A COMPARISON OF MATHEMATICS PROFICIENCY AMONG ASIAN AND AMERICAN STUDENTS

Michael Sanson, Rebecca A. Robles-Piña
Sam Houston State University, USA
E-mail: msanson@conroeisd.net; edu_rar@shsu.edu

Abstract

In light of the commonly shared view that the United States is the global superpower, one may assume that the academic performance of the nation's students exceeds all others. However, based on international study, the United States falls sharply behind many industrialized countries, primarily countries within Asia, in mathematics performance. This review explores and compares the curricular, instructional, cultural, and stereotypical influences which reportedly impact mathematical proficiency among American and Asian students. The review concludes with a summarization of critical findings, as well as possible implications for future research.
Key words: *mathematics, curriculum, Asian students, American students, cultural differences.*

Introduction

In light of the commonly shared view that the United States is the global superpower, one may assume that the academic performance of the nation's students exceeds all others. However, based on international study, the United States falls sharply behind many industrialized countries, primarily countries within Asia, in mathematics performance. This review explores and compares the curricular, instructional, cultural, and stereotypical influences which reportedly impact mathematical proficiency among American and Asian students. The review concludes with a summarization of critical findings, as well as possible implications for future research.

It is not uncommon to turn on the television and hear reports of the United States as a global superpower. However, when it comes to mathematics, the United States falls sharply behind its other global peers. According to a 2003 study by the Program for International Student Assessment (PISA), the United States was outperformed by Japan, Canada, France, and Germany in mathematics literacy (Miller & Sen, 2007). The study comprehensively evaluated mathematical abilities of 15-year old students in each of the Global Eight (G-8) countries. Based, in part, on this study, the concern among Americans is that we will drastically fall behind economically and technologically as a result of our mathematical shortcomings.

In 2006, President Bush addressed this growing concern by outlining the American Competetiveness Initiative during the State of the Union Address. The initiative set aside nearly $135 billion for math and science education (Long, 2007). But, is America doing everything wrong? According to a recent goal of the Chinese Ministry of Education Policy Division for Basic Education, there is much admiration for the motivation American teachers instill in their students (Long). However, this still does not address the drastic difference in mathematics scores, as reported in the Trends in International

Mathematics and Science Study of 2003. This study indicated that Japanese students outperformed American students by as much as 25 percentage points on varying mathematical assessments for grade four students (Baldi, Jin, & Skemer, 2007).

Based on these scores, the case for implementing mathematics curriculum and academic practices in the United States mirroring those implemented in Asian countries is an easy one to make. According to Chikoore (2008), the curricular distinctions are clear. America does not focus on building a deeper understanding of concepts and basic skills, but focuses on covering too many topics at the surface level. Chikoore also noted that the attitude of parents is one in which success in math is not critical in every day success, and only half of the population of the United States' math teachers are actually certified in mathematics education. Manzo (1997) echoes these sentiments by indicating prominent factors in mathematics proficiency such as the inconsistencies among curriculum and expectations, low standards, and poor assessment instruments.

With such federal measures as No Child Left Behind being closely scrutinized, the level of expectations and performance, as well as the link between curriculum and instruction in the United States, must be reviewed and compared to our international counterparts. Although the intent of this and other legislative acts are noble, the structure around which it was created and the means by which each standard is measured must be closely evaluated. If students only achieve the bare minimum on standardized tests, they may be growing as individuals, but this still does not address the concern surrounding the mathematical deficit of our nation.

This literature review intends to explore the varying factors affecting the perceived mathematical proficiency levels among Asian and American students. Specifically, the author will review curricular and instructional factors implemented in Asian and American public schools, cultural variables that may impact students' mathematical proficiency, and the negative and positive effects of stereotyping. At the conclusion of the review, the author intends to disclose information which may lead to a heightened awareness on how to improve mathematical literacy, as well as indicate areas in which further research may be needed.

Methodology of Research

Inclusion-Exclusion criteria

Due to the vast amounts of literature dedicated to curriculum, instruction, cultures, and stereotyping, searches of online academic databases yielded masses of results. Therefore, any study containing the words *Asian, American, mathematics, curriculum, instruction, culture,* and, *stereotyping*, were further analyzed and culled to establish a viable relationship to the topic of study. Studies addressing the math proficiency of American and Asian primary and secondary public school students were included, while those studies of students attending private schools and higher-education institutions were excluded. Additionally, the reference to *American* students includes all ethnicities and cultures present in the United States and the term *Asian* strictly refers to Asian students attending school within an Asian country.

Literature search

A search of the *EBSCO* database, using the above listed keywords, initially produced results including contemporary magazine articles, international studies, books, professional journal articles, and dissertations. Due to the large amounts of unrelated results, the search was refined to include only full-text professional journal articles. These resources were reviewed, concluding with the use of 21 articles.

