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Abstract

The present article is a national overview of current policies and practices around advanced mathematics course taking in public high schools. It begins with an explanation of the mathematics courses in public high schools. Importance of course taking in mathematics in general and *advanced* mathematics course taking in particular is highlighted. Then, academic excellence and educational equity concerns surrounding advanced mathematics course taking are discussed. A major part of the article is a detailed account of current policies and practices as they are related to excellence and/or equity in advanced mathematics course taking. Under this section, three topics are discussed: graduation requirements in mathematics, course offerings in advanced mathematics, and factors that make up the decision making mechanism for advanced mathematics course placements. Under the section on graduation requirements, three dimensions are examined: Carnegie units required, specific courses required, and high school exit exams. Based on a detailed and careful examination of these policies and practices, the article concludes with recommendations on how to enhance equity and excellence in advanced mathematics course taking.

Introduction

Currently, curriculum differentiation approach continues to dominate the U.S. public high schools. In this system, schools offer courses in great variety in terms of content and difficulty; and students are free to take courses of their choice as long as they meet graduation requirements. Such a system inevitably raises two fundamental questions: First, do students graduate being academically ready for their future jobs or education? Second, is there equity in course taking, especially at advanced level, by students from all ethnic and socioeconomic backgrounds? In this big picture, a central topic of academic excellence and educational equity is advanced mathematics course taking.

High school mathematics courses

Mathematics curriculum is cumulative in the sense that knowledge of the content of a course is mostly needed to understand the content in a succeeding course. Therefore, high school mathematics courses have a hierarchical structure. In their study, Finn, Gerber, and Wang (2002) categorized a total of 79 high school mathematics courses into five levels. Level 1 was basic mathematics, pre-algebra, and introduction to computers. Level 2 consisted of algebra 1 and other courses involving beginning algebra. Level 3 courses were algebra 2, introductory geometry, and courses involving algebra 2 topics. Level 4 was made up of algebra 3, advanced geometry, and other advanced courses except calculus. Courses at level 5 were calculus with analytic geometry and calculus. They indicated that the courses at levels 4 and 5 would be classified as advanced. Please note that none of the advanced mathematics courses are required for public high school graduation, and that, in this hierarchical structure, courses at one level are usually required as prerequisites for the courses at the next.

Importance of course taking in mathematics

Taking courses is important for academic achievement in almost all subject areas, yet it is especially crucial in mathematics. Researchers found that course taking had the largest effect on academic achievement in mathematics among the academic subjects examined (e.g., Schmidt, 1983; Jones, Davenport, Bryson, Bekhuis, and Zwick, 1986). Lee, Burkam, Chow-Hoy, Smerdon, and Geverdt (1998) found that, even when students' social background and previous academic achievement were controlled, course taking was the single best predictor –twice as strong as any other factor- of achievement in mathematics. Results from a study on NELS: 88 data indicated that there were no significant differences in terms of mathematics achievement growth among students from various SES levels who completed same number of mathematics courses (Hoffer, Rasinski, and Moore, 1995). Taken altogether, these findings indicate that mathematics learning takes place almost exclusively in school and background factors do not have much influence by way of out-of-school learning (Schmidt; Jones et al.). It can also be said that much of the SES differences in mathematics achievement growth over high school years boils down to the differences in number of mathematics courses completed during these years (Hoffer et al.).

Importance of advanced mathematics courses

No matter what their plans for future are, advanced mathematics courses are important for students. For college admissions and success, these courses play a critical role. Data collected from students admitted to four-year colleges and universities show the high levels of advanced mathematics courses completed by these students (U.S. Department of Education, 1997; Owings, Madigan, and Daniel, 1998). For students who want to enter the job market after high school, these courses are also beneficial. Knowledge offered in these courses is required for the wide spectrum of blue-collar jobs to high-tech and scientific jobs (U.S. Department of Education; Leslie, McClure, and Oaxaca, 1998). These advanced courses have also been shown to enhance students' understanding and acquisition of lower level mathematical concepts and skills (Rock and Pollack, 1995; Jones, 1985). Underrepresentation of minorities in mathematics and science fields (National Education Goals Panel, 1995; Olson, 1999) and lower levels of advanced mathematics course taking by minorities (Roey et al., 2001) also stress the importance of high school advanced mathematics.

