AN ANALYSIS OF TEACHER PREPARATION POLICIES ACROSS FOUR STATES: EXPLORING POLICIES THAT MAY RAISE STUDENT ACHIEVEMENT

By
Michael Farina

Submitted in partial fulfillment of the
requirements for the degree of
Master of Science in Education

Education Department
Wagner College

May, 2014

Wagner College
Division of Graduate Studies
Master's Thesis

Author: Michael Farina

Title: AN ANALYSIS OF TEACHER PREPARATION POLICIES ACROSS FOUR STATES: EXPLORING POLICIES THAT MAY RAISE STUDENT ACHIEVEMENT

Degree: M.S.Ed : Adolescent Education

Date of Graduation: May 2014

Thesis Review Committee:

Thesis Advisor: _____ 5-13-14
Dr. Karen DeMoss — Date

Reader: _____ 5-13-14
Dr. Stephen Preskill — Date

Reader: _____ 5/22/14
Dr. Ann Gazzard — Date

Abstract

Students in the United States have consistently performed poorly on international mathematics assessments, which could be attributed to numerous factors. This analysis concerns the impact that teacher preparation policies throughout the United States might have on students' mathematics performance. Four states—New York, Mississippi, Massachusetts, and Montana—were chosen according to their students' mathematics performance on the National Assessment of Educational Progress (NAEP) examination. The areas of teacher policy analyzed were the selection requirements for teacher preparation programs, the level and number of required mathematics courses, the mathematics tests required for certification, and the student teaching experience. The results showed that the level of content and rigor of certification tests were among the most variable factors in teacher preparation and hence may also be among the most important for student achievement. Massachusetts, which required the most advanced mathematics courses and most rigorous testing for teacher candidates, was also the state with the highest performing math students. Massachusetts teacher policies could serve as a model for other states to follow so that United States can remain competitive in mathematics.

Table of Contents

List of Tables

Chapter 1: Literature Review

The International Achievement Gap

The United States has recently lagged behind other nations in the fields of mathematics and science, a fact that is apparent in students' performance on international assessments. In *The Learning Gap*, Stevenson and Stigler (1992) delineate many factors responsible for the achievement gap between the United States and other nations in mathematics. By examining cultural differences, they were able to determine that in China and Japan, school life and home life are more closely connected than in the United States. While American students spend only six hours in school each day, children in Beijing, Taipei, and Sendai spend eight hours in school on weekdays, and an additional four hours in school on Saturdays (Stevenson & Stigler, 1992, p. 53). Given that Chinese and Japanese children spend two-thirds of the year in school compared to American children who are only in school half the year, it is easy to see that school is a more integral part of the Asian culture.

Parental involvement is another way in which home and school are connected. Parents in China are more likely to assist children as they work on their homework in order to promote their child's interest and involvement at school. American parents, on the other hand, feel that they don't need to be as involved and consequently do not work with the child's teacher nearly as much as their Asian counterparts. Whereas schools in America have occasional parent-teacher conferences, Chinese and Japanese teachers communicate daily with parents about homework assignments, test results, special activities in school, and the child's behavior (Stevenson & Stigler, 1992, p. 84). Such

close communication enables parents to ensure their children truly understand the mathematics being taught.

One of the ways we learn about such large cultural differences is through the Trends in International Mathematics and Science Study or TIMSS. TIMMS "reports on mathematics and science achievement trends at the fourth and eighth grades, providing educational policymakers, administrators, teachers, and researchers with powerful insights into how educational systems are functioning as well as critical intelligence about the possibilities for educational reform and improvement" (Mullis et al., 2012, p. 1). The TIMSS 2011 report has shown that fourth graders in the United States rank eleventh in math and seventh in science when compared with children in the same age groups internationally. In eighth grade the United States is behind eight other countries in math and nine other countries in science. Asian countries dominated the top ranks of the TIMSS assessment. According to the TIMMS 2011 study, "East Asian countries continue to lead the world in mathematics achievement. Singapore, Korea, and Hong Kong SAR, followed by Chinese Taipei and Japan, were the top-performing countries at the fourth grade. Similarly, at the eighth grade, Korea, Singapore, and Chinese Taipei outperformed all other countries, followed by Hong Kong SAR and Japan" (Mullis et al., 2012, p. 7)

Many factors may contribute to the disparity between the United States and other countries in fourth and eighth grade assessments. For example, it has been shown that teacher quality and preparation varies from country to country. Stigler and Hiebert (1999) found in the TIMSS 1994-1995 Videotape Classroom Study that teachers in German and Japanese classrooms use higher order thinking skills far more frequently than classrooms in the United States. German teachers that were observed were more likely than United

States teachers to develop proofs of mathematical concepts. Teachers leading students through a discussion of advanced procedures are also common in German classrooms. This method of teaching is not as prevalent in the United States, in which the teacher more often than not just "states" the definitions and rules to be memorized. As an example, Stigler and Hiebert (1999) mention an instance in which the United States teacher provided the class with a worksheet containing forty basic math questions related to the lesson of the day. The worksheet emphasized terms and procedures but did not entail much critical thinking.

Japanese classrooms tended to involve mostly higher order thinking. Of the lessons observed in the TIMSS 1994-1995 study, 83 percent of Japanese lessons and 77 percent of German lessons contained developed concepts compared to a mere 22 percent of United States lessons. Moreover, 96 percent of seatwork time in the United States is devoted to having students practice and only 0.7 percent requires students to invent or think. On the other hand, 41 percent of Japanese seatwork time is practice and 44 percent is inventing or thinking-oriented. According to Stigler and Hiebert, "In Japan teachers appear to take a less active role, allowing their students to invent their own procedures for solving problems. And these problems are quite demanding, both procedurally and conceptually. Teachers, however, carefully design and orchestrate lessons so that students are likely to use procedures that have been developed recently in class" (1999, p. 27). In the Japanese lesson on angles, the teacher has his students create their own challenging problems and present them to the class to solve. This contrasts with the American style of just telling the students what they are required to memorize.

Teacher quality and preparation across different countries has been analyzed by the OECD Programme for International Student Assessment (PISA), another international exam, which "provides the world's most extensive and rigorous set of international surveys of the knowledge and skills of secondary school students" (OECD, 2010, p. 3). Among the criteria for assessing teacher preparation policies are how teachers are recruited, from what pool they are recruited, their initial training, how they are mentored, the professional development they receive, and how they are compensated (OECD, 2010, p. 235). In Japan for instance, teacher preparation programs recruit from the highest performing segment to ensure schools get the best of the best teachers. Likewise, entering into teacher preparation programs in Finland is highly competitive. Of the 6600 applicants for Finnish teacher preparation programs, only 10 percent were admitted. As in Asian cultures, teaching is seen as a high-status, well-respected position. In the United States, the status of teachers is lower than that of other countries, with teaching being viewed as a blue-collar occupation rather than a knowledge-based profession (OECD, 2010, p. 236). Furthermore, OECD data show that teachers' pay in the United States is fourth from the bottom among OECD countries, when teachers' compensation is compared to that for other occupations requiring the same amount of education. In contrast, teacher compensation in East Asian countries is fixed by law to make sure that teachers are among the highest paid of all positions in the civil service (OECD, 2010).

According to the OECD (2010), Asian teachers are more inclined to participate in lesson study than teachers in the United States. Lesson study is the process by which groups of teachers meet regularly over long periods of time, from several months to a

year, to work on the development, testing, and improvement of lessons. It begins by the teachers defining a problem that has to be addressed and then planning a lesson to achieve the learning goal. The plan is presented and critiqued at a school-wide faculty meeting. At the next stage, a lesson is chosen for one of the teachers to present to a class, with the other teachers taking notes and closely monitoring what students are doing during this time. Afterwards, the teachers get together to evaluate what worked and what did not work, and the revised lesson is then taught to another class by another teacher and the process is repeated. The OECD states that in Asian countries, "Teachers work together to produce lessons that are superior in their power to engage students in the work and convey the knowledge and skills specified in the syllabus. Because teachers work together on this, no teacher's classroom is private. It is not uncommon in Asian classrooms for teachers to occupy the last rows in a classroom as they observe the practice of a teacher they particularly admire" (2010, p. 242). Through this process of evaluation and reflection teachers in Asian countries are able to master the art of teaching, as teachers who lagged behind can learn how a lesson is more effectively taught.

