

## Chapter 10

# Promoting the Physical Sciences among Middle School Urban Youth through Informal Learning Experiences

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### ABSTRACT

*Numerous reform efforts in STEM education have been targeted towards increasing the number of qualified STEM professionals in the U.S., which necessitates promoting science participation among secondary and post-secondary students. Some novel designs have focused on the middle school years, when students tend to lose interest in science and formulate opinions on science self-identification. This chapter describes the effectiveness of developing informal physical science experiences for middle school students in underserved urban communities. Several cohorts of students have participated in inquiry-based physics and chemistry weekend classes that incorporated authentic applications from the urban setting, field visits to scientists' laboratories and museums, advanced educational technology tools, and learning complex scientific concepts. Participants reported significant improvements in their attitudes, knowledge, and appreciation of the physical sciences, suggesting that well designed constructivist physical science programs are potentially transformative in improving students' academic self-efficacy, confidence, and persistence in science, and positional advantage. The potential of early, rigorous experiences with the physical sciences is explored as a means for improving science participation and diversifying the ranks of future scientists.*

DOI: 10.4018/978-1-4666-2809-0.ch010

## **INTRODUCTION**

There has been much national discussion regarding the need to expand participation in STEM (Science, Technology, Engineering, and Mathematics) careers among underrepresented minorities. Recently, the National Academies reported the concern that “the scientific and technological building blocks critical to our global economic leadership are eroding at a time when many other nations are gathering strength” (National Academies of Sciences, 2007). This report and its follow-up have increased attention on improving K-12 mathematics and science education and addressing the relatively low number of underrepresented minorities in STEM fields (NAS, 2007, 2010a, 2010b). One variable that has affected accessibility and participation has been the relatively low enrollment in gateway elective sciences for high school students. Once students get to junior and senior year of high school, they often choose not to take chemistry and physics, two courses that are essential for their post-secondary success in college-level STEM coursework. Data have shown that African-American and Hispanic students are less like to take physics than their Caucasian and Asian counterparts (American Institute of Physics, 2011). The reasons for limited participation in pre-college physical sciences are complex. In some cases, students are steered away from taking courses that are intended for the academically elite. Others may not recognize the value of a strong foundation in the physical sciences for their career goals. Educators must seriously consider improving these enrollments to improve the science preparation of secondary students since they are the next generation in a modern technology-driven, global economy.

This essay will explore one promising solution for improving student enthusiasm for the physical sciences—making chemistry and physics concepts accessible earlier in a student’s academic life. Specifically, the case will be made for middle school physical sciences in informal learning

environments. Exploring the physical sciences is a critical experience for middle school students, though many middle school science curricula place higher value on life sciences. Meaningful physical science study at this level is a rarity, particularly in urban schools. Possible explanations include a scarcity of laboratory resources, inadequate teacher training, and a testing culture that focuses on literacy and mathematics. Consequently, this author initiated, developed, and taught a Saturday program for Bronx middle school students in physics, chemistry, and mathematics. The program was part of the Enlace Latino Collegiate Society at the Bronx Institute, which provided extracurricular academic opportunities for local students. The goal was to provide academic experiences that the students did not have in their neighborhood schools, with the hope that they would be better prepared for advanced science and mathematics in high school and, consequently, admission to selective colleges.

This chapter has three main components. First, the need for meaningful physical science instruction will be established by examining research in trends in physical sciences among American high school students, and looking at reasons why the physical sciences are important in STEM study. Secondly, the program structure of the physics and chemistry coursework at Bronx Institute will be described. Finally, empirical results from studies of the Bronx Institute participants will highlight the program’s effectiveness and the potential for replication in larger contexts.

## **TRENDS IN PHYSICAL SCIENCES AMONG U.S. HIGH SCHOOL STUDENTS**

There has been much recent concern about the quality and quantity of STEM education in the United States (NAS, 2007). The complex technological challenges facing our nation require diverse solutions that most likely will come

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