Broad statistics about advanced mathematics course taking

A readily interpretable summary of recent statistics on high school advanced mathematics course taking came from a study by Finn et al. (2002). The study described data from the 1994

High School Transcript Study, which used a nationally representative sample of students and schools. The researchers categorized a total of 79 high school mathematics courses into five hierarchical levels and classified courses at the fourth and fifth levels as advanced. Results indicated that approximately 60 percent of high school graduates stopped taking mathematics courses at the third level or below, which means that they had not taken any advanced courses at all.

Raw statistics are also available from the more recent 1998 High School Transcript Study (Roey et al., 2001), which used a nationally representative sample of students and schools. Yet, there are no reports that are readily interpretable or comparable with findings from the study by Finn et al. (2002), which used the 1994 High School Transcript Study. However, when percentages of 1998 graduates who took each advanced mathematics course are compared with those of 1994, one does not see much change on a course-by-course basis. When averaged across all advanced courses, percentages for the 1998 graduates are not different from the percentages for the 1994 graduates. These nationwide statistics altogether show that advanced mathematics courses do not get the attention they deserve and that not much is being done to improve the situation.

Academic excellence concerns surrounding advanced mathematics course taking

A number of reports and studies, old and new, have expressed concern about the low achievement of U.S. secondary school students in advanced mathematics. The relatively old "A Nation at Risk" report (National Commission on Excellence in Education, 1983) illustrated the poor performance in advanced mathematics and claimed that an important reason was that the majority of students avoided even moderately challenging courses, let alone the advanced ones. One of the eight goals set in the National Education Goals Report was devoted to mathematics and science, pointing at the target of becoming the first in the world in mathematics and science achievement (National Education Goals Panel, 1995). Results from TIMSS, a recent international study on mathematics and science, did not paint a comforting picture of advanced mathematics achievement of U.S. secondary school students compared to their peers in other participating countries. U.S. performed next to last in the advanced mathematics test, which was given at the end of secondary school (Schmidt, McKnight, Cogan, Jakwerth, and Houang, 1999). In the President Bush's blueprint of No Child Left Behind Act of 2001, one of the three reasons given for the poor performance in mathematics and science in high schools was that very few students took advanced courses in these subject areas (Bush, 2001). High percentages of high school graduates who need remediation in the basics of reading, writing, and high school mathematics when they start postsecondary education are discomforting. These percentages range from 13 percent at private four-year colleges to 41 percent at public two-year institutions (National Commission on the High School Senior Year, 2001). Finally, worries about the shortage of American scientists and engineers, ever-growing dependence on foreign scientists and labor for research and high-tech jobs, and the adverse consequences American economy may suffer are being sounded by more and more scholars and business leaders everyday (Dye, 2004; Barrett, 2005). Overall, these reports demonstrate the dissatisfaction with the advanced mathematics education in high schools.

Educational equity concerns surrounding advanced mathematics course taking

Advanced mathematics course taking is a topic of educational equity, too. It is well known that mastery of content taught in advanced mathematics courses in high school is crucial in pursuing degrees in mathematics and science as well as in many other fields requiring a strong background in mathematics. A major concern, well documented in various reports and studies, has been underrepresentation of minorities in mathematics and science fields. For example, a report by National Science Foundation (Olson, 1999) stated that, despite increases between 1985 and 1995, minorities were still underrepresented in undergraduate and graduate science and engineering education. Accordingly, one of the objectives under the general goal related to mathematics and science education in the National Education Goals Report was to significantly increase the number of U.S. undergraduate and graduate students, especially minorities, who would receive degrees in mathematics, science, and engineering (National Education Goals Panel, 1995). One reason for this underrepresentation is that they take fewer advanced level mathematics courses during high school. An NCES report (Green, Dugoni, Ingels, and Quinn, 1995) on national data indicated that significant differences among races in completing the set of academic courses in mathematics during high school persisted over time (from 1982 to 1992), although the gap had somewhat narrowed. Perhaps, the best and most current picture is drawn by data from the 1998 High School Transcript Study (Roey et al., 2001). For all the lower level mathematics courses listed (i.e., basic mathematics, general mathematics, applied mathematics, and prealgebra), the percentage of Black, Hispanic, and Native American students who graduated from high school in 1998 having taken these courses were higher than the percentage of White students who took the same courses. At the algebra I level, the percentages were comparable across races. For algebra II, geometry, and all advanced courses listed (i.e., analysis/precalculus, trigonometry, statistics/probability, and calculus), the percentages of Blacks, Hispanics, and Native Americans were lower than the percentage of Whites. And the general trend was that as the level of the course got higher, the discrepancy became larger in terms of the ratio of White percentage to minority percentage.

