated that 38.54% of students are at or above grade level in mathematics (MDE, 2015). Knowing that there is a direct correlation between student achievement and teacher quality, the purpose of this case study is to discover what undergraduate programs in Maine are requiring for math courses in teacher preparation programs. Research shows the lack of mathematics course requirements contributes to teachers entering teaching positions with anxiety and inadequate content preparation (Bertram, 2014).

The researcher strongly believes that a thorough look at these programs and how they are addressing teachers’ insecurities in math may help understand the mathematics achievement gap in schools, and teachers’ overall attitudes towards math. This researcher set out to examine sixteen teacher certification programs across the state of Maine to address these research questions:

*RQ1:* How many mathematics courses are undergraduate programs requiring pre-service teachers to take for their baccalaureate education? Within the courses that are required, how many are mathematical content courses, and how many are mathematical pedagogical courses?

*RQ2:* How does a knowledgeable informant characterize the quality of elementary pre-service teacher preparation in mathematics at their institutions?

*RQ3:* How do faculty evaluate student-teacher competence for math instruction?
Site Selection

The study sites are major colleges and universities in the state of Maine. MDE acknowledges 16 out of the state’s 20 bachelor programs as “approved educator preparation programs” (MDE, 2015) A list of these approved programs are listed in Appendix A. The criteria for these schools included being a four-year school with an education major or minor that leads to teacher certification.

Sites

College of the Atlantic. College of the Atlantic in located in Bar Harbor, Maine has approximately 350 students. The College of Atlantic offers areas of concentration in educational studies with concentrations in either science, social studies and English language arts. If mathematics is a wanted area of study, students would need to pursue certification through the Maine Department of Education.

Husson University. Husson University is located in Bangor, Maine. With about 2,800 undergraduate students, Husson University has two other campuses in Westbrook and Presque Isle. Students can major in elementary education or educational studies with a minor in elementary education.

University of Maine, Farmington. University of Maine, Farmington (UMF) is one of the five universities of Maine. This university has an undergraduate student population to about 1,600 students and offers a major in elementary education with a required subject matter concentration. According to the UMF website, since 2006 UMF education graduates have been named Teacher of the Year in the state of Maine.
**University of Maine, Fort Kent.** The University of Maine, Fort Kent has about 1,900 undergraduate students on its Fort Kent public school campus. It offers a Bachelor of Science in Education.

**University of Maine, Orono.** The University of Maine, Orono it simply referred to as The University of Maine and is home to the largest undergraduate population of Maine schools of about 9,200 students. It offers a bachelor’s degree in elementary education with a required subject matter concentration.

**University of Maine, Presque Isle.** The University of Maine, Presque Isle has about 1,400 undergraduate students. It offers a bachelor’s degree in elementary education with a concentration in a subject matter area.

**University of New England.** The University of New England has a campus in both Biddeford and Portland and is home to about 2,300 undergraduate students. It offers a Bachelor of Science in elementary education with a required minor or double major in a subject matter area.

**University of Southern Maine.** The University of Southern Maine is located in Gorham, Maine with two additional campus in Lewiston and Portland. It has a total of about 6,100 undergraduate students. The university offers five elementary teacher education majors in English, geography/anthropology, history, natural and applied science and a self-designed major.

**Research Approach**

Researchers have found that a majority of education programs fail to equip their teachers with the training necessary to succeed in the classroom (Sheehy, 2014), while even more education programs have a long way to go regarding their pre-service instruction in elementary math and STEM content (Putman & Lubell, 2016).
The researcher investigated the math courses offered in these programs and examined the contrasts between math courses and pedagogical math courses offered. The difference between them is that a math course would focus on foundations of mathematics and enhancement of teachers’ mathematical content knowledge, whereas a pedagogical math course is structured around how to teach elementary math to elementary-age students. The National Conference on Research in Teacher Education indicated that most US collegiate preparation programs spend more time on how to teach mathematics rather than on the math itself (Liping, 1999).

Once data was collected, a phone interview was conducted with directors and department heads in the education offices at each school to better understand the curriculum and mathematical content of their programs (See Appendix A). Information regarding the number of students enrolled in the program was also acquired. Acquiring syllabi from the content courses required in each mathematic course added an important perspective about what is being studied and how it is being studied. Potential interview questions are located in Appendix B.

**Data Collection Methods**

This exploratory study sought to find what Maine undergraduate programs are doing to keep their elementary education programs current and within the standards of the MDE. Multiple methods were used to collect data during the research process and were executed in steps to provide rigorous and comprehensive results.

**Phase 1: Selection.** Phase one of the process was selecting the schools used in the study. These participant schools needed to meet these criteria:

(a) needed to have a four-year program that provides a Bachelor’s Degree with a major in Elementary Education
(b) needed to have an approved teacher preparation programs by the Maine Department of Education

**Phase 2: Online Data Collection.** Phase two included online data collection. The researcher gathered as much information as possible about each education program, including total credits, content-course descriptions, and program length. The researcher was able to find the amount of mathematics courses offered, and what these courses are comprised of. This data was confirmed during phase three to ensure that the information on the website was current and correct.

**Phase 3: Interviews.** Phase three included phone interviews with a member of the education department at each school. These interviews attempted to fill in gaps that were created during the online data collection. The interviews lasted from about fifteen to thirty-five minutes and were recorded on an iPhone using the TapeACall Application (see Appendix B).

**Phase 4: Analysis and Contrast.** During Phase four, the researcher analyzed the collected data in order to compare and contrast the school programs, and also sought to find potential areas of growth for each program. The analysis process brought to light five important findings regarding the curriculum and structure of each Maine program.

