

# Inequities in Physics Access and Enrollment in Urban High Schools

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**Abstract.** Despite reports to the contrary, the availability of physics as a course for secondary students is not equitably distributed throughout the U.S. While some schools provide physics access for all, a more common scenario is limited availability to select students. This is particularly true in urban districts, where this study examined access to and availability of high school physics. New York City's secondary schools were surveyed to determine where physics was offered and how many students were enrolled. Statistics were performed to compare differences between physics and non-physics schools. Additionally, organizational factors were examined that relate to physics availability, such as the magnet school configuration, the AP Physics and conceptual physics options, and science curricular sequence. Overall, it was determined that physics availability is limited in NYC schools, a serious inequity that disproportionately affects students of color and poor children. Strategies for improving access and enrollment will be discussed.

**Keywords:** Secondary schools, Physics Education Research, Conference proceedings, physics availability

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## INTRODUCTION

Despite conflicting reports, the availability of physics as a course for high school students is not equitably distributed throughout the United States. While some schools provide physics for all who wish to take it, a more common scenario is limited availability. This is particularly true in urban districts. Restricted physics access is problematic in an increasingly globalized economy, as underrepresented minorities in the U.S. remain an untapped resource in fulfilling the ranks of future scientists and engineers [1].

This study examined the question of secondary physics access in New York City, the largest school district in the United States, with over 1.1 million children enrolled. Several variables were examined to measure social and academic differences between physics and non-physics schools, such as the racial composition of the student body, socioeconomic status, science and mathematics achievement, school size, graduation rate, and the percentage of students who intended to enroll in college upon graduating. Other organizational factors were analyzed to assess their place in physics access; these factors included the magnet school enrollment of physics students, the science sequence, and the availability of Advanced Placement Physics.

## THEORETICAL FRAMEWORK

There has been considerable interest in the last decade in studies of science education in urban settings [2,3]. Much of the research points to severe inequities that are chronically prevalent in urban schools, where children are often denied access to fundamental opportunities in areas such as science. Urban districts, which educate 50% of minority children and 35% of all poor students, have widespread problems with access, retention, and achievement [4]. The proliferation of inequity in urban education manifests itself in several components of students' science education experiences. Despite governmental efforts to legislate school reform through strict accountability measures, little progress has been made in terms of improved learning for children, nor has the playing field been leveled in terms of equalized access to 'advanced' science courses such as physics.

The theoretical framework of this study was significantly influenced by the work of Oakes and Kahle in examining the inequities of opportunity for children in America's elementary and secondary schools [5,6]. A pertinent aspect of their research is embedded in the focus of this study: access to 'advanced' science courses. Oakes, along with several

other researchers, stressed that the problem of access must be clearly quantified in order to assess the extent of the disparities and to initiate sustained reforms. This study attempted to quantify certain characteristics that were associated with the opportunity to study physics in urban high schools.

## RESEARCH DESIGN

### Context

New York City (population 8.1 million) is the largest school district in the United States, with approximately 300,000 secondary school students (34% Black, 38% Hispanic, 13% Asian, and 15% White). During the 2004-2005 academic year, NYC had 316 secondary schools. This study examined these schools to see where physics was offered, and to identify institutional factors related to physics availability.

### Methodology

The researcher surveyed New York City secondary schools to determine whether or not physics was offered, and how many students were enrolled in physics at that time. The data were collected during the 2004-2005 academic year. Figures were collected from 298 of the 316 existing secondary schools. Data on demographics, size, and academic achievement were obtained from the Annual School Reports, published online by the Department of Education [7]. Descriptive statistics were generated to compare physics and non-physics schools.

## FINDINGS

Overall, physics enrollment in the 298 schools that responded to the survey was 14,935 students, or 5.2% of the high school population [8]. This corresponds to approximately 21% of NYC high school graduates having studied physics, which is one-third lower than the NY State and U.S. average of 33% for public schools [9].

Analysis of the availability of physics in these schools revealed that access to physics was not equitably distributed - a remarkable 55% (164 of 298) of the surveyed NYC high schools simply did not offer physics at all. This translates to approximately 23% of the city student population, or 23,000 students, being denied the opportunity to take any physics course in high school. Anecdotal evidence from school administrators suggests that the lack of physics offerings is not a result of lack of resources or certified teachers, but rather a result of the perceived notion that

the children who attend these schools cannot succeed in physics.

The institutional factor that best predicted physics access was school size. The vast majority of large high schools offered physics (> 1200 students), while less than half of mid-sized schools (600-1200 students) and only a quarter of the small schools did (< 600 students). Eliminating schools that had only grades 9 and 10 (and thus may have offered physics in future years), still only 39% of small schools offered physics [10]. Although small schools present a promising option in some respects, the question of access to advanced science courses needs to be addressed. Student graduation rates are likely to increase with the proliferation of small schools, but the city may actually graduate fewer physics students in the future than they do today.