The differences between high-SES and low-SES students in terms of advanced mathematics course taking are no different than the ones between majority and minority students. In their analysis of data from the 1994 High School Transcript Study, Finn et al. (2002) found that students receiving free lunch took considerably more level-1 courses (basic mathematics, prealgebra, and introduction to computers) and had a substantially lower advanced to basic ratio of mathematics courses than did students not receiving free lunch.

Current policies and practices as they are related to excellence and/or equity in advanced mathematics course taking

Graduation requirements in mathematics.

In view of the fact that course taking – especially advanced level – is important for achievement in mathematics, there is a fundamental question that needs to be asked: Do graduation requirements in mathematics effectively function as a quality control mechanism?[1] Literature suggests that there has always been a concern about the looseness of graduation requirements. The “A Nation at Risk” report (National Commission on Excellence in Education, 1983) asserted that the curricula had been diluted and, in effect, the majority of students followed an easy track and avoided even moderately challenging courses, let alone the advanced ones. Not surprisingly, one of the main recommendations in the report was to raise high school graduation requirements. The Commission recommended that all students seeking a high school diploma be required to complete four years of English, three years of mathematics, three years of science, three years of social studies, and one-half year of computer science. An additional two years of foreign languages was strongly recommended for the college-bound students.

Since the publication of the "A Nation at Risk" report (National Commission on Excellence in Education, 1983), changes in graduation requirements in mathematics can be studied in three different dimensions: Number of Carnegie units required; specific mathematics courses required; high school exit exams.

Carnegie units required for graduation.

Typically, one Carnegie unit is granted when a student completes a course that meets for five 50-55 minute periods per week for an entire school year (Hoffer et al., 1995). There has been a slow increase in the number of Carnegie units in mathematics required for graduation between 1987 and 2002. The number of states requiring 2.5 or more Carnegie units in mathematics increased from 12 in 1987 to 25 in 2002 (Council of Chief State School Officers, 2000, 2002). Despite the increase, this leaves us with half of the states requiring two Carnegie units or less. This figure indicates a very small amount of required exposure to mathematics in these states. Research on the effect of increasing the number of Carnegie units required suggested that these increases had primarily affected the states where the new requirements were set above the preexisting average course taking. Likewise, it was found that non-college-bound students, who were previously below the average, were impacted the most (Clune and White, 1992). Finn et al. (2002) analyzed more recent data and drew a similar picture. The group who benefited the most was students in vocational tracks, followed by those in general tracks.

The important question at this point is, of course, if these gains in terms of Carnegie units translated into advanced mathematics course taking. Unfortunately, research tells us that very little of these gains were in advanced courses. For example, although the percentage of students who completed the recommended number of courses by the "A Nation at Risk" report (National Commission on Excellence in Education, 1983) increased by 34.1 points from 1982 to 1992, the percentage of students who took all of algebra II, geometry, trigonometry, and calculus increased by only 1.9 points during the same period (Green et al., 1995). In their study, Clune and White (1992) concluded that "the most frequently added courses tended to be the ones at the beginning of the college prep sequence rather than the end" (p. 16). Analysis of 1990 NAEP data by Chaney, Burgdorf, and Atash (as cited in Finn et al., 2002) indicated that students tended to complete additional credits in introductory level courses rather than advanced ones.

Specific courses required for graduation.

