Many people, upon hearing that I am a math major, exclaim “Wow, good for you. I wish I was good with numbers.” This statement represents the way many American students, even those attending an academically challenging university, feel. The way math is taught in this country leaves many students struggling to understand. Eventually many just give up. Math is often not presented as a dynamic and useful subject. Especially in the United States, courses put emphasis on rote formula learning rather than true problem solving. The problems with American math education become clear when examining the results of international math and science tests. Countries such as Singapore and Japan routinely outperform the United States. International data, although influenced heavily by the diverse cultures and school systems of the countries studied, shows that the United States could benefit from reforming math curriculum, teaching methods, and teacher training.

When the United States is compared to other countries, the results show that U.S. students perform at a merely average level in mathematics compared to their peers around the world. International comparisons in math education are made using data from both the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Assessment (PISA). The TIMSS was first administered in 1995 and is now repeated every four years. It tests students on specific curriculum content. The PISA, on the other hand, tests students’ problem solving and general skills (Bybee and Stage). Both tests gauge U.S. students’ performance in relation to the rest of the world. Bybee and Stage report that the performance of U.S. fourth graders on the TIMSS has remained about the same from 1995 to 2003. Other countries, however, have improved their scores and now rank higher than the United States. East Asian countries in particular
consistently outperform the United States. Singapore, for example, ranked first in the world on the past three TIMSS assessments (Leinwand and Ginsburg 32). Even more disheartening, as Valverde and Schmidt observe, “four grades further into their schooling, in the 8th grade, students performed substantially worse in comparison to their international peers, below the international average in mathematics” (652). Fourth graders in the United States perform well, but once they get to the eighth grade, their TIMSS scores have fallen far behind the rest of the world. Students are not building on the foundation they have from elementary school. This highlights severe problems with the U.S. system of math education. The results of the PISA draw attention to even more weaknesses. U.S. students scored below about 2/3 of the countries taking the test (Bybee and Stage). Since the PISA is designed to test deeper mathematical understanding, these results show that at best the United States covers math only superficially. Both the PISA and the TIMSS show that there is plenty of room for the United States to improve.

The results of international comparisons such as the TIMSS and the PISA must be considered carefully because of the diverse nature of the countries studied. Varied cultural backgrounds contribute to differences in scores. It is common knowledge that East Asian countries, which score very well on the TIMSS, differ culturally from the United States. For example, education and educators make up a highly valued and respected part of East Asian society. Robert Gross, former superintendent at the Singapore American School, observed, “The Straits Times, Singapore's English-language daily newspaper, never published disparaging remarks about teachers or schools. Local citizens carried an almost reverent view of educators.” This attitude contrasts with that of American parents. Sometimes in the United States, parents are quick to blame the teacher when their child is not doing well. In East Asian countries, on the other hand, achievement is viewed as the student’s responsibility. If students are struggling, they are encouraged to put in more effort. To this end, many families hire tutors for their students, even if they are not necessarily able to afford it (Gross). Another cultural difference to note is the high emphasis Asian families put on doing well in math and science specifically. These subjects are viewed as critical to getting a good job. Dr. Xiaoxia Newton, who grew up in China, recalls her father telling her “If you aren’t good at math, physics, and chemistry, how can you make a living? What are you
going to do?” (682). The family and cultural background of Asian students push them to do well in math, and if they are not doing well, to try harder. This, in addition to the fact that their families are already very education orientated, contributes to the high scores Asian students achieve on the TIMSS and similar assessments. Since there are so many cultural differences, it would most likely be ineffective to try and copy the East Asian system directly in the United States.