The isolation of United States teachers and lack of collaboration has hindered our ability to improve the practice of teaching (Stigler & Hiebert, 1999). Teaching in the United States is seen as a private rather than public activity. Opportunities for professional development are less frequent here than in Asian countries. For example, in Shanghai, China each teacher is expected to engage in 240 hours of professional development within five years (OECD 2010). Similarly, Singapore "provides an entitlement of 100 hours of professional development per year to teachers to keep up with

the rapid changes occurring in the world and to be able to improve their practice. And Singapore, like other countries, is improving its performance-appraisal system, making sure that each teacher is appraised by a whole group of people every year against 16 different competencies" (OECD, 2010, p. 238). In contrast, U.S. teachers spend more time on instruction and less on professional development. Eighty percent of teachers' total working time is engaged in classroom instruction, whereas other nations' teachers spend about 60 percent of their time in instruction. Consequently, teachers in other nations have more time to plan and learn together as well as to develop high quality curriculum and instruction (Andree, Darling-Hammond, Orphanos, Richardson, & Wei, 2009).

Teacher Quality in the United States

The TIMSS 2011 study determined that teachers with more teaching experience, more confidence in mathematics teaching, and more career satisfaction are more likely to have students with higher mathematics achievement (Mullis et al., 2012, p. 281). Moreover, teacher preparation is a greater predictor of student achievement than socioeconomic status and language background (Mullis et al., 2012, p. 282). According to Marzano (2003), the most important factor determining student achievement is the teacher. By examining the achievement scores in math, reading, language arts, social studies, and science for 60,000 students in grades 3 to 5, Marzano determined that student achievement has a strong correlation with how effective the teacher is in the classroom. He states, "On the average, the most effective teachers produced gains of about 53 percentage points in student achievement over one year, whereas the least effective teacher produced achievement gains of about 14 percentage points over one year" (2003,

p. 72). For example, if a student scored in the 40th percentile on a standardized test at the start of the school year, he or she would be expected to score in the 93rd percentile on that same test at the end of the school year simply by having an effective teacher. As students typically gain 34 percentile points during an academic year, a gain of less than 34 points would be considered a consequence of ineffective teaching.

There are many categories of instructional strategies that affect student achievement. Among them are identifying similarities and differences, summarizing and note taking, reinforcing effort and providing recognition, homework and practice, nonlinguistic representations, generating and testing hypotheses, and cooperative learning (Marzano, 2003, p. 80). Students with teachers that had the class compare and contrast had a 45 percentile gain in achievement. Demonstrating how to summarize and take notes resulted in a 34 percentile gain in achievement. Reinforcing effort, homework, and nonlinguistic representations were linked to percentile gains of 29 percent, 27 percent, and 27 percent, respectively (Marzano, 2003, p. 80). These policies could be fostered through high-quality pedagogical preparation in pre-service programs.

Teachers who employ strong classroom management are also more likely to have higher achieving students. According to the TIMSS 2011 international study, 17 to 24 percent of eighth grade students were in classrooms that contained "a lot of student behavior problems, and consequently these students had lower average mathematics achievement. Eighth grade students that were in classrooms where instruction was limited by disruptive students scored 28 points lower than students in classrooms with minimal disruption. Students in classrooms where instruction was limited by uninterested students scored 34 points lower (Mullis et al., 2012, p. 390). Marzano argues, "An effective classroom manager implements and enforces rules and procedures, executes disciplinary actions,

and cultivates effective relationships with students without becoming upset if students violate classroom rules and procedures, react negatively to disciplinary actions, or do not respond to the teacher's attempts to forge relationships" (2003, p. 94). Marzano studied the effect of different disciplinary practices on student achievement, including reinforcement, punishment, no immediate consequences, and combined punishment and reinforcement. He defined reinforcement as some type of recognition or reward for positive behavior or timely cessation of negative behavior. Punishment was classified by involving some type of negative consequences such as loss of privileges or a time-out for inappropriate behavior. Combined punishment and reinforcement was found to be most effective, resulting in a 33 percentile decrease in disruptive behavior. Reinforcement alone resulted in a 31 percentile decrease. Punishment alone and no immediate consequences were least effective, resulting in a 25 percentile and 24 percentile respective decrease in disruptive behavior (2003, p. 90).

Teacher Qualification in the United States

In the United States, students learn more when teachers have additional degrees and coursework in mathematics (Mullis et al., 2012, p. 283). Twenty-eight percent of United States eighth grade math teachers majored in mathematics and mathematics education, 25 percent majored in mathematics education but not mathematics, 15 percent majored in mathematics but not mathematics education, and 31 percent majored in another subject (Mullis et al., 2012, p. 288). According to these statistics, only 43 percent of mathematics teachers in the United States have content degrees in mathematics. This number is significantly lower than those of the Asian countries that participated in the TIMSS 2011 study. For instance, 89 percent of Chinese Taipei math teachers have a

content degree in mathematics. Similarly, 81 percent of Japanese, 77 percent of Singapore, and 63 percent of Hong Kong math teachers have a mathematics content degree. The international average of eighth grade mathematics teachers with neither a math content degree nor a math education degree is 12 percent, well below the 31 percent of United States teachers without a mathematics related degree. In addition, Schmidt, Blomeke, and Tatto determined that on an international teaching assessment to measure future teachers' mathematical knowledge, the United States scored "between one and one-and-a-half standard deviations below the average performance of South Korea and Taiwan" (2011, p. 131). The majority of mathematics teachers in Asian nations are equipped with the mathematics background necessary to teach the subject, whereas the majority of United States teachers are not.

Examining the teacher preparation policies across states can give us insight as to why students in the United States have lower achievement than those of other countries. The National Council on Teacher Quality's (NCTQ) State Teacher Policy Yearbook[1] presents a "detailed analysis available of each state's performance against and progress toward a set of 36 specific, research-based teacher policy goals aimed at helping states build a comprehensive policy frame - work in support of teacher effectiveness" (*State Teacher Policy Yearbook, 2013. National Summary*, 2013, p. 1). The NCTQ analyzes five areas of teacher quality policies, including delivering well-prepared teachers, expanding the pool of teachers, identifying effective teachers, retaining effective teachers, and exiting ineffective teachers. The "delivering well-prepared teachers" criterion examines the admission into preparation programs. According to this goal, the

[1] The NCTQ is not a governmental or bipartisan national panel, as it is funded by private interests. However, its outline for teacher quality standards is reasonable for the purposes of this analysis.

state should require undergraduate teacher preparation programs to admit only candidates with good academic records. To meet this criterion, states should have teacher candidates demonstrate proficiency on a test that assesses reading, writing, and mathematics skills. Additionally, the NCTQ suggests that a common admissions test be used by all teacher preparation programs, as doing so would allow for program comparison (*State Teacher Policy Yearbook, 2013. National Summary*, 2013, p. 15). Pre-service elementary school teachers should have a content specialization in a specific subject area and be required to pass a subject matter test to demonstrate competency in the subjects being taught. Such measures would help ensure that elementary school teacher has a strong enough background to be teaching mathematics to his or her students. Elementary teacher preparation in mathematics is even an NCTQ goal of delivering well-prepared teachers. To meet the goal, teacher preparation programs should prepare prospective elementary school teachers in foundations, algebra and geometry with some statistics. Additionally, a rigorous mathematics-content test should be required for licensure, one that requires sufficient knowledge of mathematics to pass (*State Teacher Policy Yearbook, 2013. National Summary*, 2013, p. 26).