American curricular factors

According to Bishop, J. Hook, and W. Hook (2007), the six leading countries in mathematics performance have remarkably similar curricular content. Bishop et al. (2007) identified four main curricular components among both sound and poor curriculum: the number of topics covered per grade, the amount of repetition per grade, the order in which topics are presented, and the level to which a topic is expected to be explored. In each of the facets, the United States failed to meet the criteria. The

majority of the math curriculum in the United States attempts to cover too many topics per grade. The curriculum does indicate high levels of repetition, but not a deep level. Concepts within the curriculum are not presented in a logical sequence, which the authors believe lends itself to a better understanding. Lastly, the topics were not covered at a demanding level (Bishop et al.).

As of 2007, the National Council of Teachers of Mathematics (NCTM) established a panel to explore the idea of a nationalized mathematics curriculum, with strong alignment between curriculum, instruction, and assessment. According to Usiskin (2007), five basic arguments were established by the panel: (a) weak math scores are a result of a non-nationalized curriculum and will result in damage to the economy, (b) there is too much redundancy in textbooks and the expectations of each state are too varied and unclear, (c) opportunities for United States' students are unequal, (d) schools are not changing quickly enough to adapt to the changes faced as a nation, and (e) local and state standards are often weak when compared to the NCTM standards. Although some students within the United States attend schools with strong mathematics curriculum, this alone does not provide the consistency needed to compete with other industrialized nations.

Asian curricular factors

Contrary to that of the United States, most Asian countries have a nationalized curriculum, created by their respective ministry of education. In a comparison of the mathematics curricula between Japan, China, and the United States, Japan's curricula showed to be advanced with regard to the number of concepts, the time at which the concepts were introduced, and the sequence of the presentation of such concepts. China actually fell below the Japan's curricula, with the United States falling between the two (Stigler, Lee, Lucker, & Stevenson, 1982). Although this study may offer insight to the advanced performance of Japanese students, it does not, however, offer an explanation regarding the heightened performance of Asian students as a whole, specifically those students in Taiwan.

American instructional factors

Although the United States is pursuing instruction that encourages higher-level thinking, the manner in which it is being pursued may be adversely affecting critical thinking. For instance, Wagner and Herbel-Eisenmann (2008) studied the use of informal language in the mathematics classroom and compared it to the level of understanding of the students. During instruction, the dialogue between teachers and students frequently contained the word "just" in place of more formal vocabulary. This use of informal vocabulary is thought to contribute to a lack of a deeper conceptual understanding (Wagner & Herbel-Eisenmann). It should be noted that there is great variation across the United States in instruction due to the fact that the curriculum is interpreted and taught differently at the state and local levels.

Asian instructional factors

Among the factors impacting Asian student success, instruction in the Asian classroom appears to focus more on an equal balance between the practice of concepts and procedures (Schumer, 1999). In particular, Japanese schools balance mathematical thinking and mathematical understanding through spending vast amounts of time in the concrete stages of understanding and concept development, solving demanding real-world problems, exploring numerous solutions to a single problem, and intensely discussing the concepts, solutions, and applications (Schumer). The procedural emphasis in the mathematics classroom appears to outweigh the importance of the correct solution, thus allowing for a stronger cognitive foundation in mathematical processes. Another possible reason for the significant difference in the mathematics performance of Asian students is the amount of time spent on whole-group versus small-group instruction. In China, for instance, 86% of the classroom instruction is whole-group, while only 77% of instruction is whole-group in the United States. During periods of small-group instruction, 51% of American classrooms had no teacher leading the groups, while Chinese classrooms always had a teacher leading the instruction, even as students worked in groups (d'Ailly, 1992).

In reviewing the above curricular and instructional factors and evaluating their impact on math-

ematics proficiency, one may assume that the answer is simple: improve the curriculum and, as a result, performance must improve. In fact, this is what Georgia is doing in its efforts to remove barriers between math concepts (Galley, 2004). However, this leaves other important factors such as cultural variables unaddressed.

Within both Asian and American cultures, creativity in terms of problem solving is seen as a vital attribute of a well-rounded student. However, the variation between definitions provides for unique approaches to learning. For instance, in the United States one may identify his or herself as creative in the context of a group setting, where he or she contributes equally to the solution. This dependence upon a team or group may, in fact, contribute to an individual feeling less prepared to solve problems on their own (Zha, J. Walczyk, Griffith-Ross, Tobacyk, & D. Walczyk, 2006). Although both cultures value the same skill set, there are distinct differences in the approach, thus, possibly, de-valuing the importance of being self-sufficiently independent in mathematics. Both the United States and Asian countries appear to offer instruction based on the dominant culture's expectations. However, this may not address the unique cases of success among Asian students in American schools. This could, perhaps, offer validation to the case that the majority of Americans do not appear to value mathematics proficiency as essential and vital to individual and national success (C. Malloy & W. Malloy, 1998).