It has been only after late 1990's that states started to move in the direction of requiring specific mathematics courses for graduation. In the most current report on required specific courses (Council of Chief State School Officers, 2002), among 30 states for which specific mathematics courses were reported as required, 16 required algebra I. And among those 16 that required algebra I, 7 also required geometry, and only 3 required courses above algebra I. The remaining 14 states had no specific mathematics course requirements for graduation. Assuming that these 30 states reported roughly represent all of the states, the numbers given above imply that in around half of the 50 states, students are free to choose the mathematics courses to be counted towards graduation. And for many, these courses are the least demanding, nonacademic ones at the lower end of the high school mathematics curriculum, such as general mathematics or consumer mathematics. This means that students may graduate from high school without any exposure to even basic algebraic concepts and principles. And half of the other half of the states sees algebra I sufficient for graduation. Since requiring specific courses for graduation is so recent, its effect remains to be seen. However, in view of the above findings that requiring more credits for graduation only led to an increase in introductory level course taking and the current trend of only requiring these same introductory courses (such as algebra I), it can be said that, at its present form, requiring specific courses does not help much in increasing course taking above algebra I.

High school exit exams.

High school exit exams attempt to secure a certain level of student academic achievement as of the end of high school education. Many states are currently struggling over developing these exams, setting up criteria for passing the exam, or deciding when to start enforcing this policy. In this rapidly and ever-changing picture, a current publication, based on data collected in June 2003 from state departments of education, reports that 19 states had mandatory exit exams in 2003, and 5 are in the process of phasing in exit exams by 2008, while other states have not taken any steps in this matter yet (Center on Education Policy, 2003). The same report recognizes three different types of exit exams currently used or will be used: minimum competency, standards-based, and end-of-course. In 2003, out of 19 states, 6 used minimum competency exams that measure basic skills below the high school level; 10 used standards-based exams; 2 used end-of-course exams; and one gave the option of passing either a standards-based or an end-of-course exam. As expected in the light of the standards-based assessment movement, the majority of states that will have an exit exam by 2008 will be using a standards-based exit exam (16 out of 24). Among the 24 states that will have an exit exam by 2008, 19 gives a specific grade level at which mathematics part of the exit exam will be given. And among those 19, 15 will give these exams at grade 10 or below (Center on Education Policy). This means that these exams in most states will measure students' mathematics knowledge by the middle of tenth grade. For most of the public school students, the highest level of mathematics attained by the middle of tenth grade is algebra I plus some geometry. In fact, such a policy is no surprise when we realize that these exams need to be aligned with the other two types of graduation requirements (number of Carnegie units and specific courses) discussed above and their outcomes in terms of mathematics course taking.

It is also worth looking at what the content measured on high school exit exams in the U.S. corresponds to in other countries. A study by Achieve, Inc. (2004) rated the exit exams in 6 states, using an international index. The International Grade Placement (IGP) index represented "an average or composite among 41 nations of the world (both high-performing and low-performing countries) as to the grade level in which a mathematics topic typically appears in the curriculum" (Achieve, Inc., p. 15). When this index was applied to the exit exams in the 6 states in the study, it was found that none of them had an average IGP rating higher than the 8th grade. In view of the data presented above, high school exit exams will not help, at least for the time being, in raising the current levels of advanced mathematics course taking.

Course offerings.

Since students need to choose from the set of courses offered by the school, course offerings are another determining factor in advanced mathematics course taking in high schools. Beside the availability of advanced courses, the ratio of advanced to basic courses offered is also important. Research suggests that in schools, where the variety in low-end (basic, general) mathematics courses is limited, students tend to take more advanced courses (Lee et al., 1998; Finn et al., 2002). Course offerings relate to both academic excellence and equity. Regarding academic excellence, in schools with limited course offerings in basic level mathematics, students tend to take advanced courses and also have higher mathematics achievement (Lee et al.). Equity concerns are about the findings of unequal availability of advanced courses in schools with high and low average SES and schools with high and low minority concentration. Oakes (as cited in Finn et al.) found a significant inverse relationship between the proportion of low-income and minority students in a school and the relative proportion of college-prep and advanced course sections. The most striking results were for calculus. Even after excluding more than half of the high-poverty schools that offered no calculus at all, the number of sections per student in low-poverty schools was nearly four times that in high-poverty schools. Finn et al. also found that high-poverty schools offered significantly fewer semesters of calculus than did low-poverty schools. Even though not statistically significant, findings from the same study indicated that the advanced-to-basic ratio of offered courses was lower for high-poverty schools and they offered fewer advanced courses. There are other studies that supported the findings above regarding the differential availability of advanced mathematics courses in low- and high-poverty schools (Spade, Columba, and Vanfossen as cited in Finn et al.; Lee, Croninger, and Smith, 1997). In sum, research consistently suggests the presence of inequity in advanced mathematics course offerings.