Chapter 2: Methodology

Selection of States

There are many factors that affect teacher preparation. This teacher policy analysis examines the teacher preparation policies in four different states—New York, Mississippi, Massachusetts, and Montana. It was important to look at several states in this analysis due to the level of variability in teacher preparation across the country. The criteria for training teachers in one state may very well differ from the criteria of another state, because education policy in the United States is left to the purview of each state. Moreover, examining more than one state in comparison to its outcomes will give us insight as to which policies might be most effective in teacher preparation. A purposeful sample of diverse states was essential to construct a useful analysis. The states chosen here not only represent different regions of the country, but their students' national performance in mathematics, as demonstrated on the National Assessment of Educational Progress, varies widely.

The National Assessment of Educational Progress, or NAEP, is a congressionally authorized project of the National Center for Education Statistics (NCES) within the Institute of Education Sciences of the U.S. Department of Education that "collects and reports information on student performance at the national and state levels, making the assessment an integral part of our nation's evaluation of the condition and progress of education." (*The Nation's Report Card*, 2011, p. 1). Using the information obtained, NAEP informs the public about the performance of elementary and secondary students.

The NAEP mathematics assessment "measures students' knowledge and skills in mathematics and students' ability to apply their knowledge in problem-solving

situations" (*The Nation's Report Card*, 2011, p. 4). The NAEP mathematics test is scored on a 0-500 scale, and in 2011 the average national score for fourth grade math students was 240. New York was chosen as it is a middle-performing state in mathematics. On the 2011 NAEP mathematics assessment New York fourth grade math students averaged a 241 (The Nation's Report Card, 2011 p. 23). This score is roughly halfway between the lowest and highest state scores on this assessment. In addition, New York represents a densely populated, urban sector of the country. Mississippi was chosen for historically being one of the lowest-performing states in mathematics. Since 1992, Mississippi fourth graders consistently scored the lowest in the nation on the NAEP mathematics assessment. In 2011, fourth graders averaged the lowest national score of 230 on this assessment, making the state of particular interest to analyze. As Mississippi is a southern state, investigating its teacher policies can give us insight into how southern education might work. Montana was chosen as it is a middle-scoring state on the NAEP mathematics assessment. In 2011, fourth grade math students scored an average of 244 on the exam. Montana is a rural northwestern state with one of the lowest population densities in the United States. By analyzing the teacher policies there we could compare them to those of an urban area like New York. Lastly, Massachusetts was chosen as it is a densely populated northeastern state that historically has been one of the strongest performing states on the NAEP mathematics assessment. Massachusetts fourth grade math students averaged a 253 on the 2011 NAEP assessment, the highest national score for the assessment.

Policy Indicator Selection

This teacher policy analysis was performed by exploring the following areas of teacher preparation in mathematics for elementary and secondary teacher candidates:

1. The content and quality requirements for individuals, which includes
    - The selection criteria for recruiting teachers into teacher preparation programs
    - The level of content teachers must take
    - The number of math courses required
    - The mathematics examinations required for certification
2. Requirements for the teacher preparation experience, including
    - The amount of field experience
    - The number of hours of student teaching
    - The experience required of cooperating teachers

Each category was then compared across the four states, with the goal of exploring whether variations in state policies might contribute to students' achievement.

The selection criteria that states require teacher preparation programs use to recruit teacher candidates could provide useful information about the quality of individuals who become future teachers. The grade point average of incoming teacher preparation candidates is an important factor to look at when determining whether the teacher candidate is well-suited to be teaching mathematics. A low GPA may indicate the potential teacher candidate is not knowledgeable or dedicated enough to be educating students, especially in a field like mathematics, in which United States students perform poorly. The GPA provides a measure of how knowledgeable and competent the teacher

is, and is one way to ensure we have the best and brightest math teachers in our classrooms teaching our students.

The level of content and number of math courses required for math teachers varies across the United States, particularly at the elementary level. For a proper teacher policy analysis, it would be necessary to explore the level and amount of mathematics that each state requires for teachers to complete a teacher preparation program. As math teachers will be educating students in mathematics, it would be crucial that they have a deep enough understanding of the subject for students to gain the most from their lessons. Teachers without an adequate mathematics content background may not give clear enough explanations when students ask a math question, for instance. Taking many advanced level math classes provides a strong background to teach classes and students of all levels.

Testing is an important factor in teacher preparation as it is one of the only ways to truly be sure teachers possess the required knowledge to be teaching mathematics. Taking classes in mathematics is not enough, as the math courses taken by one student could be different from those taken by another student. Having different content backgrounds could mean one teacher candidate is not as knowledgeable as the other. Likewise, a teacher candidate who receives a high grade in a math course may be under the impression that he is well-prepared in mathematics when in fact he may have just had a professor who is an easy grader. Testing requirements vary state by state, and since there is no national math certification test that all math teachers must take, examining the testing requirements for teacher candidates can be a useful source of information about how well teachers are prepared in mathematics.

Student teaching is an essential component of teacher preparation, as it marks the transition from educational theory into practice. While it is imperative that teacher candidates demonstrate proficiency in mathematics, it is also important that they possess the skills to effectively convey information across to students. Mathematical knowledge along with pedagogical practice is necessary to create a high quality math teacher. One factor to be considered is the number of student teaching hours the state mandates student teachers complete as part of their teacher preparation program. More practice could imply there would be more feedback from cooperating teacher about what the student teacher is doing correctly and what areas need improvement. Another factor to consider is the experience the student teacher's cooperating teacher is required to have. A cooperating teacher who is experienced and well qualified could provide better advice to the teacher in training.

Chapter 3: Results

Selection Requirements

New York

Math teacher candidates in New York are required to achieve a cumulative grade point average of 3.0 in the program or programs leading to any degree used to meet the certification requirements ("Regulations of the Commissioner Section 52.21," n.d.). In addition, the Official Compilation of Codes, Rules and Regulations of the State of New York states that "a candidate must have achieved at least a C or its equivalent in any undergraduate level course and at least a B- or its equivalent in any graduate level course in order for the semester hours associated with that course to be credited toward meeting the content core or pedagogical core semester hour requirements for a certificate" (2011, p. 9). According to this law, teachers at the elementary and secondary level could receive a C average in all the math courses required for certification and still be permitted to teach.

Mississippi

According to the Mississippi Department of Education, "prior to being admitted to a teacher education program, students shall have completed minimum of 44 semester hours of coursework achieving a minimum grade point average of 2.5 on this coursework" (Buckley, Gettis, & House, 2006, p. 9). Unlike New York, Mississippi requires a low grade point average to be eligible to teach. To its credit, Mississippi does require prospective teachers meet certain testing requirements for admission into a teacher preparation program. Mississippi applicants have three testing options: pass the Praxis I Pre-Professional Skills Tests in reading, writing, and math; receive a minimum

ACT score of 21, with no score lower than 18 in any subcategory; or receive a minimum combined verbal and quantitative SAT score of 860 (Buckley, Gettis, & House, 2006, p. 5). Considering the national average combined SAT score is around 1000 ("Average SAT Scores - SAT Reasoning Test," 2012), Mississippi is permitting individuals who performed well below average to enter into teacher preparation programs.

Massachusetts and Montana

Massachusetts and Montana laws do not specify a required GPA for admission into a teacher preparation program (*State Teacher Policy Yearbook, 2013. National Summary*, 2013).

Four-State Comparison

New York specifies the highest, most detailed overall initial entry requirements. These policies are relatively new and would not be expected to have had an impact on NAEP scores yet.

Table 1: Selection Criteria for Elementary and Secondary Teachers in Mathematics

State	GPA	Content Grades	Admissions Test
NY	3.0	Minimum of C average required for math courses	None
MS	2.5	Grades required for math courses not specified.	Praxis I, ACT, or SAT
MA	Not specified	Not specified	None
MT	Not specified	Not specified	None

Level of Content

Due to the No Child Left Behind Act of 2001, all teachers in the United States are required to have bachelor's degree, and secondary education (grades 7-12) teacher candidates must complete 30 credits in the discipline they plan on teaching ("New No

Child Left Behind Flexibility," 2005). This requirement is equivalent to 10 math-related courses for candidates intending to teach mathematics in grades 7-12. As a consequence, high school teachers in all of the states throughout the United States should have similar content requirements to be eligible to teach mathematics. The variation in math coursework requirements is more noticeable at the primary education level.