See Table 1 entitled *Triangulation Matrix*, which demonstrates each of the research questions aligned with the specific methodologies.
Table 1. 
**Triangulation Matrix**

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Method 1</th>
<th>Method 2</th>
<th>Method 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1: How many mathematics courses are undergraduate programs requiring pre-</td>
<td>Extract Data from college websites</td>
<td>Organize data and place information in organized chart</td>
<td>Follow up during the phone interviews to</td>
</tr>
<tr>
<td>service teachers to take for their baccalaureate education? Within the courses</td>
<td></td>
<td></td>
<td>ensure the information on the websites are</td>
</tr>
<tr>
<td>that are required, how many are mathematical content courses, and how many</td>
<td></td>
<td></td>
<td>accurate and up to date</td>
</tr>
<tr>
<td>are mathematical pedagogical courses?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question 2: How does a knowledgeable informant characterize the quality of</td>
<td>Establish guidelines drawn from the National</td>
<td>Phone Interview with informant from each college or</td>
<td></td>
</tr>
<tr>
<td>elementary pre-service teacher preparation in mathematics at their institutions?</td>
<td>Council on Teacher Quality Teacher preparation study</td>
<td>university</td>
<td></td>
</tr>
<tr>
<td>Question 3: How do faculty evaluate student-teacher competence in math preparation?</td>
<td>Phone Interview with informant from each</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>college or university</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis**

The analysis process consisted of data collection and matching it with the themes from the phone interviews. There was a large amount of data, and once organized, the researcher began comparing and contrasting the different offerings from each teacher preparation program.
to show differences and similarities. The analysis included showing differences in the number of total mathematics classes between each program. The analysis examined each school’s general education or baccalaureate classes as requirements for admission into an Education Program. Data was collected into an Excel spreadsheet and categorized by each school.

**Participant Rights**

Concerns for the ethical representation of the schools chosen were very important. The researcher examined each program which was to include personal interviews. There was protection built around the treatment and use of information to safeguard participants. Written consent needed to be attained from each school specifically related to potential personal interviews with school administration (See Appendix C for Consent Form.).

**Potential Limitations**

As with any study, this exploratory study had limitations impacting both the research and the outcomes. Because of the nature of the investigation, some schools chose not to add any more information aside from what was already offered via the public website. Select schools did not embrace a detailed review regarding the amount of mathematics offered in their programs which limited interviews and the information shared.

Also, because the researcher was only looking at the number of classes offered and not an in-depth review of the classes’ substance, the review did not include an in-classroom observation. The researcher attempted to deliver the data in a non-biased way, and compared each school to one another, as opposed to providing conflicting information about each school.

The public website as a data source was also be a limitation to the study, as the researcher could not be certain that the data represented on each schools website was current. Curriculum
can change quarterly at some schools, so the researcher was required to follow up during the interviews to ensure that the website was providing the most current information.

Other limitations included the fact that there was a finite number of programs that could be examined, and the researcher was unable to predict the response rate of survey participants, thereby was not able to guarantee a cross-section of participant backgrounds.

Outside of undergraduate preparation programs, there are other reasons why pre-service teachers may find it difficult to teach mathematics. Many elementary teachers themselves struggle from mathematics anxiety and have difficulty overcoming that anxiety in front of their students. Another explanation could be that many districts were neither offering the support teachers need to stay current, nor were they offering professional development to include new knowledge and new mathematical methods and standards.

Mathematics Anxiety. Mathematics anxiety has been documented in pre-service teachers, contracted teachers, and many university students (Malinsky et al., 2006). However, pre-service teachers have the weakest attitudes towards mathematics when compared to the general college population (Gresham, 2006). Mathematical anxiety has been tied to poor academic performance of students as well as to the effectiveness of elementary school teachers (Malinsky et al., 2006). Gresham (2006) found that many of these teachers are going into the profession with severe anxiety about the subject before they even start teaching it. Research has even suggested that a teacher’s anxiety and distress from mathematics can easily be transmitted onto the students they are teaching by unintentionally passing on negative feelings and attitudes about mathematics (Gresham, 2006).

Studies have shown that too many students in America have modest levels of mathematics knowledge and an even lower level of conceptual knowledge (Gresham, 2006).
However, pre-service teachers are in the highest percentage of having mathematics anxiety (Gresham, 2006). Gresham (2006) suggests that a likely solution for this problem could lie in how teachers are prepared to become teachers. Descriptions of the nature of how these teachers were taught, and how they are currently teaching, act as a powerful source of information.

**Stronger Professional Development.** Faulkner and Cain (2013) saw these gaps and clearly stated that strong professional development to deepen mathematics understanding should be instituted to help improve learning for students. A possible approach for teacher learning was found at the California Mathematics Professional Development Institute, or CMDI. This institution offers weeklong summer training programs that demonstrate a way to improve teacher knowledge so that positive effects can be seen in student performance. This statewide program was created to provide subject matter knowledge and professional development to address teachers’ mathematical content knowledge deficiencies (Hill & Ball, 2004). Most professional development has been found to be ineffective in transferring theory to practice, as teachers are not getting the full impact of the training. Efforts have been made to describe the kinds of resources that have improved the quality of instruction in classrooms (Hill & Ball, 2004).

A lot of money is spent on professional development each year as some teachers are being tasked with sitting through meetings and workshops that are “intellectually superficial, disconnected from the deep issues of curriculum” (Ball et al., 2001, p. 437). In order to be effective, these professional development seminars must focus on two things: increasing teachers’ understanding of mathematics content and providing teachers the ability to communicate mathematics more coherently and effectively to their students. Furthermore, Ball et al. (2008) believe that professional development leaders should shift away from workshops and sessions regarding learning about students and curriculum, and spend more time providing
teachers with updates on new materials and opportunities. It has been noted that when professional development describes a skill to teachers, only 10 percent can transfer it to their practice. However, when teachers are coached through the awkward phase of implementation, 95 percent can transfer the skill (Gulamhussein, 2014). Therefore, while professional development seemingly abounds for teachers, it is not just about providing professional development but rather about providing effective professional development, using such techniques as coaching and modeling of new content after the training sessions have ended (Gulamhussein, 2014).