Possibly one of the greatest contributors to mathematics proficiency is the cultural differences regarding the expectations of students. For practical purposes, it is assumed that a correlation exists among culture and behavior. One such example of cultural variation is the widely held belief that Asian students are not permitted to question an instructor, as it symbolizes disrespect.

Phelps (2005) indicated the following as rationale for such behavior:

> Children are expected to listen, watch, and then answer. There is flexibility in the learning process, but students do not question or challenge the teacher. Because the teacher is imparting information, he or she is the focus of the children's attention. Therefore, the students pay undivided attention without talking or disrupting. Such behavior would very likely be perceived as unruly and out of step with the rest of the class. (p. 235)

Phelps also contends that this behavior is contrary to the norm within U.S. schools, as information is not perceived as absolute truths and is expected to be challenged.

Another cultural factor, posits Knoke, Sakamoto, and Zhou (2005), is that students within the Asian culture feel privileged to attend school and believe they are meant to have knowledge imparted to them. American students, perhaps, see education as more of an unnecessary obligation. In contrast to most Asian mathematics classrooms, American mathematics classrooms are formatted around the practical application of simple mathematical skill sets needed in a daily setting. United States schools tend to hold group work, dynamic interaction, and problem-solving-based application at the heart of the curriculum. This could offer explanation as to why student behavior is drastically different among the two settings. But, should this truly affect proficiency? According to a study by Lee, Stigler, and Stevenson (1987), students in grades one and five in Japan and Taiwan exhibit 25 to 35 % less off-task behaviors than do students in the United States. Assuming that the culture and behaviors are closely linked, the Asian culture's view of education as a privilege may offer some insight. Additionally, Lee et al. (1987) found that students in the United States spend almost 75 % more time in the language arts classroom in grade one, leveling out to about 50 % in language arts and math by grade five, yet the balance of 50 % per subject is consistent from grades one through five in Japan and Taiwan. Although time spent studying a subject is not specifically a cultural variable, it could, however, be an area requiring additional study of core beliefs and values among cultures, academic priorities, or, possibly, the stages of mathematical cognitive development.

Effects of Stereotyping American and Asian Students

Effects of stereotyping American students

According to Stevenson et al. (1990), the majority of American students are confident in their mathematical abilities, despite their performance in relation to students in Asian countries. The study

poses the reasoning for this feeling among American students could be the lower standards held by the students' parents. Other studies, such as one by Byrnes, Hong, and Xing (1997) show that American students may perform poorly on mathematical assessments based on gender typing. While most Asian countries view both genders as equally capable of high academic intellect and ability, the United States still appears to favor males over females as more apt to be mathematically proficient (Byrnes et al., 1997).

Effects of stereotyping Asian students

In a study comparing the self-perception of competence of American students and Chinese students, researchers found that, in general, Chinese students appear to have an overall desire to improve upon their current level of abilities. In other words, the study indicates that Chinese students do not settle with satisfactory performance (Stigler, Smith, & Mao, 1985). To illustrate the potentially positive effects of stereotyping on mathematics performance, Shih, Pittinsky, and Trahan (2006) found that Asian students performed better on mathematics-based assessments when their identity as an Asian was made known. However, it should be noted that the same technique of priming the student's identity caused deficits in language-based assessments. The indication of each of these studies is that the self-awareness of one's mathematical ability and perceived mathematical ability may be contributing factors to actual performance levels.

Conclusion

While curriculum, instruction, culture, and stereotyping each appear to impact mathematics proficiency or perhaps academic success in general, none of the literature reviewed offers a definitive answer as to the complete nature and degree of impact. At the most simplistic level, the indication is that poor curriculum and instruction negatively affect mathematics proficiency, and sound curriculum and instruction positively affect mathematics proficiency. It is also evident that culture can both negatively and positively affect mathematics proficiency. Although there are obvious subcultures within the United States, a study of Asian subcultures could possibly provide guidance for further analyzing the impact of culture on learning. Additionally, a study of Asian subcultures may aid in supporting or refuting the notion that the Asian culture, as a whole, values mathematics proficiency above other academic proficiencies, thus influencing the gap among mathematics proficiencies between Asian and American students.

