Math Education at Its Prime?

Natalie Benet

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______________________________
Nathan Putney, Ed.D.
Thesis Chair

______________________________
Colleen McLaughlin, Ph.D.
Committee Member

______________________________
Esther Alcindor, M.Ed.
Committee Member

______________________________
Brenda Ayres, Ph.D.
Honors Director

______________________________
Date
Abstract

Three main problems with current math education are negative mindsets toward math, the lagging comparison with advanced education in other countries, and ill-equipped teachers and school systems. The consequences of these problems have impacted math education by convincing students that they do not need to try at math, filling countless classrooms with ill-qualified teachers, and overall lowering the quality of U.S. math education compared to the education of rest of the world. In order to correct these problems and reverse the present and future consequences, the quality of math education must be increased. This can be done by changing the negative view of math to a positive one, offering more rigorous courses in the United States like those around the world, and equipping future teachers with better education so they will be qualified to teach in the classrooms. All across the United States, classrooms should reflect the idea that mathematics is a valuable subject, students can succeed in math, and that quality reigns supreme in the mathematics classroom.
Math Education at its Prime?

Introduction

Benjamin Franklin once said, “What science can there be more noble, more excellent, more useful for men, more admirably high and demonstrative, than this of mathematics?” (Math quotes, 2012, para.1). From this quote, it is evident that Franklin placed a great value on math education. As one of the founding fathers of the United States, he believed it was important to educate students especially in mathematics. Just like Franklin’s time, math is an integral part of education today. Also, questions “about the quality, the content and the methods of instruction” have continued to be raised (Coray, Furinghetti, Gispert, Hodgson, & Schubring, 2003, p. 10). While the quantity of math lessons has not changed greatly, the quality of math education has decreased (Garelick, 2012). A close examination of the education in the United States school systems will reveal that several aspects of math education lack quality in instruction and teachers. This lack of quality will result in consequences in schools that have already arisen along with ones that have yet to surface (Boaler, 2008).

“Why do we have to learn this?” and “When will this ever be useful for me?” are two questions commonly heard in math classrooms all across America (weusemath.org). The answer to these questions stems from the importance of mathematics in education and the appreciation of it in life. Much of what is known and used in everyday life draws from the foundations of mathematics (Black & Stewart, 2011). The buildings that people work and live in would not be standing without the knowledge and understanding of mathematical concepts. Even though certain fields of work do not directly apply math in jobs, those fields are still affected by math and require some knowledge of the math
concepts being used. President Obama once said, “In the 21st century, everyone needs to know science and math, not only to find employment, but also to be healthy and well-informed citizens” (2009, p. 75). As seen in this quote, the purpose of math education is to increase people’s knowledge in all areas, not just the talents they need for future jobs. Thus, it can be concluded that all students ought to learn math during their educational progress.

Problems with the Quality of Math Education

In a second grade public school classroom, a teacher was instructing her students in a math lesson. The teacher handed out a worksheet with problems for the students to solve. While walking around the room, the teacher stopped at one female student’s desk upon noticing that the student was struggling. When asked for help by the student, the teacher’s solution was simple: “It’s okay that you don’t understand. Boys are smarter than girls, so girls don’t have to be good at math. If you don’t know the answer, just write ‘I don’t know’ in the blank” (J.J. Benet, personal communication, July 2013).

Sadly, this is a true account of a teacher’s advice to a second grade student.

Negative Mindsets

One of the main problems with math education today is that students form early mindsets that they are not good at math (Black & Stewart, 2011). Whether this mindset stems from a teacher’s comment, some friends’ opinions, or the student’s decision, it diminishes the impact that math should have in education (Zan & Di Martino, n.d.). This damaging mindset begins to convince the students that they cannot succeed in math so they do not need to understand it or even try (Boaler, 2008). The truth is exactly the opposite: students will not succeed because they do not try to understand math (Zan & Di
Martino, n.d.). By telling themselves that they cannot solve math problems, the students limit themselves from ever learning how to solve the problems, rather than trying to understand and learn the concepts (Boaler, 2008). The United States has formed an idea that “mathematics is only for elite kids and nerdy kids” (Black & Stewart, 2011, para. 13). In the United States, kids who like math are typically labeled as nerds; however, in the rest of the world, those kids are rewarded and obtain the best job options. Rather than desiring to succeed in math, students create a disdain for math due to the nerdy label they would receive if they showed enjoyment and success in math (Black & Stewart). Another cause of negative mindsets toward math is the feeling of low achievement (Boaler, 2008). In the United States, all children are required to take standardized testing. These tests can “create low-achieving students, crushing students’ confidence and giving them an identity as a low achiever” (p. 94). Students love the feeling and rewards of success, so naturally they turn away from subjects that ruin their confidence and place them below average on test rankings (Jennison & Beswick, 2010).