**Summary**

One of the goals of this study was to examine the variability that exists in teacher preparation programs in the U.S. Many programs prepare teachers with a strong amount of subject and pedagogical knowledge; however, other programs are generating teachers who will continue to need substantial assistance well after graduation (Putman & Lubell, 2016). The methodology helped distinguish what strong teacher preparation programs are providing instructionally for their pre-service teachers, and suggestions have emerged as to how others can impact the math instruction confidence level of their graduates by implementing changes within their programs.
Chapter IV: Findings

The purpose of this study was to investigate one aspect of the quality of pre-service education programs for elementary teachers. The data collection was guided by the following research questions:

**RQ1:** How many mathematics courses are undergraduate programs requiring pre-service teachers to take for their baccalaureate education? Within the courses that are required, how many are mathematical content courses, and how many are mathematical pedagogical courses?

**RQ2:** How does a knowledgeable informant characterize the quality of elementary pre-service teacher preparation in mathematics at their institutions?

**RQ3:** How do faculty evaluate student-teacher competence in math preparation?

**Site Selection Analysis**

The setting of the study was major colleges and universities in the state of Maine. The Maine Department of Education recognized 16 out of the state’s 20 bachelor programs as “approved educator preparation programs” (MDE, 2015). The process of selecting the participant schools was based on these criteria: Must be a four-year program that provides a Bachelor’s Degree with a major in Elementary Education; and must lead to be an approved teacher preparation programs by the Maine Department of Education. As noted, the state of Maine identified 16 colleges and/or universities approved for teacher education preparation and education (MDE, 2015). Of the 16, three only offered secondary education programs, 2 were unavailable, 2 did not have an education program, and 1 declined to participate, bringing the total study participant schools to 8.

See Table 2 which elaborates on why this study examined only 8 of the 16.
### Table 2.  
**Study Participants and Rationale, 2018**

<table>
<thead>
<tr>
<th>Certified Education Programs in Maine</th>
<th>Participated in Study</th>
<th>Rationale behind not participating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bates College</td>
<td>No</td>
<td>Bates only offers secondary education, so it was disqualified from the study</td>
</tr>
<tr>
<td>Bowdoin College</td>
<td>No</td>
<td>Bowdoin only offers secondary education, so it was disqualified from the study</td>
</tr>
<tr>
<td>Colby College</td>
<td>No</td>
<td>Colby only offers secondary education, so it was disqualified from the study</td>
</tr>
<tr>
<td>College of the Atlantic</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Husson University</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Maine College of Art</td>
<td>No</td>
<td>Maine College of Art only offers an Art education program, so it was disqualified from the study</td>
</tr>
<tr>
<td>Saint Joseph’s College</td>
<td>No</td>
<td>Saint Joseph’s was going through a faculty change during the summer of 2018 and did not feel comfortable participating in the study.</td>
</tr>
<tr>
<td>University of Maine, Presque Isle</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Thomas College</td>
<td>No</td>
<td>No one from Thomas College responded to the researcher after multiple attempts.</td>
</tr>
<tr>
<td>Unity College</td>
<td>No</td>
<td>Unity College only offers secondary teacher education, so it was disqualified from the study.</td>
</tr>
<tr>
<td>University of New England</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>University of Maine, Farmington</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>University of Maine, Fort Kent</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>University of Maine</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>University of Maine, Machias</td>
<td>No</td>
<td>No one from University of Maine, Machias responded to the researcher after multiple attempts.</td>
</tr>
<tr>
<td>University of Southern Maine</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

### Participants

As noted, the Maine Department of Education identifies 16 colleges which are state certified education preparation programs. Of the 16, 11 offer an elementary education
preparation program that lead to teacher licensure. Bates College, Bowdoin College, and Colby College were eliminated from the study as they only offer secondary education majors without an emphasis on elementary education. St Joseph’s College declined to participate in the study as they are experiencing a faculty change. University of Presque Isle and University of Fort Kent have merged their programs to serve as one program for both campuses, therefore one interview was completed for both schools. University of Maine, Machias and Thomas College did not respond to multiple attempts to participate in the study and therefore, have been excluded.

Below are descriptions of the 8 colleges and universities which qualified for the study after online data collection and phone interview screening had taken place:

**College of the Atlantic.** College of the Atlantic in located in Bar Harbor, Maine has approximately 350 students. The College of Atlantic offers areas of concentration in educational studies with concentrations in either science, social studies and English language arts. If mathematics is a wanted area of study, students would need to pursue certification through the Maine Department of Education.

**Husson University.** Husson University is located in Bangor, Maine. With about 2,800 undergraduate students, Husson University has two other campuses in Westbrook and Presque Isle. Students can major in elementary education or educational studies with a minor in elementary education.

**University of Maine, Farmington.** University of Maine, Farmington (UMF) is one of the five universities of Maine. This university has an undergraduate student population of about 1,600 students and offers a major in elementary education with a required subject matter concentration. According to the UMF website, since 2006, seven UMF education graduates have been named Teacher of the Year in the state of Maine.
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Findings

The researcher focused on documenting current math requirements at all Maine teacher preparation programs. This chapter presents key findings obtained from online data collection and in-depth interviews from 8 Maine colleges and universities. Six major findings emerged from this study:
1. All schools require at least 6 mathematics credits in their elementary education programs.

2. All schools require a minimum GPA in order to graduate.

3. All schools require at least 15 weeks of student-teaching in the classroom, which a majority of schools use as a summative assessment tool.

4. All school representatives agree that the 2017 study presented by the National Council of Teacher Quality has a poor reputation because of flawed methodology.

5. The Praxis test is a gatekeeper for education students.

6. The colleges and universities in the state of Maine formed an education alliance to help strengthen their curriculum.

Following is a discussion of the findings with support and explanations for each finding. The majority of the information and quotations are taken from the interview portion of the data collection process.