In addition to cultural differences, the way school systems are run in the rest of the world influences scores on international comparisons. In the United States, virtually all students enter a general, likely public, high school. In other countries, public high schools are divided and students are tracked according to their abilities. All students attend the same school until after middle school, when they then move to schools that focus on vocational training, technical training, or university preparation (Bracey 66). This tracking system makes it so that the best students are able to get access to the best education. This system may seem elitist to Americans, who pride themselves on the notion of providing the best education possible for all students. In addition to the tracking system, education systems, especially in Europe and East Asia, are centrally run, and the Ministry of Education controls the development of curriculum from elementary through secondary education (Liu 32). In contrast, mainly state and local governments regulate the U.S. education system. As a consequence curriculum standards vary widely from county to county and state to state. When looking at the data from the TIMSS and the PISA, it is important to keep in mind the different school systems in place in each country.

In the quest for improvement the United States cannot simply transplant practices from other countries, because they will likely not work as well when applied directly to our specific culture and school system. As Gross points out:

It is difficult (and it may not even be desirable) to imagine families in the United States approaching the acquisition of mathematics skills with the zeal typically found in Singapore. However, by continuing to examine our own approach to the teaching of math and by studying curriculum and teaching practices of other countries, we can ensure greater success in moving our students along the continuum.
While America may be at a disadvantage culturally, there are still several things the United States can do to improve in math. Some of the most important areas which need improvement are math curriculum, teaching methods, and teacher training.

One of the areas where the United States can learn the most from other countries is in curriculum. We may think that our curriculum is fine according to our own national standards, but “the intended curriculum of the USA was found not to measure up to the most common expectations for student learning found in other nations” (Valverde and Schmidt 652). We cannot even hope to get on an equal footing with the rest of the world until the content of our math curriculum is up to par. U.S. math education needs reform specifically in the focus and coherence of the math taught in U.S. classrooms. Currently, the focus of U.S. math curriculum only skims the surface of the topics covered, including too many topics to really foster deeper learning. Many experts, such as Dr. Xiaoxia Newton, describe American math curriculum as “a mile wide and an inch deep” (683). In Singapore, for example, elementary aged students cover about fifteen subjects a year, compared to 54 in Florida (Leinwand and Ginsburg 34). Due to the fact that U.S. teachers must cover so much material, they can only very superficially address the subject matter. In comparison, teachers in Singapore have much more time to expand and develop deeper understanding of the topics. In addition to focus, the United States also needs to improve the coherence of math curriculum. Math in the USA is split up by subject, and often not tied together in a logical fashion. This contrasts with countries successful in math, where mathematical “themes” connect and support the curriculum (Valverde and Schmidt 662). Two main underlying topics to which much of the curriculum in these countries is connected are algebra and geometry (Valverde and Schmidt 662). Singapore in particular places problem solving at the center of their curriculum (Leinwand and Ginsburg 33). By having a coherent focus for their curriculum, these countries set students up for deeper understanding of how all of mathematics works together, instead of having students learn unrelated topics and fail to see the bigger picture. Studying and implementing curriculum strategies from successful countries will aid the United States in reforming math education.
Equally important to math curriculum are the teaching methods used in math classrooms. In fact, Richard Askey, a professor of math at the University of Wisconsin-Madison argues that “the biggest problem with how math is taught isn’t the choice of curriculum. It’s whether the teachers are able to do their jobs effectively” (qtd. in Goya 371). In order to compete on an international level, American teachers must alter their teaching methods. Studies of teaching methods show that the most effective methods for teaching math include emphasis on problem solving, using proofs, and presenting material in mathematical language (Newton 682). These areas are often not emphasized by American teachers. East Asian classrooms better highlight these areas, especially problem solving. For example, Japanese teachers often give students a “nonroutine” problem and have them solve it by themselves (Tatsuoka 923). Teachers encourage students to think of different solution methods and then bring the class together and discuss how they solved the problem (Tatsuoka 923). This approach encourages more thinking about how to solve problems, instead of just being concerned with churning out the right answer. Other aspects of teaching math often underutilized in the United States include use of mathematical proof and mathematical language. U.S. educators often assume that mathematical language will go over students’ heads. However, this may mean that American students are being deprived of a key advantage in understanding math. Frederick Leung makes the case that, “it seems highly likely that there is a close relationship between emphasis on this abstract aspect of mathematics [proof] in the East Asian classroom and the superior performance of students in international comparative studies of mathematics achievement” (210). U.S. students, in contrast with their Asian counterparts, are being presented a watered-down version of math. Until the methods of teaching math rise up to the standards of the rest of the world, the United States will continue to perform at a merely average level.

