Equity Implications for Mathematics Learning Outcomes

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Abstract

The call for “mathematics for all” reaffirms the belief that all students should have equal access, equal educational experiences, and equal educational outcomes. Existing gap in students’ mathematics achievement have long been coupled with the demographic categories of race and ethnicity, culture and language, SES and social class, gender and disabilities. Standards-based reform in mathematics education has a goal of high academic standards for all students. The literature review of research on equity implications for mathematics learning outcomes in the context of standards-based reform is presented. The purpose of this paper is to examine the effects of various equity variables on mathematics outcomes. The review analyzes the factors that contribute to mathematics achievement gap in terms of standards-based reform.

Objectives

In the field of mathematics education, over the past three decades, the call for "mathematics for all" and discussions of equity in education have become traditional (Shoenfeld, 2002). The literature addresses significant achievement gaps among students of diversity in terms of demographic categories such as race/ethnicity, gender, and socioeconomic status (SES)/social class (Lubienski, 2006, 2008). Standards-based reform in mathematics education has a goal of high academic standards for all students (National Council of Teachers of Mathematics (NCTM, 2000). This paper presents the literature review of equity implications for mathematics learning outcomes in the context of standards-based reform. The purpose of this paper is to examine the effects of various equity variables on mathematics outcomes.

Perspectives

The call for "mathematics for all" reaffirms the belief that all students should have equal access, equal educational experiences, and equal educational outcomes. Disparities in students' mathematics achievement have long been coupled with the demographic categories of race and ethnicity, culture and language, SES and social class, gender and disabilities.

Recently, the researchers view equity from a new perspective in that any differences in achievement and learning must be framed as responses to social issues and not as characteristics of individuals. In this paper, equity is perceived not only in terms of equal opportunities or the same education for all students, but rather in terms of equal outcomes or equal educational experiences that provide equal achievement

Modes of Inquiry

This literature review examined the factors that contribute to mathematics achievement gap in terms of standards-based reform. The researchers view these factors as the demographic categories of race and ethnicity, culture and language, SES and social class, gender and disabilities. In this paper, each of these factors was critically examined. Also, the reported successes and failures for improving achievement were discussed by focusing on standards-based instruction.

In order to establish a clear picture of the equity issues in mathematics education, various sources were consulted including journal articles, books and monographs on equity from 1989 to 2012. Along with manual search, an on-line computerized search was conducted using Educational Resources Information Center (ERIC) EBSCO database. Another database used was Education Journals in PROQUEST.

Materials

Gender

In mathematics education, concern has been shown for disparities between male and female students, particularly, that boys are outperforming girls. The historical pattern in the U.S. is for White, middle-class boys and men to tend to dominate both participation and achievement in mathematics (Secada, 1995). Many scholars have tried to understand the exact nature of the gender gap, including what areas of mathematics seem to be particular strengths and weaknesses for each gender (Fennema, Carpenter, Jacobs, Franke, & Levi, 1998).

Fennema, et al. (1998) reported on the results of a longitudinal, three-year long, gender study on the implementation of the reform-oriented curriculum in the elementary school. They monitored 38 girls and 44 boys in first to third grades. In all grades, the researchers found no gender differences in students' ability to solve problems with exception for some higher achievement patterns among boys on extension tests. However, they reported the gender differences in the problem-solving strategies and algorithms used by boys and girls. Also, the researchers found the use by girls of concrete solution strategies and traditional algorithms as opposed to the use by boys of more abstract solution strategies and self- invented algorithms. They concluded that the significance of the result was that girls may possess predispositions to employ lower cognitive styles. They suggested that it may explain the gender differences in mathematics achievement.

McGraw, Lubienski, and Strutchens (2006) analyzed NAEP scores in order to gain insight about potential differences in mathematics achievement by gender. After in depth analyses of gender differences, they examined disparities in achievement related to gender gap with respect to mathematical content components. These components included the following: numbers and operations, data analysis, statistics and probability, algebra and functions, geometry and

measurement. Overall, gender-related research gains attention and respect from mathematics education researchers.

Race and Ethnicity

The researchers give attention to other equity variables such as race/ethnicity and SES/social class. McGraw et al. (2006) analyzed the differences in mathematics achievement scores as related to race/ethnicity and SES. From these analyses, they revealed that the differences across ethnic groups were much greater than within ethnic groups. The researchers concluded that this fact shows the presence of the achievement gap regarding ethnicity.

Based on the data of the NAEP from 1971 to 2004, Reardon and Robinson (2008, as cited in Lubienski, 2008) explored patterns in the gaps in mathematics achievement that related to ethnicity and SES. They found that when controlling for SES, gaps between African American and Caucasian students increased, while gaps between Hispanic and Caucasian students decreased.

With rapid growth of the demographic diversity within American schools, the studies documenting the influence of standards-based curricula on groups of diversity are becoming increasingly significant (Lubienski, 2006). Ladson-Billings (1997) revealed that the standards-oriented pedagogy was heuristic for solving the problem of poor mathematics achievement for 6th grade students in a working-class, low-income, predominantly African American school district. She found that these students thrived in a classroom environment with a challenging content. In such an environment, everyone was expected to perform at high levels of competence.

Thompson (2009) showed that African American students who used manipulatives reflected on their solutions and communicated with each other to solve non-routine mathematics problems. These students demonstrated better performance on mathematics assessments. Thompson implied that these behavior and result are associated with standards-based instructions.