**Finding 1.** *All schools require at least 6 mathematics credits in their elementary education programs.*

The Maine Department of Education requires that each elementary education program offers 6 credits of mathematics courses for their pre-service teachers. The findings are conclusive that all Maine colleges and universities follow this criterion with 100% of schools exceeding that expectations. Of the 8 participants, 7 require six credits of just content mathematics courses and three in methods-based courses, while 1 of 8 participants require ten content mathematics courses and three methods-based courses. Based on the participants’ descriptions, MDE does not specify in what type of math course the six required credits need to be, (methods versus content), they just need to be mathematics.
Some of the Maine colleges and universities structured their elementary education curriculum around students choosing a subject-matter concentration as a focus for their coursework. Although some of the schools offered mathematics as a concentration, the data set is specific to concentrations that are not math focused. The sample looked at what the other concentrations in elementary education were in terms of mathematics requirements.

This participant expressed how important it is for the right people to be teaching the mathematics content courses to future teachers:

It is important for the quality of our courses that mathematics content courses for teachers are taught through the math department, not the education department, this ensures that our students are getting a quality mathematics base with their education.

Another participant articulated the strengths of having a smaller program and student population:

Our program only has one elementary education math teacher and [she] teaches all sections of the math courses. Therefore, we can provide a parallel education for our students as it is the same educator teaching all.

Many of the participants conveyed how strongly they believed strong content courses were important for pre-service teachers, and how the types and time spent on that content is important as well:

The elementary education program on our campus offers many types of content-level mathematics for teachers because they need a strong base for their knowledge. We require an Algebra course, along with a Probability and Statistics courses before they even begin their methods courses.
For a very long time, our mathematics content courses for elementary education students was one semester during their freshman year, however we recently realized that there is so much content to cover, and our faculty was rushing students through this course. We have decided to break the courses into two courses, which span two semesters so that our students are getting a quality mathematical content education.

Many programs offered information which suggested their education curriculum had just been updated, or was in the process of updating certain requirements and courses. A participant noted that:

Education Departments are always changing because we are always trying to adapt to new state and federal standards. So, although this is how we are managing our program currently, does not mean that it will stay that way from year to year.

One participant mentioned that Maine Department of Education expects too few required math credits for pre-service teachers and that the state should really increase its demands. However, after data collection the researcher found that all schools must feel this way, as they all require more than the six credits.

In 2007, The Holmes Group, a collection of education deans and academic officials from major research universities in each of the 50 states, came together and evaluated student performance and teacher quality (Holmes Group, 2007). One of their overall suggestions was that undergraduate programs start replacing methods courses with subject-matter courses. Although the universities and colleges from Maine have not completely eliminated their methods courses, many of them have required more subject-matter content courses in their pre-service preparation than methods courses.
Finding 2. All schools require a minimum GPA (grade point average) in order to graduate.

All participants stated that their programs require a minimum GPA in order to graduate; however, a majority of the participants specified that they require students to have a higher-grade point average in their Education Courses than in the general education courses. Many colleges and universities have their content mathematics courses taught through the math department, and their methods courses taught through the education department. Thus, the passing requirements for content mathematics courses are lower than those of regular education courses. Six of 8 participants had their education grade point average a half of a point higher than their overall grade point average, while 2 of 8 had the same grade point average for all courses. Two of the schools noted that their overall GPA would be increasing Fall 2019.

Finding 3. All schools require at least 15 weeks of student-teaching in the classroom which a majority of schools use as a summative assessment tool.

The State of Maine requires pre-service teachers to student-teach for at least 15 weeks. Seven of 8 schools require the 15-week student-teaching requirement to be done prior to a 30-50 hour practicum in two grade-level placements, one upper elementary and one lower elementary so students can have a range of experience. However, 1 of 8 participants require 16 weeks of student-teaching after a 16-week practicum. Participants use student-teaching as a way to observe their students and see how they are incorporating their classroom content knowledge in an active teaching environment.

Our student-teaching is offered to students during their senior year in their programs. At this point they have passed a majority of their curriculum and are set to try their methods out on real students.
Participants mentioned that student-teaching is a way to view how competent students are in the classroom, teaching their subject-matter courses and basic classroom knowledge:

We use outside supervisors and rubrics to observe our students in the field. This can provide professionalism and consistency when grading the students’ progress and making goals for their next lessons.

Our program uses the Charlotte Danielson rubrics as a way to conduct an observation for our students during their student-teaching. It addresses many aspects of the student-teaching experience and provides a guideline to provide feedback to our student post-observation.

Having a way to provide feedback and progress reports to students after they have completed their coursework can be an effective way of seeing if students subject-matter knowledge is proficient. Using thorough rubrics, one-on-one meetings and model lessons are different ways of assessing the quality of student-teachers before they complete their practicum.

Finding 4. All schools agree that the 2017 study presented by the National Council of Teacher Quality has a poor reputation because of its flawed methodology.

In 2017, the National Council of Teacher Quality presented a study that categorized and graded each state on their teacher preparation. The state of Maine did not garner a high grade, and overall received a “Meets All Goals,” for the Elementary Education Teacher Mathematics Preparation section. The researcher used this study as a talking point with the schools to see if they agreed with the rating and to follow up with how Maine colleges and universities used this data to prepare their curriculum. The participants reacted this way when asked about the study:

This issue with the NCTQ study is their superficial methodology. It is not thorough, and they base a lot of their ratings off of what they read online. Also, so many of Maine
colleges and universities don’t even bother to participate, so the numbers they gather are based off of about 4 to 5 schools.

Don’t pay attention to the NCTQ ratings. They do not come onto campus, they don’t sit through classes, they just rely on documentation to make their assessments. Their data is equivalent to judging a restaurant by its menu, and not by actually tasting the food.

In all honesty, I was surprised by the NCTQ results. I think Maine does a great job, but I do think we could do a better job by eliminating the math bias for all students. We should be building our curriculum to make students more confident with the math abilities and so far, we aren’t really addressing that. We do not focus on those results at all, but more importantly we can always be doing a better job.