New York

According to the Official Compilation of Codes, Rules and Regulations of the State of New York (2011), New York elementary education candidates must complete 30 credits of coursework in a liberal arts or sciences field in addition to general education requirements. The rules and regulations further state that "The candidate shall complete six semester hours in mathematics, six semester hours in science, and six semester hours in social studies within the content core and/or the general education core in the liberal arts and sciences" (p. 11). These rules mean that to teach mathematics at the elementary level in New York, two mathematics courses are required at a minimum. The state does not specify a specific level for the mathematics courses to be taken, so in theory even the most basic of math courses can count toward the requirement.

New York secondary teachers must "complete 30 semester hours of coursework in the subject area of the certificate title, which may include no more than six of the 30 semester hours in a cognate, meaning a related field as determined by the department" (Official Compilation of Codes, Rules and Regulations of the State of New York," 2011, p. 10). While this law follows the NCLB requirement of 30 credits in the subject to be taught, teachers are able to have 6 of those credits in cognate courses. This means two of the ten required classes can be outside of mathematics, in a related field such as computer

science. In theory, secondary education teachers in New York only need eight mathematics classes to teach grades 7-12.

Mississippi

The Mississippi Department of Education requires that all elementary teacher candidates take 9 semester hours in mathematics as part of their preparation for their certificate (Buckley, Gettis, & House, 2006, p. 6). This equates to three mathematics courses. Again, as in New York, the level of math courses required of elementary teacher candidates is not specified. Secondary education candidates "must have a major in a content area licensed by the state and complete a program of study" (Buckley, Gettis, & House, 2006, p. 7). The specific math courses that secondary education candidates must have are not specified by the Mississippi Department of Education, and therefore would vary depending on the program a teacher candidate is enrolled in.

Massachusetts

The Massachusetts Department of Education Guidelines for the Mathematical Preparation of Elementary Teachers requires elementary candidates to take "at least three to four college-level, subject-matter courses, i.e., 9–12 semester-hours, taught by mathematics faculty, potentially in partnership with education faculty" (Driscoll, Anderson, Chernow, & Plain, 2007, p. 4). The Massachusetts guidelines further specify the mathematics coursework required of elementary teachers as well as the weight each topic should receive. The recommended breakdown of content is 45 percent numbers and operations, 25 percent functions and algebra, 20 percent geometry and measurement, and 10 percent statistics and probability. The numbers and operations strand is emphasized because of its central role to teaching elementary mathematics (Driscoll, Anderson,

Chernow, & Plain, 2007, p. 4). Additionally, the more advanced topics that appear in the elementary mathematics classroom such as algebra, geometry, and statistics depend on having a solid foundation in the basics of numbers and operations.

As part of Massachusetts' subject matter knowledge requirements, secondary math teacher candidates complete courses in algebra, Euclidean geometry, trigonometry, discrete/finite mathematics, introductory calculus through integration, history of mathematics, abstract algebra, number theory, calculus through differential equations, probability and statistics, non-Euclidean and transformational geometries ("Regulations for Educator Licensure and Preparation Program Approval," 2014). Massachusetts uses specific language regarding what type of mathematics preparation is expected of secondary education candidates. The courses required are very advanced and exceed the knowledge necessary to teach secondary mathematics. The law makes it clear that taking low-level math classes will not satisfy the 30 math credit requirement.

Montana

Montana's board of education licensure guidelines do not specify how many mathematics credits or courses are required of elementary teacher candidates. They only state, "To obtain an elementary endorsement, an applicant must provide verification of completion of an accredited elementary teacher education program to include student teaching or university supervised teaching experience" ("Educator Licensure," 2009, p. 25). It is left up to the individual program the number and level of math courses to be taken. Theoretically, elementary teacher candidates can become certified without taking any math courses.

Secondary endorsement in Montana requires the applicant complete: "16 semester credits in a professional educator preparation program, including student teaching or an appropriate college waiver; and 30 semester credits in an approved major and 20 semester credits in an approved minor; or 40 semester credits in an extended major" ("Educator Licensure," 2009, p. 25). Montana's licensure laws require secondary math teachers have a minimum of 30 math credits, as would be expected from the NCLB Act. Rule 10.58.518 of Montana's "Standards for State Approval of Teacher Education Programs" (2007) requires secondary math teachers demonstrate content knowledge in numbers and operations, algebra, geometries, calculus, discrete mathematics, data analysis, statistics, probability, and measurement. This subject matter would be adequate to teach at math at the high school level; however, the level is basic and would not go beyond the mathematics encountered in high school. Higher level mathematics courses would be needed in order to have a deep understanding of the meaning of mathematics.

Four-State Comparison

Massachusetts was unique in that it had the most specific and most advanced mathematics content requirements, as shown in Table 2.

Table 2: Math Content Requirements

State	Number of Math Courses Required (Elementary)	Number of Math Courses Required (Secondary)	Level of Math Courses (Elementary)	Level of Math Courses (Secondary)
NY	2	10	Not Specified	Not Specified
MS	3	10	Not Specified	Not Specified
MA	3 - 4	10	Numbers, Algebra, Geometry, Probability	Advanced level courses
MT	0	10	Not Specified	Medium level courses

Elementary Testing Requirements

New York

New York teacher candidates must pass the New York State Teacher Certification Exams (NYSTCE) in order to receive certification. According to the NYSTCE Program Overview, the NYSTCE are "criterion-referenced, objective-based tests designed to measure a candidate's knowledge and skills in relation to an established standard rather than in relation to the performance of other candidates" (2014). The main reason these tests were adopted was to help identify and certify the candidates who have demonstrated the appropriate level of knowledge and skills required for performing the responsibilities of a teacher in New York State public school. One NYSTCE exam elementary education candidates must pass is the Multi-Subject content specialty test (CST), which includes material on mathematics among other subject. As New York is currently in the process of revising the content certification tests, the formats of the Multi-Subject CST required before and after September 2014 differ ("NYSTCE Program Update," 2014). The mathematics portion of the Multi-Subject CST currently in effect comprises approximately 18 percent of the entire exam. As the entire exam is 90 questions long, this amounts to about 16 mathematics questions.

The topics that elementary education teachers are expected to know on this exam fall into several categories. Understanding skills and concepts related to number and numeration, and applying these concepts to real-world situations is one objective of the multi-subject CST. Within this objective, test takers are expected to understand the commutative, distributive, and associative properties; use ratios, proportions, and percents to model and solve problems; solve problems using equivalent forms of numbers (such as integers, fractions, decimals, percents, and scientific notation), and problems

involving number theory (e.g., primes, factors, multiples); and simplify basic algebraic expressions. Knowledge of geometry is required for the multi-subject CST as well. Test takers are expected to apply knowledge of basic geometric figures to solve real-world problems, such as those involving area and perimeter, understand the concepts of similarity and congruency, use coordinate geometry to represent and analyze properties of geometric figures, and understand transformations including reflections, rotations, and dilations. Topics on measurement include demonstrating knowledge of the fundamental units, converting measurements, and determining the perimeter, area, and volume of different shapes. Lastly, test takers encounter questions regarding data analysis, statistics, and probability. They are expected to interpret data from different formats, such as histograms, tables, and pie charts; apply knowledge of mean, median, and mode; and compute probabilities using methods such as ratio, tree diagrams, and tables ("NYSTCE Multi-Subject CST Preparation Guide," 2006). One shortcoming of this version of the Multi-Subject CST is that it does not have a specific minimum score for the mathematics section. Given that the mathematics component of this CST makes up less than one-fifth of the exam, one could easily fail the entire mathematics section and still receive a passing grade on the test that would certify the person to teach mathematics. For the purposes of this analysis, it is important to note that this exam is the one current classroom teachers have taken. Thus, any relationship between tests and student achievement would be connected to this test, not the new one.