**Stereotypes in mathematics.** Math stereotypes also have a great impact on the students’ attitudes toward and mindsets about math. Some of those stereotypes are that “Asians are better at math than Americans; There’s no need to learn math if you have a calculator and a computer; Most women can’t do math” (Drew, 2011, p. 6). Countless students have been led to believe these stereotypes, affecting their desires to study or even attempt to learn math. Just like the introductory account from a second grade classroom, students are told from a young age that girls should not be as good as boys at math (Drew). Some may argue that the small number of women pursuing math degrees supports this idea; however, the problem is not inability, but rather “their math avoidance
at crucial stages of schooling. Society expects males to be better than females at mathematics. This affects attitudes; attitudes affect performance; performance affects willingness to study more mathematics; and, eventually, males do better than females” (pp. 37-38). If the negative mindset of boys and girls toward math is not changed, several math stereotypes will likely become more of a reality as math education continues to decline.

**International Ranking of U.S. Mathematics Education**

In comparison with the levels of math education around the world, the United States lags far behind several other countries (Black & Stewart, 2011). Schools in the United States may have better athletic or art programs; however, education of some core subjects (Math and Science) falls short of the standards for the rest of the world because too little emphasis is placed on them. The curriculum of these core subjects is not demanding enough to compare with the content taught in classrooms across the world (Black & Stewart, 2011). Some programs exist to strengthen the education of the core subjects.

**STEM education.** One of those programs is STEM, which supports the advancement of science, technology, engineering, and mathematics in the classroom. STEM is comprised of the “core technological underpinnings of an advanced society” and uses an “interdisciplinary and applied approach that is coupled with real-world, problem-based learning” (What is STEM, 2012, para. 1). In an effort to combine these four subjects into one curriculum, STEM education creates a unified method of teaching that connects all of the subjects together. Through creativity, problem solving, and critical thinking, students become engaged in the lessons and learn how to connect
concepts with society, future careers, and the world (What is STEM). STEM education equips students with a boldness in and passion for lifelong learning. Various people and organizations have joined with STEM to increase the quality of education in these fields. One of those groups is the White House. In *The Obama Education Plan: An Education Week Guide*, the idea behind STEM education is described: “Technology is the application, or fulfillment, of engineering… Engineering is the application of math and science and technical principles” (Obama, 2009, p. 95). This connection between subjects holds the program together and enables students to see connections not only in the lessons, but also outside of the classroom.

As seen in Figure 1, STEM education program challenges schools and teachers to offer higher education in mathematics (Kettlewell & Henry, 2009, p. 6). This STEM challenge focuses on the idea that the quality of math teaching impacts students’ understanding. It initially proposes the addition of math practices in K-12 schools, impacting the quality of higher education students. Next, it suggests an increase in math teacher-preparation in higher education, which will impact the quality of math teaching in K-12 schools. With these changes, the proponents of STEM education hope to begin improving the quality of math education across all grade levels by better equipping teachers along with students.

**Perspectives of students and parents.** Another issue that causes math education in the United States to lag behind is the perspective of the parents and students. Too often, parents in the United States accept the notion that students are just not good at math and do not have to learn it; however, people in other countries believe that it is “important for all children to learn mathematics and science, and that they can learn
Figure 1: Flow of Students and Teachers in K-16 Loop. STEM education proposes this strategy to increase the quality of mathematics education. Source: Increasing the competitive edge in math and science, Kettlewell & Henry (2009), p. 6, Rowman & Littlefield. All rights reserved.

mathematics and science” (Black & Stewart, 2011, para. 10). On the other hand, students sometimes overestimate their understanding and believe themselves to be more successful in a subject than is actually true. As seen in Increasing the Competitive Edge in Math and Science,

U.S. high school seniors ranked number one among students from the twenty participating nations in believing that they were doing well in mathematics…The problem is that in the actual mathematics examination, the same group of students finished eighteenth out of twenty. (Kettlewell & Henry, 2009, p. 3)

Without a proper understanding or perspective of math and science, students in the United States will be ill equipped to work in the world and compete for jobs against other nations’ students.