In 2017, the NCTQ released a review on the Teacher Preparation Programs in the U.S.. The review ranks programs based on standards the NCTQ created themselves to provide a look at what colleges and universities are preparing teachers best for teaching. In the latest review, Maine had scored an overall grade of a D- of how it prepares its teachers, but more importantly, received a “meets goals,” for the elementary education mathematics preparation subheading. The researcher thought this status demonstrated a strong standing for Maine and used it as a talking point during data collection. Much of the responses to this study were negative, as many school representatives expressed that the NCTQ did not do a thorough job in collecting their own data and passed a lot of judgment on each program.

Based on the most current research, the Maine school participants are not the only ones who have expressed overall concern regarding the National Council on Teacher Quality’s’ Teacher Prep Review that was completed in 2017. The National Education Policy Center released a review in April of 2018. The review ultimately finds that the NCTQ uses syllabi and
documentation as a valid measure of preparation program quality (Cochran-Smith, Keefe, Chang, & Carney, 2018). The review indicates that the NCTQ’s methods are “a maze of inconsistencies, ambiguities and contradictions” (p. 8). The NEPC noted that the report ignores recent research on teacher policy, teacher preparation and licensure issues.

**Finding 5. The Praxis test is a gatekeeper for education students.**

Students in Maine need to pass the Praxis I test which measures academic skill and specific subject-matter content knowledge. Based on information gathered, this test is regularly taken before the student’s sophomore year in their undergraduate education. Six of 8 participants mentioned that their students are challenged with passing the mathematics portion of the Praxis I test. Participants discussed their Praxis reactions in the following ways:

- Our students have struggled so mightily with the Praxis I math test that we are going to add Praxis prep courses to the freshman curriculum of our program. However, we have noticed that students choosing Mathematics as their concentration at our school do not struggle with the Praxis I test as much.

- Participants even mentioned structuring their curriculum around the Praxis standards to help promote proficiency. This equates to structuring a curriculum around a specific exam:

  - Because of the past struggles with our students passing the Praxis I math portion, our program has built the elementary education mathematics curriculum around Praxis preparation and standards that will be seen on the Praxis I test. With our student base, the math and social studies portions of Praxis are the most failed tests throughout our Education student body.
As a faculty, we have structured our program around making sure students are taking a majority of their mathematic content courses before they take their Praxis I test, therefore we can prep them as much as we can.

Participants also mentioned that because of the later time frame of the Praxis II test, normally before senior year, that students do a much better job passing:

The passing of Praxis II has not been as much of a worry for our students because they are taking this test towards the end of their program before they start their student-teaching. Therefore, they have taken all the required mathematics courses in the program prior to the taking of this particular test.

Many states require proficiency exams such as the Praxis in order to improve subject-matter knowledge for teachers, however mathematics is not the only test that students struggle with. Although a majority of the schools have expressed serious concern with their students passing scores, schools have also mentioned that the writing subtest and social studies subtest can be difficult as well

**Finding 6.** The colleges and universities in the state of Maine formed a math alliance to help strengthen their math curriculum.

Many of the interviews revealed that every year the participating colleges and universities send one representative to a meeting that is focused on discussing the mathematics curriculum in their undergraduate programs. The program, the Teacher Education Alliance of Maine (TEAMe) was developed to support one another in their practices of preparing teachers in higher learning (Department of Maine, 2017). The interviewees mentioned that:

This alliance gives us a chance to see what each school is doing to promote a stronger education for pre-service teachers. We can meet, talk, share ideas, collaborate and
attempt to make our programs stronger by seeing what our colleagues are doing at different schools.

Of the several interviews, five of the interviewees were the actual correspondents at the Alliance:

One of our major goals is to recognize and embrace the diversity in Maine schools while also supporting continued professional development of teacher education.

This alliance was a key finding during the interviews because many of the schools used this membership as evidence why their programs are continually changing and improving. The fact of the alliance also provided an explanation about why schools did not participate in the NCTQ reports, because they use the alliance as a tool for collaboration and efficiency. Since the colleges and universities are relatively small, both in student population and education programs, membership fulfills a need for group effort and teamwork among the participants.

**Conclusion**

This chapter presented the six findings that were uncovered by this study. Findings were organized by the research questions and data was collected by online collection and phone interviews. Extensive samples from the interviews were provided by quotation from the participants.

The primary finding of this study is that all of the participant schools require at least six mathematics credits in their elementary education programs. The finding showed that Maine requires this of the colleges and universities, however a majority of the schools require more than six credits. Several participants suggested that they felt Maine’s requirements were too low, and therefore many of the participants added more to their curriculum.

The second finding found that all schools require a minimum GPA in order to graduate. This was key as it showed that the education programs are holding students accountable and
providing guidelines for proficient course work. Most of the participants described that their 
programs offered two graduating GPAs; one for their education courses and one for the students 
overall course work. In addition to providing multiple GPAs, the data found that the education 
course GPA was higher than the overall GPA required of graduating students.

The third finding was that schools require at least 15 weeks of student teaching. Although 
this is a state requirement, it proves key as many of the participants suggested that student 
teaching is used as a way to check on pre-service teachers levels of competence in the classroom. 
Participants described student teaching as a way to provide assessment on the knowledge of all 
subject matter, while also providing strong feedback and guidelines for the pre-service teachers 
to work on. As mentioned in the data collection, many of the participants admitted to using 
rubrics as a way to provide a grading system.

The fourth finding indicated that the research provided by the National Center of Teacher 
Quality has a poor reputation at many of the colleges and universities in Maine. The participants 
mentioned that although they grade each state very thoroughly, their data is based off of online 
document searches and information found from other sources. The council does not come onto 
campus, sit in on courses, or check on current syllabi to ensure quality and proficiency.

The fifth finding found that the Praxis test is an academic roadblock for many pre-service 
teachers. Many of the participants mentioned that because of this deficiency, many colleges and 
universities have restructured their programs curriculums to provide Praxis support and test 
preparation during the elementary education program.

The sixth finding revealed that the colleges and universities in the state of Maine 
developed an education alliance that meets every year to collaborate and discuss curriculum 
changes and progressions for the next year. The participants were all very positive and
encouraging about this alliance and mentioned that because the state of Maine was so small, in
terms of the amounts of colleges and universities, they were able to work more closely together
as a unit.