The format of the new Multi-Subject CST that goes into effect September 2014 will be markedly different than the current version. One major change is that this new version will consist of three separate subtests, one of which is mathematics ("Multi-

Subject: Teachers of Childhood Assessment Design and Framework Draft," 2012). The significance of this change is that teacher candidates must show competency in basic mathematical principles, as a passing score will be required for the math section in order to be eligible for certification. The number of multiple choice questions will increase to 40, nearly three times the number on the current exam. This difference means that elementary candidates will be tested more extensively on their knowledge of mathematical material. A new addition to the new CST is the inclusion of an open response mathematics question. This change is significant in that the test takers will have to show step by step how to solve the mathematics problem, and use higher-order thinking skills during the process rather than just choose the right answer. The mathematics topics on the new CST do not differ by much from those on the original; however, the new version specifies the weight each topic will receive ("Multi-Subject Framework Draft," 2012, p. 3). The outline of the test can be summarized in Table 3:

Table 3: New Multi-Subject CST Math Subtest Format

Topic	Number of Questions	Percent of Subtest
Numbers and Operations	3	6
Ratios and Proportional Relationships and Number Systems	15	30
Algebra, Measurement, Geometry, and Data	17	34
Instruction in Mathematics	5	10
Constructed Response	1	20
Total	41	100

In the updated Multi-Subject CST, the basic number-related topics receive approximately equal weight with the more advanced topics of Algebra, Measurement, Geometry, and Data. Consequently, elementary candidates would have to show they have as much proficiency in topics taught in early grades as those taught in higher grades. The open

response will be worth one-fifth of the total subtest score, indicating the new version emphasizes the process of analyzing and solving mathematics problems.

Mississippi

Elementary teacher candidates in Mississippi must pass the Elementary Education: Curriculum, Instruction and Assessment Praxis II test ("Mississippi Licensure Guidelines K-12," 2013). This 2 hour Praxis test consists of 110 multiple choice questions, 20 percent of which are about mathematics. This amounts to 22 mathematics questions for test-takers. Topics covered include number operations, geometry, measurement, algebra, and probability and statistics ("Elementary Education: Curriculum, Instruction and Assessment Preparation Guide," 2014, p. 14). The Elementary Education Praxis exam is analogous to the New York Multi-Subject CST. However, this Praxis test incorporates both content and pedagogy-based questions at once. Questions are not only on the content of mathematics, but on the instruction and assessment of mathematics as well. This differs from New York in that the test covers content and pedagogy together, rather than on separate tests.

Massachusetts

Massachusetts requires that all elementary teachers pass the Massachusetts Test for Education Licensure or MTEL General Curriculum test. Massachusetts provides an excellent example for testing future elementary teachers in mathematics, as the MTEL is one of the few elementary certification tests nationwide that contains a separately scored math subtest. Consequently, if a teacher candidate fails the mathematics subtest then he or she must retake the test. This practice differs from New York's prior policy and Mississippi's current policy, in which it is possible to fail the entire math section of the

test, receive a passing score, and be eligible for certification. The math subtest contains approximately 45 multiple choice mathematics questions as well as a written response math question. The MTEL subtest is broken into five categories, each of which receives different weight. The test is 41 percent numbers and operations, 22 percent functions and algebra, 18 percent geometry and measurement, 9 percent statistics and probability, and 10 percent integration of knowledge and understanding ("Massachusetts Tests for Educator Licensure General Curriculum Test Objectives," 2008). The MTEL mathematics subtest outline is illustrated in Table 4:

Table 4: MTEL Mathematics Subtest Outline

Topic	Number of Questions	Percent of Subtest
Numbers and Operations	21	41
Functions and Algebra	11	22
Geometry and Measurement	9	18
Statistics and Probability	5	9
Constructed Response	1	10
Total	47	100

The content contained on this test is akin to that of the Multi-Subject CST and the Praxis, with the exception that functions are included as a topic. The format of the MTEL is noticeably different from both the current Multi-Subject CST and the Praxis exam in that it contains significantly more math questions for elementary teacher candidates. It contains approximately three times the number of math questions on the old Multi-Subject CST and twice the number on the Praxis. Another major difference is that there is a written math component on the MTEL. Students are to apply their mathematical knowledge and reasoning to communicate detailed solutions to a problem involving two or more of the aforementioned MTEL math categories. In addition, unlike New York and Mississippi tests, the Massachusetts test has a set percentage of questions for each

category. For example, about two-fifths of the test is on numbers and operations. This ensures elementary teacher candidates are tested more extensively on the topics they will encounter the most when teaching.

Montana

Montana is one of only two states in the United States that does not require any teacher certification test, either pedagogy or content-based (*2013 State Teacher Policy Yearbook. Montana*, 2013). The lack of a testing requirement is one factor that puts Montana's teacher preparation behind that of most other states. Both elementary and secondary teacher candidates can become certified without demonstrating they have the knowledge of the content necessary to teach mathematics. As a consequence students from kindergarten all the way up to twelfth grade are taught mathematics by teachers who may not be competent in the subject.

Four-State Comparison

The state by state test results are demonstrated in Table 5. The future New York test will have a similar format to the current Massachusetts test.

Table 5: Testing Requirements for Primary Teachers in Mathematics

State	Test	Number of Math Questions	Separately Scored Math Subtest	Open Response Math Question
NY[2]	Multi-Subject CST	16	No	No
NY[3]	Multi-Subject CST	40	Yes	Yes
MS	Praxis	22	No	No
MA	MTEL	45 + Open Response	Yes	Yes
MT	None	0	No	No

[2] Current Multi-Subject CST format
[3] Multi-Subject CST format effective September 2014

Secondary Testing Requirements

New York

New York secondary math teacher candidates must pass the Mathematics Content Specialty Test (CST) as part of the certification process. The test contains 90 multiple-choice test questions and one constructed-response (written) assignment. The Mathematics CST assesses knowledge and skills of secondary mathematics teachers in six areas: Mathematical Reasoning and Communication; Algebra; Trigonometry and Calculus; Measurement and Geometry; Data Analysis; Probability, Statistics, and Discrete Mathematics; and a Constructed-Response Assignment ("NYSTCE Mathematics CST Preparation Guide," 2006, p. 6). Additional goals of Mathematics CST are for the mathematics teacher to demonstrate an ability to reason logically, understand the connections between mathematics and other disciplines, communicate mathematically (as in explaining mathematical concepts and processes), and apply mathematics in real-world settings ("NYSTCE Mathematics CST Preparation Guide," 2006, p. 7). The incorporation of the open-response advanced algebra question enables test-takers to demonstrate their thought process while solving the question, something not possible on multiple choice questions. The Mathematics CST Preparation Guide (2006) requires that test-takers "support the response with appropriate examples and/or sound reasoning reflecting an understanding of the relevant knowledge and skills" (p. 42). The benefit of this requirement is that the teacher candidate is evaluated not just on a correct answer but how well he or she is able to effectively communicate the solution. Because communication is an essential component of teaching, the inclusion of this type of question can provide a similar experience to explaining the steps to solving a problem to a math student.

Mississippi

Secondary teacher candidates in Mississippi must pass the Praxis II in the content area of Mathematics ("Mississippi Licensure Guidelines K-12," 2013, p. 12). The Praxis Mathematics test is "designed to assess the mathematical knowledge and competencies necessary for a beginning teacher of secondary school mathematics" ("Praxis Mathematics: Content Knowledge Topics," 2013, p. 12). Moreover, the Praxis requires the test taker to "understand and work with mathematical concepts, reason mathematically, make conjectures, see patterns, justify statements using informal logical arguments, and construct simple proofs" (2013, p. 12). The Praxis test consists of 50 questions total, nearly half the number on the Mathematics CST. The test covers the areas of Algebra and Number Theory, Measurement, Geometry, Trigonometry, Functions, Calculus, Data Analysis and Statistics, Probability, Matrix Algebra, and Discrete Mathematics. The topics covered on the Praxis are the same as those on the Mathematics CST; the main difference is the number of questions and ratio each topic receives. For instance, the algebra section on the Praxis contains only eight questions, whereas the Mathematics CST contains more than triple that number, indicating the Praxis is not as comprehensive at assessing topics teachers are most likely to encounter in high school mathematics classrooms. Another weakness of the Praxis is that it lacks a constructed response section, meaning test-takers are not challenged to think analytically, nor demonstrate the ability to explain the step-by-step process of solving a complex mathematics problem.