Tracking, the student's choices, parental involvement in course taking decisions, and counseling.

Mathematics course taking decisions are shaped by four factors: tracking practices in the school, the student's choices, parents' involvement and preferences, and counseling. Weight of each of these factors may change from school to school and from student to student. Counseling impacts all of the first three factors at varying degrees depending on the school and the student.[2]

An important question in this scheme is how informed students' course taking decisions are. Well-educated parents can guide their children in course taking decisions, because they are knowledgeable about course sequences, contents of courses, and their prerequisites. Yet, many parents with low levels of education cannot help their children in these important decisions (Useem, 1991). Under these circumstances, counseling in schools becomes important in informing students and parents about these issues. There has been an ongoing concern about the availability of counseling services to students and parents, mostly due to high student-to-counselor ratios and counselors' record keeping duties (Powell, Farrar, and Cohen, 1985; Martin, 2002). Results from a study that used a nationally representative sample of public school students in grades five through eleven indicated that a high percentage of students were not informed about the academic consequences of their course taking decisions in mathematics. Counseling was not offered to parents, either. For many students, the resulting picture was a lack of understanding of the course taking steps necessary to reach their academic or vocational goals for future (Leitman, Binns, and Unni, 1995).

To make matters worse, low-SES and/or minority students are less likely to have access to guidance counseling for course taking decisions (Lee and Ekstrom, 1987; Leitman et al., 1995). Needless to say, these are the ones who need the guidance the most, because they cannot get sufficient - if any - guidance from their families or communities. Another concern expressed by researchers is the discriminatory treatment of minority students by guidance counselors and teachers through discouraging from demanding academic courses and recommending less demanding nonacademic ones (Calabrese, 1989; Leitman et al.). In sum, counseling in schools about course taking has a lot to do with equitable access to information needed for educated decision making about courses, which is a necessity for academic excellence, especially in mathematics.

Even if parents somehow find out the necessary information about courses, they may still have limited say in their children's course taking. Schools vary in the extent to which they allow parental intervention in course taking decisions. In her article on the relationship between school policies and parental involvement in course placements, Useem (1991) elaborates on ways in which schools block parental intervention in these decisions. She also asserts that, in schools that try to obstruct parents' attempts to get their children placed in higher-level mathematics classes, parents with a college degree or above have more of the intellectual and social resources to get the needed information about course placements and the courage to take action. Parents with low level of education remain uninformed and discouraged by guidance counselors and teachers. Lareau (1987) makes a similar assertion that socio-economically and/or culturally advantaged parents usually have the privilege of being more welcomed by schools than are low-SES and/or minority parents. From the above literature, it can be concluded that much of the criticism towards tracking in mathematics stems from either explicit or implicit discriminatory use of course placement policies against disadvantaged students.

Recommendations

Even though excellence and equity are not mutually exclusive yet interdependent, and strategies to improve one may also contribute to the other, recommendations will roughly be grouped under two categories for clarity of presentation. First are the ones to improve academic excellence and second to enhance equity.

Research reviewed in this article clearly shows that the current status of advanced mathematics in high schools is far from satisfactory and needs significant improvement for the U.S. to reclaim its lead in the world in mathematics, science, and research. Despite this fact, there is an evident mismatch between what needs to be done and what is being done about it. Therefore, recommendations regarding excellence will be aimed at eradicating this mismatch.

First, policymakers should see the already initiated movement of standards-based assessment as a valuable opportunity to set *and* maintain high standards in mathematics. The whole purpose behind the standards-based testing movement is to improve the quality of public school graduates. Clearly, the last checkpoint in the whole process is the graduation requirements. However, if graduation requirements in mathematics will be set at the levels discussed in this article, the highest level of mathematics reached by the overwhelming majority of students at the end of high school will not be satisfactory. And most likely, a considerable amount of time, effort, and money put in the movement will be wasted. In other words, if this movement is to be a true revolution in the education system, low expectations must vanish. The starting point should be to set academic expectations including graduation requirements at a high level, even if the current academic level of students is not close to that level. Then, every effort should gradually, but persistently, be made to reach that set goal without giving in to any pressure to lower the expectations back. It is true that such a revolution is a long and painful way to go, but this is what this nation has to accomplish for a prosperous future.