The racial composition of students in schools that did not offer physics was notably different from the city as a whole, with White and Asian students much less likely to found in these schools. Schools that did offer physics typically had a racial composition of 72% Black and Hispanic, and 28% White and Asian; schools that did not offer physics had 91% Black and Hispanic students, and 9% White and Asian. These disparities illustrate large racial inequities in access to physics.

Prior performance in mathematics and biology and chemistry was significantly related to whether a school offered physics. Schools where students had a higher average in passing rates on Biology and Chemistry Regents Exams were more likely to offer physics, suggesting that prior performance in these subjects was a de facto prerequisite for enrolling in physics.

The majority of magnet schools in the New York City school system were designed with science themes. The physics enrollment in the eight selective schools/magnet schools was analyzed to determine how many physics students in New York City attended these schools. While students at these schools represented only 7% of the total New York City high school population, they represented 27% (4036 out of 14,935) of all students enrolled in physics. Additionally, the magnet schools had much larger numbers of White and Asian students than the average for city schools; conversely, there were very few Black and Hispanic students in the magnet schools. The percentage of students who qualified for free lunch in the magnet schools was 20%; this is a stark contrast to the 69% for the overall school population. It would seem that socioeconomic status is much higher for those students accepted to these competitive schools, which have a wide array of physics options.

Of the 298 secondary schools who responded to the survey, just 20 offered Advanced Placement Physics (whether version B, C, or both). The schools that offer

AP Physics tend to be large schools, with higher proportions of White and Asian students, fewer Black and Hispanic students, and fewer poor children, when compared to the city average.

The last consideration that was examined in the study was the physics sequence in secondary schools in NYC, that is, the year in which students were first able to take physics, whether required or an elective. The types of physics that were typically offered included Regents Physics, which is a challenging mathematically-based course culminating with a standardized exam, and Non-Regents Physics, which was usually a conceptual course with limited mathematical applications. Advanced Placement Physics is excluded from this group since it is most often a second year course. If physics is first offered in ninth grade, 33% of that school's students will graduate having taken for physics for one year. If physics is first offered in tenth grade, then the figure is 14%. If physics is not offered until eleventh or twelfth grade, then just 7% of a school's population will have taken physics for one year. If schools are unable to provide physics opportunities until late in the high school sequence, it is unlikely that students will elect to take this course.

## CONCLUSIONS

At the time of this study, students' race, socioeconomic status, prior achievement in mathematics and science, and school size were major determining factors in whether they had the opportunity to study physics in NYC high schools. This inequity in access to physics needs to be addressed in a comprehensive plan to improve science education for students in urban districts if the goal of "science for all" is to be realized.

Other school-level factors characterized physics availability to some degree. AP Physics is very restricted in city schools, offered in just 20 of the 298 schools surveyed. Students who have participated in AP Physics often pursue STEM-related fields in post-secondary study. The eight magnet schools in NYC enroll more than one-quarter of the city's physics students; this disproportionate distribution suggests that physics is only widely available for those students who are considered academically elite. The science sequence may have a significant affect on physics access. When schools push physics to the end of the science sequence, it seems that schools often choose not to offer it, and many students choose not to take it.

Small schools seem to have considerable difficulty in providing physics options for students, which is troubling considering that NYC increases the number of small schools each year. Although small schools

seem to have higher graduation rates than their large counterparts, a commendable outcome, the curricular restraints that may go along with small economies of scale need to be examined further. Creative solutions for sharing resources and teachers may result in a greater degree of access than what exists today.

Major changes are required in schools' structuring of science offerings, with an increased emphasis on higher quality elementary and middle school science education, which will lead to greater preparedness for advanced science study in secondary school. Too often, science is an afterthought in primary and middle education, and teachers need additional training and resources to create meaningful science experiences for their students.

A further consideration is the necessity of more transparent data reporting systems for public education. Although some progress has been made in reporting Annual Yearly Progress (AYP) for underrepresented groups in schools, the public should also be informed of opportunity-to-learn considerations. If a remarkable 55% of city schools is not able to offer physics for one reason or another, the public should be aware of this. During a time of increased emphasis on the science proficiency of American students, such disparities need to be reported for progress to be made in implementing solutions.

Additionally, keeping an eye on racial and socioeconomic balance is necessary in providing socially just opportunities for the study of physics. The evidence presented in this study is a starting point for identifying the extent of the inequities in order to inform the development of long-term reform efforts that will improve physics access and eliminate racial and socioeconomic gaps in participation.

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