This chapter described the results and key findings of the undergraduate education
programs in the state of Maine. Through data collection and analysis, these findings emerged as
key points in the research. Although other findings were apparent in the study, these found to be
most significant to the original research questions. From these themes, the reasoning behind the
research questions began to take shape. Each finding proves as evidence to the research questions
that framed this study from the beginning, which is elaborated in chapter five.
Chapter V: Conclusion

The purpose of this exploratory study was to investigate teacher education programs in one state regarding the amount of mathematics training required for pre-service teachers during their undergraduate education. It was hoped that a better understanding of how colleges structure their elementary education curriculum would provide insight into some reasons why teachers remain uncomfortable and unsteady when teaching elementary mathematics.

The research utilized qualitative data by collecting online data from each school and conducting phone interviews with a small group sample on the topic of each school’s specific curriculum. Participants in the study included 8 colleges and universities in the state of Maine. The data was coded, themed and organized by each of the similar findings that emerged from the study. The study was based on the following three research questions.

Research Questions

*RQ1:* How many mathematics courses are undergraduate programs requiring pre-service teachers to take for their baccalaureate education? Within the courses that are required, how many are mathematical content courses, and how many are mathematical pedagogical courses?

*RQ2:* How does a knowledgeable informant characterize the quality of elementary pre-service teacher preparation in mathematics at their institutions?

*RQ3:* How do faculty evaluate student-teacher competence in math preparation?

Themes emerged that connected directly to the studies research questions and these themes were used to help code data and present the findings in chapter four. When analyzing
these findings, the researcher searched for connecting themes in the literature review that helped support and compare the findings raised by the data.

The previous chapter presented the findings of this study by listing 5 themes that developed in connection with the research questions. The findings were listed with narratives from the interviews to show support and evidence. They were also concluded with a summary that connected each finding back to relevant research raised by the literature. The purpose of this chapter is to provide interpretation for these findings and to present understandings taken from the data.

The discussion concerns the literature on elementary education preparation programs along with the need for strong mathematical content knowledge for elementary teachers. The effects of these findings supported some of the reasoning behind why mathematics still remains problematic for some teachers to teach. The chapter concludes with a review of the researcher’s assumptions about the interpretations along with an annotation regarding researcher bias in interpretation the findings.

**Research Question 1: How many mathematics courses are undergraduate programs requiring pre-service teachers to take for their baccalaureate education? Within the courses that are required, how many are mathematical content courses, and how many are mathematical pedagogical courses?**

The first research question aimed to find how many mathematics credits were being required of elementary school teachers and to identify the differences in the content and methods courses’ curriculum. Participants noted that many of their programs required more credits than the state of Maine expected pre-service teachers to take. Participants also elaborated the need to have more content courses than methods courses in their education programs as it allows
students to form a foundational mathematical knowledge early in their studies. Many of the mathematics content courses were taken early in the students’ academic career, while the methods courses were left to senior year, right before student-teaching.

It was suggested in 2012 by the National Council of Teachers of Mathematics that preservice teachers should take 12 credits of mathematics during their undergraduate studies. They believed that all of these credits should be in content courses to help promote strong content knowledge in elementary school teachers. Although the State of Maine only requires half the amount of credits that the NCTM does, many institutions do follow the suggestion that more of the credits should be in content courses.

Gerstenschlager and Tassell (2017) discuss beliefs that these numbers do not really mean anything as they believe there is no connection between an increased amount of mathematics courses in college and a stronger mathematical content knowledge for teachers. The real issue, they argue, is that colleges are not addressing the pre-service teacher’s anxiety and discomfort in mathematics which will ultimately affect the way that they teach their students. Gresham (2006) agreed with this observation and noted that the anxiety and self-efficacy of teachers is connected to their effectiveness as mathematics teachers. Although some of the participants mentioned the importance of this concern in interviews, none of them noted that their courses are doing anything to address this problem.

On the contrary, Even and Ball (2009) believe that strong mathematics classes in undergraduate education offer a focus on the teachers specifically, as opposed to how teachers can help their students. The transition from methods courses to content courses can allow teachers to approach the content of elementary math, as opposed to just learning how to model lessons that are appropriate for the classroom. In terms of the amount of credits being required,
Ball et al. (2005) recommend that teachers be required to study and receive as much mathematics training as possible. This could be obtained by taking extra coursework in college programs, or a well-structured preparation program where teachers focus solely on mathematics.

In summary, it has been argued that more collegiate courses in mathematics can enhance and strengthen a pre-service teacher’s mathematical content knowledge. Although this has not been proven, many researchers believe that the addition of more content courses will increase pre-service teachers’ overall anxiety regarding teaching mathematics. Other researchers believe that the more math courses pre-service teachers are required to take, the more confident and at ease those teachers would be.

**Research Question 2.** *How does a knowledgeable informant characterize the quality of elementary pre-service teacher preparation in mathematics at their institutions?*

Strong admission requirements can be an addition to a quality undergraduate preparation program. Admission requirements focus on GPA and test scores that require admission into elementary education undergraduate programs while also providing a necessary requirement to upkeep grades and success throughout the program. An overall GPA and passing test scores allow students to keep track of their progress and does not allow for students to underachieve during their program.

Greenberg and Walsh (2008) discussed the strength of admission into undergraduate education programs in the U.S. Schools have set such low expectations for students that admission into programs and success throughout the program is almost guaranteed. Maine colleges have all provided structured expectations and at least a B-average in their education courses to provide rigor for their pre-service teachers.
One of the findings identified by the researcher was the separation between required education course GPAs and the overall GPA. In all programs that documented two different GPAs, the overall GPA was lower than the education coursework GPA. This allows students to perform lower on their mathematics courses without it affecting their education GPA. The different level of academic expectations may allow pre-service teachers to make the assumption that their education courses are more important than their non-education courses. Many of the pre-service programs have their math content courses taught through the mathematics department, and they are not considered education courses. So therefore, those courses fall into the lower GPA requirement.