Even though how to set standards is a topic by itself, I will briefly comment on one important point. The first step in setting high standards should be to meaningfully define what 'high standards' are in mathematics education. In today's ever-shrinking world, a global perspective is a must in making policies aimed at leading in science and technology and having a globally competitive workforce. Therefore, policymakers should pay much attention to what other countries in the race are doing to achieve this objective. From another perspective, what is being accomplished in mathematics education in other industrialized countries should be a major benchmark in setting the standards in this country. In other words, we can and should learn from these countries what is doable in mathematics education at various grade levels. Otherwise, using a wrong yardstick that shows a 'false high' may easily negate all the good intentions and efforts to have high standards.

Second, a nationwide campaign should be initiated to inform people at all levels about the importance and the current unsatisfactory status of mathematics education in schools. What research tells us about the topic should be widely disseminated by all institutions involved. What role mathematics plays in today's world of research and technology, and what needs to be done to become competent in mathematics in various roles in the workforce or post-secondary education should become common knowledge and replace the frequently reinforced all-too-common fear and avoidance of even simple mathematics. Television programs may play a very important role in creating a more positive attitude toward mathematics in general through giving the message to youth that mathematics is not something to be scared of, and through informative programs on applications of mathematics in various jobs. Related research institutions and foundations should distribute free publications about the impact of an unsatisfactory mathematics education on individuals' job opportunities and on American economy. Colleges of education should incorporate these issues into their curricula for mathematics teacher preparation programs. Professors collaborating with schools/school districts should convey this message to teachers and administrators in these schools/school districts. School districts should update their teachers in their in-service training programs about the ever-increasing importance of a solid preparation in mathematics for global competition. Schools should offer informative sessions to parents and students; send homes publications (brochures, flyers, etc.) explaining the importance of advanced courses; organize speeches by scholars; invite college students and professionals to attest to the value of these courses. Middle and high school teachers should continually emphasize the importance of advanced courses, and encourage and guide their students to advance in mathematics as much as they can. All these efforts will be useful regardless of whether or not there will be a significant push towards advanced mathematics courses by new policies in the near future. If there will be, these policies will be backed up by public awareness of the necessity for these policies. If there will not be any changes in current policies, including graduation requirements, then these efforts will be even more useful. Since current graduation requirements only enforce learning mathematics up to 9^{th} or 10^{th} grade, it is totally at the student's discretion to take nonrequired advanced mathematics courses at 11^{th} and 12^{th} grade. Without the knowledge and belief that these extra courses will be useful in their future education and/or careers, students may easily waste these two invaluable years in terms of mathematics education.

Third, parents should also play their role. In the presence of unavoidable bureaucracy, they should not totally depend on school administrators or counselors to properly guide every student in course selections or to timely inform them about prerequisites or other course placement criteria. Parents should be advocates of their children and closely oversee their educational affairs. Where necessary, they should insist on getting the information they would need to guide their children's course selections. They should make sure that their children willing and prepared to take advanced mathematics courses would not be limited by course offerings. If and when that happens, they should seek ways to have those courses offered in the school. In sum, parents should not forget that they are the people who should oversee their children's education more carefully than anyone else.

Finally, more of a warning than a recommendation is about a very real danger posed by standards-based assessment policies to higher-level curricular activities. Since the primary concern of public schools is to get and keep accreditation, they put almost all of their effort and resources to pull the achievement levels of underachieving students up to the level imposed by the standards. That automatically jeopardizes higher-level activities. Even though there are yet no reports of decreased numbers of advanced level mathematics course offerings in high schools due to current assessment policies, there are indications that there may be a much-reduced emphasis on these courses. A case in point is gifted education. There is a growing body of literature pointing out the current trend of minimizing, or even eliminating, services to gifted students in many schools (e.g., Golden, 2003; Schemo, 2004).[3] Advanced mathematics education in high schools may follow suit and resources may be shifted towards improving student achievement in course content that appears on proficiency and/or graduation tests. Under these circumstances, there should be some elements within the standards-based assessment policies that will safeguard higher-level curricular activities, including advanced mathematics courses.