Professor Bill Schmidt of Michigan State University (as cited in Black & Stewart,
2011) states, “If we don’t prepare our children in ways that have them be competitive internationally, jobs will go away” and the United States would no longer be viewed as the “technological scientific leader of the world” if it cannot produce students with advanced performance on international test standards (para. 20). To avoid a great loss of jobs or a losing comparison to the rest of the world, the United States must increase the quality of math education in school systems. Professor Schmidt also declares that other countries have “much higher demands on their students, especially during the middle grades…they study algebra, geometry, physics and chemistry. In this country, our kids, most of them at least, are still studying basic arithmetic and they’re doing very elementary, descriptive science” (para. 5). He continues to point out that the education system of America does not compare well internationally because its curriculum is not demanding or rigorous enough, teachers are not equipped with as much knowledge in subjects as the teachers in other countries, and students as well as parents accept the notion that the students are just not good at math. The combination of these problems is a large part of why education in the United States falls short in comparison to education in other countries around the world.

**Literacy in mathematics.** Mathematical literacy serves as an effective means of comparison for the math education systems around the world. The OECD Glossary of Statistical Terms defines math literacy as “the capacity to identify, understand and engage in mathematics, and to make well-founded judgments about the role that mathematics plays in an individual’s current and future…life as a constructive, concerned and reflective citizen” (Definition of mathematical literacy, 2003, para. 1). From this definition, math literacy is a good means of comparison for education on an international
scale since it measures the students’ own understanding of math along with their application in their own lives. In 2003, the Organization for Economic Co-operation and Development conducted a survey of the math literacy scores of 15 year-old students across the world. The results are seen in Figure 2, with the United States ranking 24th in the world (Drew, 2011, p. 27). In order to raise the ranking of America teachers need to focus on the math literacy of their students, better preparing them for future math courses and for their futures.

In 2009, a similar survey (seen in Figure 3) assessed the performance of students. It showed that 15 year-old students in the United States scored below the international average on math tests and assessments (Friedman & Mandelbaum, 2011, p. 104). This low ranking shows that students in the United States as a whole are ill equipped to use their math skills and understanding in assessments and challenges. However, the problem with math education does not stop with the students’ international rankings.

**The Quality of Teachers and Instruction in School Systems**

Another problem with current math education results from the teachers and school systems. In many cases, students cannot gain an understanding of mathematical concepts simply because they do not receive a proper education (Boaler, 2008). This lack of proper education can stem from ill-equipped teachers and poor instruction in the classroom. According to a 2003 survey by the National Center for Education Statistics (NAEP), 85% of the nation’s eighth graders are taught by teachers who are certified by their state. When examined by teachers’ degrees, 30% of the nation’s eighth graders had teachers with an undergraduate degree in mathematics; 26% had teachers with an undergraduate degree in mathematics education; and the
Figure 2: Ranking of Countries in the OECD Math Literacy Study, 2003. This study shows that the United States ranks 24th internationally in math literacy. Source: STEM the tide. Drew (2011), p. 27, Johns Hopkins University. All rights reserved.

Figure 3: International Performance in Mathematics, Reading, & Science, 2009. This study shows that the U.S. ranked below the international average. Source: That used to be us, Friedman & Mandelbaum (2011), p. 106, Straus &Giroux. All rights reserved.
remaining students were taught by a teacher with a degree in some other
discipline. (Dossey, Halvorsen, & McCrone, 2008, p. 53)
The research further stated: “the fact that at least one-third of the nation’s eighth-grade
students are still being taught mathematics by teachers without substantial mathematics
training is a matter of major concern” (p. 54). Students cannot be expected to properly
learn mathematics when their teachers are ill qualified. According to other studies, “some
37 percent of America’s high school math teachers are thought to lack any mathematical
qualification” and “[i]n a number of middle and high schools children are taught
mathematics by teachers trained in other fields” (Boaler, 2008, p. 201). To improve the
quality of math education, school systems need to hire teachers with proper knowledge
and preparation.