In order to implement improved teaching methods effectively, math teacher training must be reformed. Susan Goya argues that, “the first prerequisite for improving math instruction is to upgrade the quality of the teachers” (372). No matter how good the curriculum a teacher is given, if that teacher does not have sufficient training, it will not benefit students. Math teachers need to receive a background in mathematics as well as having adequate educational training. One of the most fundamental requirements for math teachers should be an
undergraduate degree in mathematics. Troublingly, as the demand for higher level math courses increases, many of these courses are being taught by teachers with more than one subject assignment, which stretches their knowledge of subject material. Indeed, the number of U.S. teachers with certification in math is decreasing (Bybee and Stage). This contrasts with the situation in Singapore. As noted in a recent study, more than half of Singaporean teachers receive training in at least two content areas during college and teach in those areas, whereas about two-thirds of American teachers studied only one content area (VanTassel-Baska et al. 347). This means that there is a greater likelihood that Singaporean teachers are trained in the area they are teaching in. Clearly, being taught math by a teacher who understands the subject matter will greatly improve a student’s chances of learning the material. In addition to making sure math teachers know math, it would also be helpful for the United States to look at how other countries certify teachers. In the USA, teachers must complete a practicum, have a university degree, and pass a probationary teaching period. However, in many high-achieving countries, teachers must also pass an exam and complete year long “supervised inductions” into teaching (Bybee and Stage). These additional requirements make sure that the teachers not only know their subject matter, but that they are also qualified educators.

Teacher training, especially in a topic as vital and complex as math, is of the utmost importance.

There is hope that the United States will begin to improve math education. A recent report put out by the United States Department of Education outlines what the United States needs to do to improve the standards of math education. The report is titled *Foundations for Success: The Final Report of the National Mathematics Advisory Panel*. The Panel included educational experts from various institutions, including Cornell University, Harvard University, the National Council of Teachers of Mathematics, and the National Science Foundation. Among their recommendations is to focus curriculum on key topics, including a priority on raising standards in algebra (National Mathematics Advisory Panel xvi-xvii). They also recommend requiring that math teachers “know in detail the mathematical content they are responsible for teaching and its connections to other important mathematics” (National Mathematics Advisory Panel 37). While these are all important reforms, the panel’s recommendations have yet to become policy.
If the United States is to have any hope of gaining a surer foothold among its international peers, reforms must be made in math education. It is not enough, however, to simply look at what another country is doing right and directly transplant those methods into the American system. Careful consideration must be given to what will work best in the context of the American culture and school system. As Jane Liu says, “building a positive learning community involves efforts in eclectic practice, taking the best from each instructional practice” (36). The best approach to reforming U.S. math education is to pick and choose the methods used by the best of the best and apply them carefully through research. At first, the task of picking what methods to adopt may seem overwhelming, but Tatsuoka makes this suggestion:

Useful insights concerning curricula, schools, and teaching practices may emerge more easily via indepth investigation of only a few countries at a time. By so doing, one can go deeper into the effects of culture and educational systems, making it easier to extract useful information to improve education internationally. (924)

Therefore, we do not have to look at everybody else in the world; we should consider only those countries that do well on the things we need to improve upon. No matter what, a difference will not be seen in international results until changes take place across all aspects of math education in the USA. Without a good curriculum, teachers will not be as effective, and we must have good teachers to implement the curriculum. Once all the parts are fixed, the system as a whole will begin to function as it should. Only then will students see the true value in math and be able to say with pride, “I’m glad I’m good with numbers.”
Works Cited