Passing of a state certified licensure test can ensure consistency among applicants and provide another demand for admission. In terms of licensure tests, 45 of 50 states require the passing of the Praxis test to gain teacher licensure. This test, normally taken in two parts, tests subject matter knowledge and professional knowledge for upcoming teachers. In Maine, passing of Praxis I is normally required before the students reach their sophomore year in the program, and the passing of Praxis II needs to occur before students start their student-teaching senior year. There has been some resistance to this state testing, as it is said that the tests are exacerbating an existing shortage of teachers (Pfannenstiel & Petroski, 2018). In Iowa, officials are considering eliminating the requirement of passing this test for teachers altogether, as it “provides a road-block for the teacher and the administration that wants to hire them” (Pfannenstiel, 2018). Mississippi is following this pattern as well. Although they are not trying to eliminate the test in general, they have lowered the passing score for the mathematics subtest by eight points. State officials say that Mississippi is having such a hard time keeping good teachers that this was a necessary change (Jackson, 2018).
**Research Question 3:** How do faculty evaluate student-teacher competence in math preparation?

The State of Maine requires a 15-week student-teaching assignment during the student’s senior year of college. This student-teaching practicum allows students to take their prior years of coursework knowledge and apply it to a live group of students under the supervision of a mentor teacher. Traditionally, a student-teacher observes for several weeks, then eventually begins to take over certain subjects one at a time in order to gain experience. During this time, advisors, or faculty from the college or university, will come and observe their student teachers in action. This observation provides one way to assess the student’s instructional capabilities and classroom management skills. Rusznyak (2012) explains that student-teaching is very difficult to assign one assessment level to as it involves professional judgments, short observations, and mentor teacher cooperation. Therefore, many participants mentioned the use of school-wide rubrics to provide consistency in their grading systems.

One participant mentioned that Charlotte Danielson’s rubrics have been most helpful during the evaluation of student teacher (The Danielson Group, 2013) (See Appendix D for samples). They are thorough, provide strong talking points, and allow teachers to set goals for their next observation. The rubrics have four domains to be graded including: *Planning and Preparation, Classroom Environment, Instruction, and Professional Responsibilities*. These rubrics allow for students who are being observed by different faculty members to receive a more consistent assessment as their peers.

**Implications of Findings**

The discussion of the findings reveals that undergraduate education offers pre-service teachers a general education that roughly covers the major subjects that will be taught. In the
case of the state of Maine, although the state has established rather low standards for mathematical preparation, many colleges and universities have chosen to require more than the allotted amount.

The challenges throughout the data process was establishing inconsistencies from online data collection and phone interviews. Another challenge was getting in contact with representatives at all the colleges and universities to conduct the interviews. Once data was collected it was not difficult to identify common patterns in the school programs and curriculum requirements. Although many of the schools have a unique way of presenting their curriculum and courses, overall it seems the schools’ purposes are aligned. The interview process revealed that the state of Maine has a teachers’ alliance, formed by the participating schools, through which faculty connect once a year to share data and upcoming changes in their education and mathematics programs. This alliance provides support so every school in the state has the opportunity to provide reliable curriculum while also sharing their thoughts and opinions with the other schools. Although the schools require different courses from their students, this alliance has constructed a framework for the state of Maine based on that information.

When it comes to the Praxis test, it remains discouraging that college faculty feel the need to teach to the test to ensure their students’ passing scores. Having to add courses around Praxis proficiency further demonstrates that pre-service teachers do not have a strong mathematics content knowledge. Although passing this test does not ensure stronger pedagogy from the teacher, it does to some degree assure that the teacher’s foundational content knowledge is strong. Program leaders should continue adding to their mathematics curriculum to manage the many mathematical needs for their future teachers while still targeting requirements of the Praxis I test.
While organizing the findings, the researcher found the study warrants a description of limitations. First, the sample is small. Between working with a rather small state in general and not getting all schools to participate, the overall study sample does not fully represent every program in the state. Second, the rigor of the programs was difficult to judge based on phone interviews and online data collection. Thus, the perceptions of the faculty was the only measurable factor of program strength. Therefore, the implications that are depicted are solely from the perspective of the sample group and one department representative.

**Recommendations for Further Research**

The researcher recommends further studies be conducted to develop added information and to gain a more comprehensive understanding of elementary education preparation for pre-service teachers.

1. To enhance this study, live observations of the content courses at each college and university would help establish the strength of the mathematics curriculum provided to each pre-service teacher. Also, an analysis of the textbooks used in each content course would offer insight into the rigor and mathematic content which is being taught in each course.

2. A further and similar study would be to locate colleges and universities that are addressing the anxiety and emotional stress that pre-service teachers experience and see how effective such a focus is, as opposed to adding more mathematics or harder mathematics courses to the undergraduate degree.

**Conclusion**

The essence of strong teacher quality has been rooted in the mathematical content preparation in undergraduate education. The insight gained from this study allow future students
to see what Maine colleges and universities do in order to provide a strong elementary education.

It also provides a look into how Maine colleges and universities have progressed and emerged throughout the changes in education. As elementary programs develop in undergraduate education, Maine has shown that innovation and collaboration is an important aspect to growing and enhancing their programs.

As work in the education field continues, each state may begin to develop higher expectations for their pre-service teachers, along with more competitive passing scores for entrance-level examinations. Concentrated efforts need to continue to be made to ensure that pre-service teachers are challenged and held accountable for their mathematical knowledge.
References


Bloom, R. M. (2010). Implementation practices of differentiated instruction in the upper elementary and middle school math classroom: A discovery through grounded theory. *ProQuest LLC.*


https://doi.org/10.17226/10055.