**Accreditations and degrees of the teachers.** An international comparison was
conducted in the Trends in International Mathematics and Science Study (TIMSS) also in
2003. Instead of focusing on the math literacy of the students, TIMSS focused on the
accreditations and degrees of the math teachers in the classroom. According to the
results, only 47.3% of math teachers in the United States possessed math degrees, ranking
the United States 41st in the world (Drew, 2011). This survey shows that the quality of
teachers’ education and preparedness also needs to increase. In *The Obama Education
Plan: An Education Week Guide*, the issue of teacher preparation is addressed: “Qualified
teachers are critical to the success of any educational program…in early-childhood
settings, being qualified is taken to mean a teaching certificate based on a bachelor’s
degree in education, child development, or a related field” (Obama, 2009, pp. 22-23). In
order to fill classrooms with qualified teachers, the schools must find teachers with the
proper credentials. When searching for new math teachers, schools should pay attention to only those resumes that show the teachers have obtained a minimum of a bachelor’s degree in mathematics and a full state certification and that they hold and demonstrate “subject-matter competency in each of the academic subjects in which the teacher teaches” (Highly qualified teachers, 2007, para. 1). With an emphasis on proper certifications and subject competency, schools will hire better qualified teachers and increase the quality of math education in the classrooms.

Low quality of classroom instruction. This concern of math education correlates with poor instruction that students may receive in the classroom. Some teachers, qualified or not, teach their students through ineffective methods of instruction. This poor quality of math education can lead to an increased number of low achieving students (Garelick, 2012). In some classrooms, the teachers tell the students how to plug numbers into formulas and solve problems with their calculators; however, they omit the mathematical explanations and logical connections (Klein, 2005). Teachers commonly use passive learning in math classrooms, which mistakenly leads students to believe that math requires memory, not thought. Through this approach, “[s]tudents who are taught using passive approaches do not engage in sense making, reasoning, or thought (acts that are critical to an effective use of mathematics), and they do not view themselves as active problem solvers” (Boaler, 2008, p. 41). The passive approach causes students to learn in silence, prohibiting them from talking through the methods for complete understanding. Since students are not actively learning math, they cannot learn how to properly reason and justify their solutions (Boaler). Some teachers grade solely based on the correct answers and do even not pay attention to how or why the students solved the problems.
This type of instruction teaches the students only how to punch numbers into a machine for a solution and “not worry about the theory and calculations that go into the answer” (para. 6). When the students have the right answers even though they do not understand the concepts, they still obtain passing grades and move on to the next math class, continuing to lack understanding (Brunette).

**Standardized testing.** Another factor to problems in the school systems is that standardized testing in the United States has become damaging and overdone (Boaler, 2008). The multiple-choice format cannot assess the students’ levels of understanding, the test is biased (especially for minorities), the time limit causes stress and anxiety, and the test only shows the students’ abilities to complete the test (Boaler). Standardized testing does “not assess thinking, reasoning, or problem solving, all of which are at the core of mathematics” (p. 87); however, teachers spend the majority of classroom time preparing students for the test rather than ensuring they gain the knowledge for life. Another problem in the classroom is that teachers tend to give less feedback as the students age. According to Boaler, “students’ belief in the power to improve their own understanding, and their motivation to learn, declined steadily from fifth to twelfth grade” (p. 97). While the teacher cannot be entirely blamed for this loss in confidence and motivation, it is the teacher’s role to encourage students and to continue helping them improve and deepen their understanding of math.

**Problems with curriculum.** Another issue in the classroom is the lack of rigor in the curriculum. As stated in *Learning Mathematics for a New Century*, math curriculum is “superficial, boring, and repetitious. It fails to prepare students to use mathematics in their lives outside of school” (Burke & Curcio, 2000, p. 224). Over the past few decades,
math content and curriculum have been lessened as teachers seek to accommodate the
deficient capabilities of the bottom percentage of students as well as to teach directly to
the content covered by standardized testing. Since the math curriculum in elementary and
secondary schools is lacking, the untaught areas of secondary mathematics must be
covered in colleges; thus, “relatively few college students ever take a calculus course.
This fact alone should make reform in the mathematics curriculum of prime importance”
(p. 101). When students graduate from high school, they are the product of American
education and represent the quality of that education, or lack thereof. Thomas Friedman
and Michael Mandelbaum (2011) point out an article by the Associated Press and
Education Trust, which states:

[N]early one-fourth of the students who try to join the U.S. Army fail its entrance
exam, painting a grim picture of an education system that produces graduates who
can’t answer basic math, science, and reading questions…. Questions are often
basic, such as: “If 2 plus $x$ equals 4, what is the value of $x$?” (p. 220)
This alone shows the inadequacy of American math education in its inability to instill
basic math knowledge in students by the time they turn eighteen. Another proof of
inadequacy is that “America’s lagging mathematics performance reflects a basic failure
to understand the benefits of adapting the curriculum to meet the varying instructional
needs of students” (Vigdor, 2013, para. 4). In order to improve math education, teachers
ought to teach traditional basic and higher-order skills while looking at content
knowledge. Students should realize that math is not dependent on memorization and that
learning math is an ongoing process through the lifetime ability to use and apply math
(Burke & Curcio, 2000). To improve education, schools ought to fulfill their duties “to
provide sound mathematical training for our future leaders of science, mathematics, and other learned fields” and “to insure mathematical competence for the ordinary affairs of life” (p. 98). By focusing on these important duties, the schools will improve math education with better-equipped teachers and refocused students.

**National decline of mathematics education.** In his book *The State of State Math Standards*, David Klein (2005) thoroughly describes the decline in the quality of math education in the United States. In the 1990s, new state standards emerged in hopes to improve the math education system in America. Over the next decade, the No Child Left Behind Act and other changes led to only lower state standards and grades (Klein). In 2005, education was graded by state all across America, excluding Iowa and including the District of Columbia. The United States education system received 3 A’s, 3 B’s, 15 C’s, 18D’s, and 11F’s, nationally averaging out to a high D in mathematics (Klein). As seen in Figure 4, the change in quality of education varied greatly from one state to another. The state grades were based on a 4-point scale of criteria for evaluation: clarity, content, reason, and negative qualities. The grade charts for the individual states can be found in Appendix 1. After evaluating the states’ educational systems, Klein pointed out several key problems. First, teachers place an overemphasis on calculators, even in some kindergartens. Second, students do not memorize basic number facts or even know the basic algorithms (addition, subtraction, multiplication, and division), so they are unable to solve or simply understand complex problems. Third, students are unable to work with fractions or derivations without calculators or computers. Fourth, teachers overemphasize estimation, accepting *close* answers while there is only one exact correct answer. Fifth, math curriculum delays and then places too much emphasis on probability.
and statistics such that important topics of algebra and geometry are left untaught (Klein).

Klein’s state evaluations pinpoint several of the main problems in the declining math education system and prove that state and national standards must be raised in order to improve the quality of math education.

**Solutions to Increase the Quality of Mathematics Education**

**Positive Mindsets Toward Mathematics**

In order to begin improving math education in the school systems, students must first form positive mindsets toward math. According to Black & Stewart (2011), “Statistics show most children around the world don’t like math and science. They find it hard, and it’s not really their favorite thing. But that doesn’t matter. Schooling is to learn those important things you need for the future” (para. 11). Teachers ought to encourage
their students to pursue math, desire a better understanding, and realize its importance. They should show enthusiasm about math so that their students also become engaged in the subject (Burke & Curcio, 2000). It is true that some students are stronger in certain subjects rather than others; however, that does not mean that students can just give up on math entirely. Students should apply themselves to math, for that is the only way to improve (Black & Stewart, 2011). This change of attitude would have a great impact on the process of math education. Students would approach math with less timidity and exert more effort into understanding the subject. By conquering the thoughts that they are not good at math, students will break free of the limitations they previously placed on themselves (Jennison & Beswick, 2010). With encouragement from teachers and mental openness toward math, students would have the ability to go further in their math education.