Massachusetts

Secondary education mathematics candidates seeking certification in Massachusetts must pass the Mathematics MTEL test, which "assesses the candidate's proficiency and depth of understanding of the subject at the level required for a baccalaureate major, according to Massachusetts standards" ("MTEL Test Information Booklet - Mathematics," 2013, p. 23). The Mathematics MTEL consists of 100 multiple-choice questions and 2 open-response item assignments. The topics include number sense and operations; patterns, relations, and algebra; geometry and measurement; data analysis, statistics, and probability; trigonometry, calculus, and discrete mathematics; and integration of knowledge and understanding. Out of all states in this analysis, Massachusetts has the greatest number of questions, indicating teacher candidates are tested extensively on mathematics skills. Like the Mathematics CST, algebra receives the most emphasis on the MTEL exam, containing about twenty-seven such questions. On the topic of geometry and measurement, the MTEL contains at least six more questions than the CST and three times as many as the Praxis. In contrast to the Mathematics CST, the MTEL emphasizes basic math topics in addition to the advanced ones by including about 14 questions on number sense and operations. One unique quality about the MTEL is that it contains two open response math questions, making it one of the strongest test designs. Teacher candidates' critical thinking skills are tested thoroughly when they apply knowledge of subject matter, provide high-quality and relevant supporting evidence, and demonstrate a soundness of argument and understanding of the mathematics field ("MTEL Test Information Booklet - Mathematics," 2013, p. 23).

Montana

Montana does not require secondary math teacher candidates take a certification test in mathematics.

Four-State Comparison

The content breakdown of each test is illustrated in the Table 6. Massachusetts and New York have the strongest secondary test formats, given they both have the highest number of questions in addition to having an open-response section.

Table 6: Number of Questions by Topic on Secondary Mathematics Content Tests

	New York		Mississippi		Massachusetts	
	CST (Number)	CST (Percent)	Praxis (Number)	Praxis (Percent)	MTEL (Number)	MTEL (Percent)
Number Sense and Operations	0	0	8	16	14-16	12
Algebra	26	26	8	16	27-29	22.4
Measurement	17	17	3	6	23-25	19.2
Geometry			5	10		
Trigonometry	17	17	4	8	19-21	16
Calculus			6	12		
Discrete Mathematics	17	17	3-4	6-8		
Statistics and Probability			7-9	14-18	12-14	10.4
Matrix Algebra	0	0	4-5	8-10	0	0
Mathematical Reasoning	13	13	0	0	0	0
Open Response	1	10	0	0	2	20
Total	91	100	50	100	100	100

Student Teaching and Field Requirements

New York

Student teaching is an integral part of the teacher preparation experience. New York requires that "All registered programs shall include at least 100 clock hours of field experiences related to coursework prior to student teaching or practica" ("Regulations of

the Commissioner Section 52.21," n.d.). The inclusion of field experience means that teacher candidates can learn different pedagogical practices from the teachers they observe, which could ultimately prepare them for when they student teach. Teacher candidates may also use their observation time to assist the teacher such as by tutoring students in individually or in groups. Once observation experiences and coursework requirements are complete, the teacher candidate begins student teaching. Student teaching in New York "shall include at least two college-supervised student-teaching experiences of at least 20 school days each; or at least two college-supervised practica with individual students or groups of students of at least 20 school days each. This requirement shall be met by student teaching" ("Regulations of the Commissioner Section 52.21," n.d.). This totals a minimum of 40 days of student teaching in order to be eligible for certification. By requiring a minimum of two student teaching placements, teacher candidates receive guidance from at least two cooperating teachers, which results in a more complete teacher preparation experience.

Mississippi

According the Mississippi department of education, "Prior to completing a teacher education program, students shall have successfully completed a minimum of 12 weeks (60 working days), full day student teacher experience" (Buckley, Gettis, & House, 2006). Interestingly, the number of required student teaching days exceeds that of the other three states, which can be seen as a strength of the state. However, Mississippi guidelines make no mention of what the student teaching experience entails or how student teachers are evaluated. Moreover, Mississippi guidelines do not mention a requirement of field experiences for teacher candidates prior to student teaching, meaning

there is a possibility of teacher candidates entering student teaching after spending only minimal time observing classes.

Massachusetts

Massachusetts emphasizes the importance of observation experiences that teacher candidates must have: "Field-based experiences are an integral component of any program for the preparation of educators. They must begin early in the preparation program (pre-practicum) and be integrated into the courses or seminars that address Professional Standards for Teachers" ("Regulations for Educator Licensure and Preparation Program Approval," 2014). However, the law does not specify a required number of hours for teacher candidates to observe classrooms prior to student teaching. For student teaching Massachusetts regulations require that all teacher candidates to complete 300 hours of a practicum or practicum equivalent. Furthermore, "All individuals in educator preparation programs shall assume full responsibility of the classroom for a minimum of 100 hours" ("Regulations for Educator Licensure and Preparation Program Approval," 2014). Of all the states in this analysis Massachusetts is the only one that specifies the amount of experience the student teacher's cooperating teacher must have. The cooperating teacher must have "at least three full years of experience under an Initial or Professional license and has received an evaluation rating of proficient or higher, under whose immediate supervision the candidate for licensure practices during a practicum." ("Regulations for Educator Licensure and Preparation Program Approval," 2014). This rule helps ensure the student teacher is receiving guidance from someone who not only has years of teaching experience, but has demonstrated the skills of being an effective teacher.

Montana

Montana requires students observe classrooms as part of their teacher preparation program experience. Montana's administrative rules state: "Field experiences facilitate candidates' development as professional educators by providing opportunities for candidates to observe in schools and other agencies, tutor students, assist teachers or other school personnel, attend school board meetings, and participate in education-related community events prior to clinical practice" ("Standards for State Approval of Teacher Education Programs," 2007, p. 13). Montana's board of education licensure laws require "teaching experience while under the supervision of an accredited professional educator preparation program" ("Educator Licensure," 2009, p. 9). Montana uses assessment strategies to evaluate candidates' performance and effect on student learning, such as providing candidates feedback from peers and faculty during the student teaching experience. The goal of clinical practice is for candidates "to develop and demonstrate knowledge, skills, and dispositions for helping all students learn" ("Standards for State Approval of Teacher Education Programs," 2007, p. 13). While it is clear Montana emphasizes student teaching, its laws do not specify a required number of hours or days for student teaching.

Four-State Comparison

The student teaching requirements of each state can be outlined in Table 7. Massachusetts provides the most complete student teaching experience, by requiring field experience, hours of full-classroom responsibility, and a proficient cooperating teacher.