Similarly, Balfanz, Mac Iver, and Byrnes (2006) reported gains in mathematics achievement of African American and low-SES students in an urban setting. The researchers assumed that these gains are associated with standards-based instructions. Thus, the success of the students in the above discussed studies provides evidence that standards-based instructions offer a means to increase mathematics achievement of African American students.

Socioeconomic Status (SES) and Social Class

As with gender and race/ethnicity, the studies have found correlations between SES/social class and achievement in mathematics (Secada, 1992). The main goal of the reform is to help all students gain “mathematical power”.

Particularly, this goal was reached in the Research on the Quantitative Understanding: Amplifying Student Achievement (QUASAR) Project (Stein, Boaler, and Silver, 2003). The QUASAR Project was created to implement reform oriented curriculum and teaching practices in poor and minority communities. The project was a longitudinal, five-year study. It was conducted in six urban middle schools serving socially and culturally diverse students’ populations in California, Georgia, Massachusetts, Oregon, Pennsylvania, and Wisconsin. Two schools served predominantly African American students, two served primarily Latino students, and the other two had more cultural diversity. The majority of students had lower-SES background. Teachers developed and implemented a reform oriented, open (i.e., with a focus on problem solving) mathematics curriculum. Besides the learning of procedures, students also worked with problem solving strategies. The project involved mixed-ability classes.

As measured over time, the QUASAR Project revealed extremely positive results. The researchers reported these results as the following: (a) significant gains in students’ achievement; (b) much higher level of students’ performance than in comparable groups on a range of different assessments; (c) equal distribution of the gains among the different racial/ethnic, and linguistic groups of students. As stated by Stein et al. (2003), “…the achievement gap [between racial groups] grew no wider in most [of the QUASAR] schools and was reduced in some” (p. 250).

Knapp et al. (1995) referred to the standards-based teaching as a teaching for meaning in their study. They suggest that this teaching “…is especially appropriate for children from low-income families” (p. 193). The researchers found that using standards-based teaching as the teaching for meaning in high-poverty mathematics classrooms resulted in the children developing higher-order or advanced skills at the same time that they were learning basic skills and facts.

Lubienski (2000a, 2000b) reported on the qualitative multi-case study of the students' experiences with the implemented mathematics curriculum in the middle school in a medium-sized city in the Midwest. The purpose of the study was to examine students' experiences in terms of higher/lower-SES levels. The study was conducted in 7th grade in a school with predominantly White, socio-economically diverse population. The school was a pilot site for the reform-oriented, problem-based Connected Mathematics Project (CMP). The implemented curriculum was focused on students' learning mathematical content and processes through solving open, contextualized problems. The pedagogy was centered on students' exploration, discussion, and making sense of important mathematical ideas.

Lubienski exposed that real-world context problems have the potential for increasing the achievement gap between the lower- and higher-SES students and between students of different cultural groups. She found that significant difficulties arose when students were required to simultaneously engage in a context as though it was real and to ignore factors that would pertain to the real-life version of the task.

Additionally, Lubienski revealed that the lower-SES students often considered a complex variety of real-world variables in solving problems while the higher-SES students were more likely to approach the problems focusing on the intended, overarching, mathematical ideas. She stated, "More of the higher-SES students than lower seemed to possess orientations and skills that allowed them to actively interpret the open problems, believe their interpretations were sensible, and follow their instincts in finding a solution" (2000a, p. 465).

Next, Lubienski noted differences in her students' participation in and reactions to whole class discussions--a pedagogical feature supported by the standards. She reported that while the higher-SES students viewed the whole class discussions as helpful for exchanging ideas, the lower-SES students become confused by conflicting ideas and preferred more direct instruction from the teacher and from the text. Lubienski stated, "The lack of teacher directives seemed to create confusion for more of these students" (2000b, p. 397).

Also, Lubienski found that lower-SES students lacked confidence in their ability to participate in discussions and that this lack of confidence kept them from participating. Accordingly, when lower-SES students did participate, they responded to easier, more straightforward questions, and they focused on giving a correct answer, whereas higher-SES students were more likely to discuss their ideas and methods of solving problems.

Lubienski (2002) argued that, in several fundamental ways, the culture of a standards-based classroom is more aligned with middle-SES students' preferred ways of learning, knowing, and communicating than with those of lower-SES students. She suggests that students in poverty may not benefit from the kind of open-ended, problem-solving-type settings that are considered part of reform.

Points of View

The researchers report successes and failures of standards-based instruction. Still, there is no consensus among researchers about the potential of standards-based curricula and standards-based teaching to promote equity. Some researchers have expressed doubt about the ability of standards-based teaching to enhance the learning and achievement of all students (Lubienski, 2000a, 2000b, 2002). For instance, Strutchens, Lubienski, McGraw and Westbrook believe that higher-SES students are more likely to be taught critical thinking skills, while lower-SES students are more likely to be taught to be obedient to the rules their teachers give them.

Scholarly Significance of Paper

Overall, in the mathematics education literature, the researchers documented the achievement differences among groups based on gender, race/ethnicity, and SES/social class, as opposed to the processes contributing to those outcomes (Lubienski, 2008). More research documenting the benefits and limitations of using standards-based curricula with students of diversity is needed to provide insight about their impact on these groups.

Throughout this review, demographic equity variables such as gender, race/ethnicity, and SES/social class were addressed. The review analyzes the results of research with students who have different demographic characteristics. It can be implied that standards -based instructions are useful for the students. The changes in mathematics teaching should be enacted if the mathematics education community is to attain its goal of "mathematics for all" in the 21st century.

This review is significant as there is a need to improve mathematics achievement of all students in order for them to compete for jobs in the global market.

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