**Correcting stereotypes in mathematics.** Much like the second grade girl in the introductory story, countless girls are led to believe that their gender should not be good at math (Drew, 2011). In recent studies, girls have shown to have equal or higher achievement than boys due to their capability and drive (Boaler, 2008). It is also shown that “girls who were taught in classes that encouraged the discussion of concepts saw mathematics as compatible with their preferences for communication, understanding, and depth” (p.135). While several girls pursue the mathematics to higher levels of study, “the only reason that they drop math in high numbers is because the subject is misrepresented and taught badly in too many classrooms in America” (p. 144). In their classrooms, teachers need to encourage boys and girls alike in their pursuits of mathematics and strive to demonstrate the various techniques to assess and solve problems.
Improve Mathematics Education in the United States

The second problem that needs to be addressed is the low ranking of math education in the United States compared to math education of other countries. President Barak Obama once said, “[T]he country that out-educates us today will out-compete us tomorrow” (Friedman & Mandelbaum, 2011, p. 100). The solution to this problem is not to cut out all extracurricular programs and electives. Instead, the other courses and activities can still be offered to the students while the emphasis of education must be placed on the core subjects. Math and science ought to be at the forefront of education along with the other core subjects. With more emphasis on the core subjects, students would have more time to receive a thorough and solid education in those subjects. Students would still be involved in athletic and art programs, but more time would be spent learning the core subjects. This shift in emphasis would cause the school systems in the United States to raise their standards in these core subjects and teach more in depth according to the new standards of learning (Kettlewell & Henry, 2009). With higher education standards, school systems in America would begin to see improvements in students’ understanding in the classrooms as well as in the education rankings with the rest of the world (Black & Stewart, 2011). Education in the United States can be improved by changing the expectations of and standards for the students (making them more rigorous and challenging), by better preparing teachers for the rigorous education and higher expectations, and by teaching parents to view math education as important and deserving of more attention (Black & Stewart).

New Approaches in the Classroom

Response to standardized testing. The lack of proper math education must be
corrected in school systems. The use of standardized testing in the school systems has altered the focus and effectiveness of teaching. Even though standardized testing is inaccurate, biased, and lacks the ability to measure achievement or understanding, schools place a heavy importance on their use and assessment in the classroom (How standardized testing damages education, 2007, para. 1). Countless teachers base their curriculum solely on the topics covered by standardized tests. While the test content should serve as a minimum guideline for the curriculum, standardized testing should not be the only standard considered. Overall, “[t]est content is a very poor basis for determining curriculum content, and teaching methods based on the test are themselves harmful” (para. 2). Several teachers become overwhelmed with the task of raising test scores, so they resort to teaching to the test in hopes of positive results. However, instead of showing evidence of knowledge comprehension or academic achievement, teaching to the test narrows the curriculum by focusing on the memorization of facts rather than the development to higher thinking (How standardized testing damages education).

Math teachers should never simply tell students what facts to memorize for a test or how to find answers with calculators or plug numbers into equations without understanding the concepts. Instead of this approach to mathematics, teachers should explain the concepts entirely and draw connections between the variables and concepts involved in the lessons through higher thinking. Math education can be improved by teaching traditional basic and higher-order skills, by demonstrating that learning math is an ongoing process through life, by encouraging all students to study math, and by teaching content knowledge and the ability to use math (Burke & Curcio, 2000). If the students understood the connections behind the math concepts, they would better
understand why the answers make sense and also how math relates to current jobs. Students ought to understand the process of solving math problems, not just find answers or memorize facts. If they understood the process, they would show academic progress in the class and on the tests. With a broader curriculum that covers the test content along with additional topics, teachers would encourage the students to learn the nature of mathematics so they would be confident and competent in any type of math assessment or course (Popham, 1999). The focus of mathematics curriculum needs to change for its quality to increase.

**Use of calculators.** With this in mind, calculators should be less emphasized or not even used in earlier math classes. According to the article *Ten Myths about Math Education and why you Shouldn’t Believe Them*, a “study of calculator usage among calculus students at Johns Hopkins University found a strong correlation between calculator usage in earlier grades and poorer performance in calculus” (Budd, Carson, Garelick, Klein, Milgram, Raimi, & Wilson, 2005, Myth #6). Instead of allowing students to become dependent on calculators, teachers should encourage their students to solve the problems on their own first. According to the National Assessment of Educational Progress survey, only 21% of middle school students and 26% of high school seniors used calculators in the classroom in 1986. Just six years later, 81% of middle school students and 92% of high school seniors used calculators in the classroom (Burke & Curcio, 2000). Since the introduction and availability of personal calculators in the classroom greatly contributed to this statistic, the increased use of calculators is not the main problem. However, the result of a grown dependency on calculators serves as a major factor in the decline of math education. To obtain a balance of using calculators in
math, students ought to solve the problems on paper and use technology intelligently and appropriately to check answers and work out problems once the students understand how they can reach the correct answers (Burke & Curcio).