Table 7: Student Teaching Requirements by State

State	Field Experience	Number Student Teaching Days	Hours of Full Classroom Responsibility	Cooperating Teacher Experience
NY	100 Hours Required	40	Not Specified	Not Specified
MS	Not Specified	60	Not Specified	Not Specified
MA	Required	40	100	3 Years and a Rating of "Proficient"
MT	Required	Not Specified	Not Specified	Not Specified

Chapter 4: Discussion

Mathematics plays an integral role in students' futures, as it enables them to think logically and abstractly. The National Council of Teachers of Mathematics (NCTM) contends: "Today's students must master advanced skills in mathematics, science, and technology to stay on track for college and for promising careers. Mathematics teaches ways of thinking that are essential to work and civic life" ("Mathematics in Today's World," 2014). Many careers involve mathematics on some level. For example engineering jobs require a deep understanding of mathematics; however, few students in the United States have studied engineering in comparison to Asian nations. In 2008, "4 percent of U.S. bachelor's degrees were awarded in engineering, compared to 31 percent in China." ("America's STEM Education Problem," 2014). The fact that so few Americans enter into engineering may stem from the quality of mathematics preparation they received early on. If students do not receive a strong mathematics background from their teachers in elementary school and high school, then their potential for employment in mathematics-related careers is limited. It is not just engineers who require mathematics skills. Blue-collar jobs require mathematics as well. The critical thinking skills that are a natural part of mathematics "can help students succeed in their jobs and their lives even if they do not continue their education beyond high school or do not pursue a math- or science-oriented career" (Why it is Important to Learn Algebra, 2009). For instance, to become an electrician, applicants must demonstrate competency in mathematics by passing an algebra test when applying to an apprenticeship program ("Applying and Qualifying for Apprenticeship in the Electrical Industry :: NJATC," n.d.). According to the NCTM, advanced mathematics formulas are used by entry-level automobile workers

when wiring a car's electrical circuits ("Mathematics in Today's World," 2014). Even construction jobs involve measurement, understanding of angles, and use of the Pythagorean Theorem.

Education policies across the United States will probably not be able to match the home-life connections, salary parity with other professions, or the number of school days in Asian countries. However, states do have control over how they prepare their teachers. Given that United States is ranked eleventh internationally in fourth grade mathematics, and eighth in eighth grade mathematics on the TIMSS examination, it is essential that the United States adopt the best teacher preparation requirements to help reverse the poor performance of students in mathematics. As it stands now, Asian nations will continue to dominate in mathematics, and the United States will continue to fall behind unless action is taken. The No Child Left Behind Act was one measure to improve teacher quality in the United States, as all secondary mathematics teachers now must have the equivalent of a mathematics major in order to teach. Teacher preparation impacts students' mathematics performance at both the national and international levels, and encompasses a variety of factors, including requirements for teacher candidate selection, the level of mathematics courses that must be taken, certification testing, and student teaching. How states address each area may be a determining factor in their students' success in mathematics.

States should be more selective about who can be admitted into a teacher preparation program. The United States as a whole appears to be somewhat lax in its selection criteria. In all of the states examined, from low-performing to high-performing, the selection process was at best a matter of the GPA. The lowest performing state in

mathematics, Mississippi, required a 2.5 GPA for teacher candidates entering into teacher preparation programs. A 2.5 GPA does not require much effort, considering that GPA is just above a "C" average. Permitting individuals with such a low GPA to train to become future educators of children suggests that even those who demonstrate minimal competency in mathematics could be educating the next generation of students. Of all the states in this analysis, only New York's laws specified a minimum grade for content coursework leading to certification. However, a grade of "C" in the math courses leading up to certification should not be sufficient for those intending to teach mathematics. Such low standards imply that prospective teachers could simply take the required mathematics classes without acquiring much knowledge. Massachusetts, despite being a top state for student performance in mathematics, did not even specify a GPA requirement for admission. Although Massachusetts' strengths in other areas of teacher preparation outweighed its failure to include a minimum GPA requirement, it is nonetheless illogical to allow those with little to no education to be entering into careers in education. There ought to be more uniformity in the United States regarding the minimum grades necessary to be admitted to teacher preparation program, especially in the subject being taught. A reasonable suggestion would be for all states to require a minimum 3.0 GPA both overall as well as in the area of content specialization.

Another way for the United States to be more selective is for all states to require an admissions test. Interestingly, the one state that required an admissions test for teacher preparation programs, Mississippi, was also the state with the lowest student performance in mathematics on the NAEP assessment. While an admissions test in principle could be beneficial in allowing only the very best to enter teacher preparation programs, it fails to

achieve its purpose when individuals with SAT scores below the national average are permitted to enter into Mississippi teacher preparation programs. To be more selective, states could adopt a similar policy of requiring the Praxis I or SAT scores for education programs but simply raise the minimum score to that of the national average. Doing so would mean that teacher candidates chosen would have at least a basic understanding of mathematics before even beginning the program.

The level of content a teacher candidate is exposed to was one of the more significantly variable factors in the teacher preparation process. In order to remain competitive with the rest of the world in mathematics, United States teacher preparation programs need to address the inconsistency of math content requirements that exists from one state to another, especially at the elementary level. Montana's laws on education, for instance, contained no language requiring mathematics courses for teaching requirements or for a bachelor's degree in general, which potentially allows elementary teachers to teach without taking any math courses. If elementary students are taught by teachers with minimal or no mathematical preparation at the elementary level, then it stands to reason that those same students may struggle in mathematics during their high school years, with the possibility of never truly grasping mathematical principles. At the same time, there were states like Massachusetts, in which the laws provided clear, specific language on the content background that is required for teacher candidates. By requiring both elementary and secondary math teacher candidates to experience advanced mathematics before ultimately teaching the subject, Massachusetts proved to be a quintessential example of policy requirements for pre-service teachers. In contrast, none of the other states in this analysis required elementary teacher candidates to take specific math coursework. Given

that Massachusetts students lead the United States in mathematics performance, states should take note of the policies in Massachusetts and consider requiring elementary teacher candidates to take courses similar to those of Massachusetts, namely, numbers and operations, functions and algebra, geometry and measurement, and statistics and probability.

Although there was no variation in the number of math courses needed for secondary math teacher candidates due to the NCLB Act, Massachusetts stood out by requiring challenging, high-level math courses for future secondary math teachers. All states would likely benefit by requiring secondary education candidates to take advanced math courses, because teachers should have a deep understanding of mathematics in order to be able to explain to students why certain mathematical rules exist. A strong content background would enable teachers to engage students in developing proofs as is done in Asian nations. Teaching high school students with a minimal mathematics background, which is possible in New York, Montana, and Mississippi, limits the opportunities for having students use higher-order thinking skills. If teachers have inadequate content preparation, one could expect classrooms in which students simply memorize facts and rules to be commonplace, and those that actually engage students' critical thinking in activities such as proofs to be the exception, not the rule.

Content certification tests should also be an integral part of any teacher preparation policy for mathematics. The quality of mathematics certification tests for teachers appeared to correlate with student performance on the NAEP mathematics assessment. For instance, the strongest performing state on the NAEP assessment, Massachusetts, also had the best format for math certification tests. While the vast

majority of states do require content certification tests for teachers, there is still a lot to be done regarding the format of these tests. One measure that could be taken is to increase the number of mathematics questions on the elementary certification tests. Massachusetts' MTEL General Curriculum test contained significantly more multiple choice math questions than the other states, and could serve as a template for certification tests in other states. Fortunately, New York is in the process of converting to an elementary certification test format similar to the MTEL. More questions mean the teacher candidate's math skills are tested more extensively. Moreover, elementary certification tests should include an open response question like the MTEL does so that test takers can demonstrate they have the ability to analyze a situation and show their thought process as they solve the problem step-by step. How one arrives at a solution is as important as the solution itself. The Praxis II could be described as one of the weaker elementary teacher certification exams, not only for the limited number of math questions, but because it mixes pedagogy with mathematical content. As a consequence, it could be argued that the Praxis does not measure mathematical knowledge as well as tests of other states, such as New York or Massachusetts, as these states test content knowledge and pedagogical knowledge on different examinations. Lastly, elementary certification tests should contain a separate subtest for mathematics, as is the case in Massachusetts. This measure would preclude elementary teacher candidates from becoming certified teachers without specifically passing a mathematics subtest. The Praxis and current NYSTCE Multi-Subject CST both failed to include a mathematics subtest, making it possible for teacher candidates to fail the math sections yet still pass the test and become certified.

The student teaching experience is a crucial part of any teacher preparation program. As it is practice-based, it is the part of the teacher preparation program that most directly prepares teacher candidates for their future as teachers. All states would benefit by requiring field experiences, full-classroom responsibility, and an experienced cooperating teacher.