Appendix A: Approved Educator Preparation Programs

The Maine Department of Education [MDE] listed these schools as “Approved Educator Preparation Programs” (2015)

<table>
<thead>
<tr>
<th>College</th>
<th>City</th>
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<tbody>
<tr>
<td>Bates College</td>
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<td>Bowdoin College</td>
<td>Brunswick</td>
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<tr>
<td>Colby College</td>
<td>Waterville</td>
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<td>College of the Atlantic</td>
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<td>Husson University</td>
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<td>Maine College of Art</td>
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<tr>
<td>Saint Joseph’s College</td>
<td>Standish</td>
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<td>University of Maine at Presque Isle</td>
<td>Presque Isle</td>
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<tr>
<td>Thomas College</td>
<td>Waterville</td>
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<tr>
<td>Unity College</td>
<td>Unity</td>
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<tr>
<td>University of New England</td>
<td>Biddeford</td>
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<tr>
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<td>University of Maine</td>
<td>Orono</td>
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<tr>
<td>University of Maine at Machias</td>
<td>Machias</td>
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<tr>
<td>University of Southern Maine</td>
<td>Gorham</td>
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</table>
Appendix B: Interview Questions

Interview Questions

Briefly explain your role at your department and school/university.

Describe your current involvement, if any, in the Education Department curriculum selection.

Does your school offer an Education major that concludes in Certification in Elementary Education?

If no, interview is complete. School is eliminated from study.

If yes, continue with questions.

Is the program content and requirements for teacher licensure published on the college website accurate?

How have National Center for Teachers of Mathematics (NCTM) standards influenced your program’s math curriculum?

The National Council for Teacher Quality (NCTQ) has just published updated findings about teacher quality. They suggest that elementary teachers in the state of Maine meet the standards for teaching math. The 2017 report indicates that teacher preparation for all content areas does not meet that organization’s standards. With regards to these findings, has your pre-service teacher preparation changed? In what ways?

What are next steps your faculty have taken or might take to respond to NCTQ standards?

What teacher preparation standards does your department use to evaluate your teacher candidates after they complete their student-teaching?

Could you provide a copy of the syllabi for each mathematics course in the education program?
Appendix C: Consent for Participation in Research

UNIVERSITY OF NEW ENGLAND
CONSENT FOR PARTICIPATION IN RESEARCH

Project Title: MATHEMATICS PREPARATION IN PRE-SERVICE UNDERGRADUATE PROGRAMS IN THE STATE OF MAINE

Principal Investigator(s): The principal investigator is the researcher, Jessica Cefalo Osich. Doctoral Student at the University of New England. Email: josich@une.edu
The faculty advisor for this study is Michelle Collay, mcollay@une.edu

Why is this study being done?
- The purpose of this study is to investigate one aspect of the quality of pre-service education programs for elementary teachers. The researcher will focus on documenting current math requirements at all Maine teacher preparation programs.

Who will be in this study?
- You have been selected as a potential participant in this study because the Maine Department of Education listed you as a contact for teacher preparation at your current college or university.
- You must be at least 18 years of age to participate.
- There will be 16-20 participants

What will I be asked to do?
- The participant(s) will be asked to take part in one, 20-30-minute phone interview with the researcher.
- There is no financial reward for taking part in this study

What are the possible risks of taking part in this study?
- Although there is not foreseeable risks in taking part in this study, the concerns for the ethical representation of the participating schools are very important. The researcher wants to accurately represent each program and also will strive to provide anonymity to the representative and reassurance about how the information will be treated and used. The analysis of each program will not focus on evaluating goodness of each program, but instead provide objective representations of each school's requirements.

What are the possible benefits of taking part in this study?
- Assuming this data is made available to participants in the study, program leaders will have information regarding how their collegiate preparation for prospective teachers aligns with emergent standards. The findings may also provide insight into the range of mathematics offered by each college or university for prospective elementary educators.

What will it cost me?
- There are no costs that are foreseeable to the participant in order to take part in this study.

How will my privacy be protected?
- The information that is gathered by the researcher will be directly connected to the school that the participant works for and not the participant themselves.

How will my data be kept confidential?
- Most of the research that is collected will be from public websites provided by the colleges and universities, therefore there will be no confidential information as the opinion of the participants are not being asked for.
- A copy of your signed consent form will be maintained by the principal investigator for at least 3 years after the project is complete before it is destroyed. The consent forms will be stored in a secure location that only members of the research team will have access to and will not be affiliated with any data obtained during the project.
- A copy of the study can be provided to each participant.
What are my rights as a research participant?
- You will be informed of any significant findings developed during the course of the research that may affect your willingness to participate in the research.

What other options do I have?
- If you cannot commit to a phone interview, the questions can be emailed to you and answered by hand. Please let the researcher know if this procedure better fits your needs.
- You may choose not to participate. That being the case, the information gathered from the school's website will be the primary source of data.

Whom may I contact with questions?
- The researcher conducting this study are Jessica Cefalo Osich. For questions or more information concerning this research you may contact her/him/them at (208) 631-9220 and josich@une.edu.

NOTE: Student researchers are required to have the faculty advisor listed. The faculty advisor is expected to take an active role in students’ research activities and provide supervision throughout the duration of their research study. The faculty advisor is legally responsible for all research activities.

- If you have any questions or concerns about your rights as a research subject, you may call Olgun Guvench, M.D. Ph.D., Chair of the UNE Institutional Review Board at (207) 221-4171 or irb@une.edu.

Will I receive a copy of this consent form?

General requirement language:
- You will be given a copy of this consent form.

Participant’s Statement
I understand the above description of this research and the risks and benefits associated with my participation as a research subject. I agree to take part in the research and do so voluntarily.

Participant’s signature or
Legally authorized representative

Date

__________________________

Printed name

Researcher’s Statement
The participant named above had sufficient time to consider the information, had an opportunity to ask questions, and voluntarily agreed to be in this study.

__________________________

Researcher’s signature

Date

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Printed name
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<th>Domain I: Planning and Presentation</th>
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<td><strong>Domain</strong></td>
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<td>Classroom Management</td>
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**Table of Scores**

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**Notes**

- The scores are based on the Charlotte Danielson Rubrics for Student Teaching.
- The rubric evaluates teacher performance in planning and classroom management.
- The total score is calculated by summing the scores for each domain.
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