The very first recommendation to improve equity is to have a full range of advanced mathematics courses offered either in all high schools or, at least, in all districts, regardless of their average SES or minority concentration. In other words, any student willing and prepared to take these courses should not be limited by offerings.

Second, every effort should be made to increase enrollment of underrepresented groups (i.e., minority and/or poor students) in these courses. To this end, three important objectives need to be achieved. First, schools should have clearly stated, objective criteria for course placements. Second, there should be easy access to this information by all who need it. Schools can realize this through making sure that these criteria are widely published and posted. Schools should see to it that students and parents receive this information and be reminded of frequently. It is odd that students and parents are sometimes informed and reminded of relatively insignificant content or events - such as bake sales at school - more frequently than of this kind of vital material. Third, beside efforts to inform all students, parents, and even the general public about the importance of mathematics in general and advanced courses in mathematics in particular, additional steps should be taken to motivate students coming from disadvantaged families and communities.[4] In this respect, counseling services provided to these students and their parents should be improved in terms of quality and quantity. Beside availability of these services, their equitable accessibility is also a must. Parents of all types of background should be welcomed by schools, and their cooperation should be sought. Whenever and wherever possible, they should be seen as a major part of the solution. When this is not possible, it should be borne in mind that, in the absence of a push by school policies towards advanced coursework, the only source of guidance, encouragement, and support for students from families and communities with little appreciation of education and/or little knowledge of the education system will be their teachers and school counselors. I believe that successful implementation of the above recommendations on equity would help in achieving increased enrollment of underrepresented groups (i.e., minority and/or poor students) in high school advanced mathematics courses. In addition, the above strategies to enhance equity may facilitate resolving issues around tracking in mathematics, since much of the criticism towards tracking in mathematics stems from either explicit or implicit discriminatory use of course placement policies against disadvantaged students

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Footnotes

[1]In this article, I did not tackle the question of whether or not a differentiated mathematics curriculum with a variety of course offerings, leaving the course selections to the student, should be preferred over a narrow set of academic mathematics courses mandatory for all students. Any attempt to answer such a question requires engaging in philosophical discussions, such as whether depth or breadth of curriculum should be observed in education, or whether or not all high school students are capable of learning advanced content. I have taken for granted the fact that curriculum differentiation has been the preferred approach over a narrow common curriculum in U.S. public schools.

[2]In this article, I did not deal with tracking as a separate topic due to several reasons. First of all, tracking is an issue for course taking not only in mathematics but also in several other subject areas; and it has its own voluminous and controversial literature, which I wanted to avoid in this article. Second, there is a multitude of tracking practices in schools, which prevents discussion of and conclusion about a uniform policy or practice. Such variation among schools is also a major reason for the controversial literature. Third, when carefully analyzed, it can be seen that tracking in mathematics mostly takes place through the use of two interrelated criteria for placement of students in mathematics courses: Previous mathematics achievement and prerequisites. Instead of singly tackling a comprehensive, yet non-uniform practice of tracking, I find it more useful to relate the use of the above criteria to the other three factors mentioned above.

[3]According to some researchers, gifted education has its own equity problems (e.g., Ford, 1998; Ford, Harris, Tyson, and Trotman, 2002). Since there are yet no publications reporting reduced emphasis on advanced mathematics courses, I am only using gifted education as an example higher-level curricular activity, which has already been reported to be seriously affected by standards-based assessment policies.

[4]A thorough discussion of reasons behind poor academic outcomes for minority and/or poor students is well beyond the scope of this article. It is a very comprehensive topic with its own extensive literature. Therefore, I will limit my recommendations to the ones that are warranted by the findings reported in this article. On a brief note, however, I should acknowledge that there are a number of projects – mostly local in nature – that have been proven to improve academic outcomes for minority and/or poor students. Some of these projects may have certain aspects that may also help motivate disadvantaged students towards advanced mathematics course taking in high school. Identification of these aspects through a careful analysis of these projects and their implementation thereafter in similar schools/ school districts may improve the current status of advanced mathematics course taking by disadvantaged students.