New York, Massachusetts, and Montana all required field experiences prior to student teaching. New York put the most emphasis on field experiences by requiring teacher candidates to observe classrooms for 100 hours. This policy is beneficial in that it creates a smooth transition from teacher candidate to student teacher. Teacher candidates would have already have some experience interacting with students and performing classroom functions before they take a more active role in student teaching.

The states in this analysis had different laws regarding the amount of time required for student teaching. Mississippi stood out by requiring the greatest number of hours for student teaching. Montana also stood out by neglecting to mention a required amount of time for student teaching. New York and Massachusetts both required the equivalent of 40 hours of student teaching; however, Massachusetts' laws also mentioned that the student teacher must have at least 100 hours of full-classroom responsibility. States would benefit by following a similar policy of requiring hours for full-classroom responsibility in order to be sure the student teacher receives thorough training.

Lastly, the quality of student teaching is vital to teacher preparation as well. Quantity is not sufficient. While Mississippi was strong with regard to the quantity of student teaching, its failure to articulate requirements for the cooperating teacher could be viewed as a weakness. Out of all the states, Massachusetts appeared to excel in the area

of student teaching quality, and could serve as an example for other states to follow. It was the only state that required a cooperating teacher with years of experience and a rating of "proficient." Being trained by an experienced teacher with strong credentials ensures the student teacher receives a high quality experience, which was not apparent in the other states' laws.

References

America's STEM Education Problem. (2014). National Math + Science Initiative. Retrieved from http://nms.org/education/thestemcrisis.aspx

Applying and Qualifying for Apprenticeship in the Electrical Industry :: NJATC. (n.d.). Retrieved April 22, 2014, from http://www.njatc.org/training/apprenticeship/sample/sample_test.html

Average SAT Scores - SAT Reasoning Test. (2012). College Board. Retrieved from https://professionals.collegeboard.com/testing/sat-reasoning/scores/averages

Buckley, D., Gettis, G., & House, L. (2006). 2006 Process Guide: Annual Process and Performance Reviews of Mississippi Educator Programs. Mississippi Department of Education. Retrieved from http://www.mde.k12.ms.us/docs/educator-licensure/process-and-performance-reviews-2006.pdf?sfvrsn=0

Driscoll, D. P., Anderson, M. C., Chernow, M. H., & Plain, J. (2007). Guidelines for the mathematical preparation of elementary teachers. Malden: Massachusetts Department of Education. Retrieved from https://www.doe.mass.edu/mtel/mathguidance.doc

Elementary Education: Curriculum, Instruction and Assessment Preparation Guide. (2014). Educational Testing Service. Retrieved from http://www.ets.org/s/praxis/pdf/5011.pdf

Educator Licensure. (2009). Administrative Rules Of Montana. Retrieved from http://opi.mt.gov/PDF/arm/57chapter.pdf

Marzano, R. J. (2003). What works in schools [electronic resource]: translating research into action / Robert J. Marzano. Alexandria, VA: Association for Supervision and Curriculum Development, c2003.

Massachusetts Tests for Educator Licensure General Curriculum Test Objectives. (2008). Massachusetts Department of Elementary and Secondary Education. Retrieved from http://www.mtel.nesinc.com/PDFs/MTELobjs_newfld03_2.pdf

Mathematics in Today's World. (2014). The National Council of Teachers of Mathematics. Retrieved from http://www.nctm.org/resources/content.aspx?id=9344

Mississippi Licensure Guidelines K-12. (2013). Mississippi Department of Education. Retrieved from http://www.mde.k12.ms.us/docs/educator-licensure/licensure-guidelines-k-12.pdf?sfvrsn=0

MTEL Test Information Booklet - Mathematics. (2013). Pearson Education, Inc. Retrieved from http://www.mtel.nesinc.com/PDFs/09_MATH.pdf

Mullis, I. V. S., Martin, M. O., Foy, P., Arora, A., International Association for the Evaluation of Educational Achievement, & Trends in International Mathematics and Science Study. (2012). TIMSS 2011 international results in mathematics.

Multi-Subject: Teachers of Childhood (Grade 1 - Grade 6) Assessment Design and Framework Draft. (2012). New York State Education Department. Retrieved from http://www.nystce.nesinc.com/PDFs/NY221_222_245_OBJ_DRAFT.pdf

New No Child Left Behind Flexibility: Highly Qualified Teachers. (2005). U.S. Department of Education. Retrieved from http://www2.ed.gov/nclb/methods/teachers/hqtflexibility.html

NYSTCE Mathematics CST Preparation Guide. (2006). New York State Education Department. Retrieved from http://www.nystce.nesinc.com/PDFs/NY_fld004_prepguide.pdf

NYSTCE Multi-Subject CST Preparation Guide. (2014). Retrieved March 24, 2014, from http://www.nystce.nesinc.com/PDFs/NY_fld002_prepguide.pdf

NYSTCE Program Overview. (2014). Retrieved March 23, 2014, from http://www.nystce.nesinc.com/NY17_overview.asp

NYSTCE Program Update. (2014). Retrieved April 18, 2014, from http://www.nystce.nesinc.com/NY_annProgramUpdate.asp#TestMaterials

OECD (2011), Lessons from PISA for the United States, Strong Performers and Successful Reformers in Education, OECD Publishing. http://dx.doi.org/10.1787/9789264096660-en

Official Compilation of Codes, Rules and Regulations of the State of New York. (2011). Department of State - Division of Administrative Rules. Retrieved from http://www.highered.nysed.gov/tcert/pdf/part80-3.pdf

Praxis Mathematics: Content Knowledge Topics. (2013). Educational Testing Service. Retrieved from http://www.ets.org/s/praxis/pdf/5061.pdf

Regulations for Educator Licensure and Preparation Program Approval. (2014). Massachusetts Department of Elementary and Secondary Education. Retrieved from http://www.doe.mass.edu/lawsregs/603cmr7.html?section=08

Regulations of the Commissioner Section 52.21. (2014). Retrieved April 7, 2014, from http://www.highered.nysed.gov/ocue/52.21.htm

Schmidt, W. H., Blomeke, S., & Tatto, M. S. (2011). *Teacher Education Matters: A Study of Middle School Mathematics Teacher Preparation in Six Countries*. New York, NY: Teachers College Press.

Standards for State Approval of Teacher Education Programs. (2007). Administrative Rules Of Montana. Retrieved from http://opi.mt.gov/PDF/arm/58chapter.pdf

State Teacher Policy Yearbook. Montana. (2013). National Council on Teacher Quality.

State Teacher Policy Yearbook, 2013. National Summary. (2013). National Council on Teacher Quality.

Stevenson, H. W., & Stigler, J. W. (1992). *The Learning Gap: Why Our Schools are Failing and What We Can Learn from Japanese and Chinese Education*. New York: Simon & Schuster.

Stigler, J. W., & Hiebert J. (1999). *The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom*. New York: Simon & Schuster.

The Nation's Report Card: Mathematics 2011. National Assessment of Educational Progress at Grades 4 and 8. NCES 2012-458. (2011). National Center for Education Statistics.

Why It Is Important to Learn Algebra. Parent/Student Guide. (2009). EdSource. Retrieved from http://files.eric.ed.gov/fulltext/ED505525.pdf

Wagner College

Graduate Thesis Copyright Release Form

Document Identification

Student Name: Michael Farina

Thesis Title: AN ANALYSIS OF TEACHER PREPARATION POLICIES ACROSS FOUR STATES: EXPLORING POLICIES THAT MAY RAISE STUDENT ACHIEVEMENT

Department: Education

Author Agreement

I hereby grant to the Board of Trustees of Wagner College and its agents the non-exclusive license to copy, publicly display, archive, lend, and make accessible, my thesis in whole or in part in all forms of media, now or hereafter known.

I understand that Wagner College will make my work available to all patrons of its library, including interlibrary sharing.

I agree to the unrestricted display of the bibliographic information and the abstract of the above title.

I retain all other ownership rights to the copyright of the work.

Signed Michael Farina Date 5/12/14