What is also still unclear, and an area for future study, is the link between curriculum, instruction, and culture. One could question the impact the culture has upon the curriculum and instruction, or the impact the curriculum and instruction has on the culture. The interrelationship and influence of each of these elements upon the other may also provide insight into the societal forces at work within each country. As the world continues to become smaller in terms of the ability to communicate, the ease and speed of travel, and commerce among nations, the importance for industrialized countries to work together becomes increasingly evident. However, working together implies an equal contribution be made by everyone, including students from the United States. Not only will a shared level of mathematics proficiency provide both a common, universal language, but also the ability for everyone to contribute equally to solving the problems of today and of the future. Each country has its share of potentially positive and negative attributes. Through deeper exploration and research, new light may be shed upon cultural influences, as well as best practices for creating and implementing consistent, effective mathematics curricula on a global scale.

References

Baldi, S., Jin, Y., & Skemer, M. (2007, December). *Highlights from PISA 2006: Performance of US 15-year-old students in science and mathematics literacy in an international context*. Retrieved June 14, 2008 from National Center for Education Statistics Web site: http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2008016

Bishop, W., Hook, J., & Hook, W. (2007, June). A quality math curriculum in support of effective teaching for elementary schools. *Educational Studies in Mathematics,* 65*,* 125-148.

Byrnes, J., Hong, L., & Xing, S. (1997, October). Gender differences on the math subtest of the Scholastic Aptitude Test may be culture specific. *Educational Studies in Mathematics,* 34*,* 49-66.

Chikoore, H. (2008, June). Staying competitive. *State Legislatures,* 34, 30-34. d'Ailly, H. (1992, March). Asian mathematics superiority: A search for explanations. *Educational Psychologist,* 27, 243-261.

Galley, M. (2004). Georgia reaches out to Japan for math-curriculum model. *Education Week,* 23, 13.

Knoke, D., Sakamoto, I., & Zhou, Y. (2005, July). Rethinking silence in the classroom: Chinese students' experiences of sharing indigenous knowledge. *International Journal of Inclusive Education,* 9, 287-311.

Lee, S., Stigler, J., & Stevenson, H. (1987, October). Mathematics classrooms in Japan, Taiwan, and the United States. *Child Development,* 5, 1272-1285.

Long, C. (2007, January). Can we compete? *NEA Today*, 25, 24-28.

Malloy, C., & Malloy, W. (1998, September). Issues of culture in mathematics teaching and learning. *Urban Review,* 30, 245-257.

Manzo, K. K. (1997, May). U.S. falls short in 4-nation study of math tests. *Education Week,* 16, 6.

Miller, D. & Sen, A. (2007, August). *Comparative indicators of education in the United States and other G-8 countries: 2006*. Retreived June 14, 2008 from National Center for Education Statistics Web site: http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2005021

Phelps, L. (2005). Academic achievement of children in China: The 2002 Fulbright experience. *Psychology in the Schools,* 42, 233-239.

Schumer, G. (1999). Mathematics education in Japan. *Journal of Curriculum Studies,* 31, 399-427.

Shih, M., Pittinsky, T., & Trahan, A. (2006, January). Domain-specific effects of stereotyping on performance. *Self & Identity,* 5, 1-14.

Stevenson, H., Lee, S., Chen, C., Lummis, M., Stigler, J., Fan, L., & Ge., F. (1990, August). Mathematics Achievement of Children in China and the United States. *Child Development,* 61, 1053-1066.

Stigler, J., Lee, S., Lucker, G., & Stevenson, H. (1982). Curriculum and achievement in mathematics: A study of elementary school children in Japan, Taiwan, and the United States. *Journal of Educational Psychology,* 74, 315-322.

Stigler, J., Smith, S., & Mao, L. (1985, October). The self-perception of confidence by Chinese children. *Child Development,* 56, 1259-1270.

Usiskin, Z. (2007, November). Do we need standards with teeth? *Educational Leadership,* 65, 38-42.

Wagner, D., & Herbel-Eisenmann, B. (2008, February). "Just don't": The suppression and invitation of dialogue in the mathematics classroom. *Educational Studies in Mathematics,* 67, 143-157.

Zha, P., Walczyk, J., Griffith-Ross, D., Tobacyk, J., & Walczyk, D. (2006, July). The impact of culture and individualism-collectivism on the creative potential and achievement of American and Chinese adults. *Creativity Research Journal,* 18, 355-366.

Adviced by Laima Railienė,
Šiauliai University, Lithuania

Michael Sanson Doctoral student in the Department of Educational Leadership & Counseling at Sam Houston State University in Huntsville, TX, USA.
E-mail: msanson@conroeisd.net
Website: http://www.shsu.edu/

Rebecca A. Robles-Piña Associate Professor in the Department of Educational Leadership & Counseling at Sam Houston State University in Huntsville, TX, USA.
E-mail: edu_rar@shsu.edu
Website: http://www.shsu.edu/