**Quality of teachers in the classrooms.** Changes in curriculum or math standards alone will not make much progress in improving math education unless time, money, and effort are spent to properly equip and train teachers. To increase the quality of math education, school systems need to seek out the best college graduates to teach, equip them with meaningful and quality education, respect them, and pay them appropriately (Drew, 2011). By improving the math preparation of the teachers, they will be better equipped to teach students with a more rigorous curriculum and deeper content. Several studies have shown a link from “teacher quality and effectiveness to student interest and achievement” (Kettlewell & Henry, 2009, p. 61). Hiring properly educated teachers is a greatly important step in improving the quality of math education in America because those teachers are the students’ role models and authorities regarding math content.

**Teaching techniques.** In order to reignite a love for math and improve the quality of education, teachers must show students how math can be communicated through multiple representations, such as graphs, symbols, words (Boaler, 2008). They should also encourage their students to work in groups to discuss different methods for approaching and solving problems. Interaction between students in the classrooms would encourage the students to explore math concepts in new ways and learn how to discuss mathematical concepts with others. Assessments in the classroom, such as tests and quizzes, should also increase the students’ learning and not just serve as a reflection of the lessons taught previously (Burke & Curcio, 2000). These different learning
techniques would refocus the curriculum on the importance and depth of mathematics while still equipping them for application and assessment through tests and assignments (Obama, 2009).

**Financial investment in mathematics education.** Regarding testing, national and state tests are currently poor quality and cheap, but “[r]esistance to spending more money is part of the reason they have not changed—as is a lack of understanding of their destructive influence” (Boaler, 2008, p. 105). To improve the tests, either the knowledge of teachers can be increased, class sizes can be cut, or money can be invested. While the first two options offer little guarantees for improvement, an investment of money doubles the speed of learning and actually would cost less than $5,000 per teacher (Boaler). This result is seen when teachers are trained to use assessments for learning, which enables students to learn information in six months that used to take a whole year for them to learn (Boaler). In 2010 Michelle Rhee, former chancellor of DC school system, said the following:

> This country is in a significant crisis in education, and we don’t know it…We treat education as a social issue. And I’ll tell you what happens with social issues: When the budget crunch comes, they get swept under the rug, they get pushed aside. We have to start treating education as an economic issue.” (Friedman & Mandelbaum, 2011, p. 101)

The school systems, in individual states as well as nationally, need to invest money in the improvement of education in order to see strong and lasting results for a better quality of mathematics education.
Conclusion

In the United States, the school systems should not take math education lightly. Instead of continuing on with the current teaching methods and mindsets, teachers need to realize the decline of math education and attempt to correct the resulting consequences. If the students gain positive mindsets toward math, they will be more open to learning new concepts. Since their students’ would be ready and willing to learn, the teachers will cover the subject in depth with complete explanations and connections for understanding. With a better education process, math education in the United States school systems will increase in quality, bringing its standards and scores closer to those of the rest of the world. This new process of math education would line up with a quote by Albert Einstein: “Teaching should be such that what is offered is perceived as a valuable gift rather than a hard duty” (Lombard, n.d., para. 4). Mathematics should be seen as a valuable subject, where quality reigns supreme.
References


Klein graded the states’ math education systems based on clarity, content, reason, and negative qualities. Below are the grade charts for each state and the national trends. 
<table>
<thead>
<tr>
<th>Grade</th>
<th>Parental Involvement</th>
<th>Teacher Qualities</th>
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<td>Weak</td>
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<td>Medium</td>
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<td>High</td>
</tr>
<tr>
<td>11th</td>
<td>Good</td>
<td>Strong</td>
<td>Excellent</td>
<td>Very high</td>
</tr>
<tr>
<td>12th</td>
<td>Excellent</td>
<td>Outstanding</td>
<td>Outstanding</td>
<td>Outstanding</td>
</tr>
</tbody>
</table>

The table above shows the evaluation results for students across different grades, with an emphasis on parental involvement, teacher qualifications, content quality, and clarity of instruction.
Appendix 2

The figures included in this thesis are drawn from listed references. Various publishers granted permission for the use of the figures in this thesis.


I can present documents of granted permission upon request.