Engagement in Practice: Successes Gleaned from the St. Elmo Brady STEM Academy

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Introduction

Internationally, the U.S. ranks 25th in science performance and 40th in mathematics according to the 2015 Performance for International Student Assessment (PISA). Average science performance among U.S. students according to the PISA has been more or less stagnant since 2006, and has fallen to below average in mathematics during the same time period (PISA, 2015).

The landscape becomes somewhat more troubling when the data are disaggregated and one considers mathematics and science performance among those students who traditionally are underrepresented (UR) in science, technology, engineering, and mathematics (STEM) education and careers. These students include African Americans, Latinos, Native Americans, Pacific Islanders, those with special learning needs, and women. For instance, fourth grade African American students scored on average 24 points lower than their White counterparts, and 35 points lower than their Asian American counterparts in 2015. In eighth grade, the gaps are even larger: 32 and 47 points, respectively. In science, African American fourth graders scored 33 points lower than White fourth graders, and 36 points lower than Asian American fourth graders (NAEP, 2015).

Strikingly, literature also demonstrates that the problem of underrepresented male persistence in higher education, especially STEM, is a result of systematic neglect that starts long before college enrollment (Guess, 2008; Moore, 2006). Academic problems among males from underrepresented communities begin as early as elementary school; for example, teachers and counselors tend to impose negative college attendance expectations upon Black males in comparison to their White counterparts (Moore, 2006; Ogbu, 2003). Additionally, Black males are disproportionately disciplined (Hale, 2001), underrepresented in gifted education programs (Jackson & Moore, 2008) and overrepresented in special education (Levin, Belfield, Muennig, & Rouse, 2007; Haycock, 2006). In light of this data, strategies must be identified to encourage the participation and academic success of underrepresented males (Öztürk, 2007) at all levels of the PK-20 educational pipeline.

Low student achievement in elementary and secondary education, particularly among UR students, is concerning for several reasons. First, STEM is the fastest growing sector of the economy and therefore is likely to experience more job growth than other sectors. Importantly, STEM-related jobs pay well relative to other sectors of the economy. A growing number of these jobs, however, also require at least a high school degree and often relatively specialized skills (Vilorio, 2014). Students must be provided with the education and experiences necessary to get and keep them engaged in STEM learning to prepare for STEM-related jobs. A second reason low student achievement among UR students matters, is that workplaces benefit from diversity. Research suggests that diverse teams enhance creativity and lead to more innovation (Bassett-Jones, 2005; Richard, 2000), and also may improve the decision making process by bringing together different perspectives and knowledge bases (Bantel, & Jackson, 1989; De Dreu, & West, 2001; McLeod, Lobel, & Cox, 1996).

Although, teachers endeavor to make instruction meaningful and engaging to support students' interest in learning science and help cultivate positive attitudes toward science, some students do not develop the interest necessary to prompt them to learn, and persist in science. For these students, particularly those who may feel left out in traditional instruction, after school programs can facilitate unique environments for exploration. After school programs, for example, complement classroom science by affording additional opportunities to introduce students to science concepts, but also take advantage of smaller group size and greater flexibility in instructional methods to captivate students (Dabney, K. P., Tai, R. H., Almarode, J. T., Miller-Friedmann, J. L., Sonnert, G., Sadler, P. M., & Hazari, Z., 2012). In addition to introducing or reiterating science concepts to students, after school science programs can provide a setting that allows students to discover aspects of science that appeal to them and grant an opportunity to develop the skills and confidence needed to pursue those interests (Maltese, A. V., et al., 2010).

While higher education interventions have shown to be effective, research suggests that student interest in science is high at age 10 (Murphy & Beggs, 2005) and the point of declining interest begins as early as fifth grade (Bennett & Hogarth, 2009; Murphy & Beggs 2005). In addition, Tai, et al. (2006) demonstrated that children's life-world experiences prior to age 14 are the major determinant of any decision to pursue the study of science. Thus, college, high school, and even middle school interventions may be too late to meaningfully impact students' interests and motivation towards engineering careers. Early exposure and engagement is likely to be a key intervention for developing interest in STEM related careers

This paper details the St. Elmo Brady STEM Academy (SEBA), a program that is currently in its third year, which was created to expose underrepresented 4th and 5th grade boys to innovative STEM learning opportunities. Students participating in the after-school SEBA program complete hands-on activities and inquiry-based learning modules that serve to reinforce core concepts and generate new ideas. Participants also learn about STEM pioneers and inventors, with an emphasis on professionals who are also from underrepresented groups and may appear more relatable to the students. Perhaps most importantly, participants interact with underrepresented graduate and undergraduate students, faculty and staff to complete experiments. Finally, family learning is fostered through the inclusion of fathers, male relatives and/or mentors who attended and worked alongside participants.

Participants and Context

Administrators at two participating elementary schools were asked to nominate African American, Hispanic, Asian American and Native American boys, from grade 4 and 5, who they felt had interest in science and who could benefit from the mentorship of STEM professionals. Students who wanted to participate completed an application with their parents and returned them to administrators. Students were selected based upon successful completion of the application which included an essay about why they wanted to be a part of this free afterschool program. Up to this point all students who have expressed interest have been accepted to the program.

One of the schools is designated as a STEM Magnet School (hereafter STEM Magnet), while the other is a more typical elementary school (hereafter Midwest Elementary). It is important to note that STEM Magnet has an open admissions policy and is located in a traditionally underserved neighborhood, giving both schools similar diversity in their normal science classes. In addition, Midwest Elementary School, like other elementary schools in the area, dedicates only about 40% of the school year to teaching science (i.e. 12 weeks per school year). During the most recent year of the program STEM Magnet generally had 20 participants, and Midwest Elementary had approximately 15 participants each week.

Parents, Teaching Assistants, and Mentors

The program sought to engage students by having them interact with several different adults who could act as role models; parents, teaching assistants, and mentors. Fathers, or other male relatives, of each participant were invited to participate in the program (conduct experiments with students on Saturdays). The number of male role models who attended varied from week to week, with 5-10 male role models attending in a typical week. Undergraduate and graduate students interested in acting as teaching assistants for the program completed an application and were selected through a competitive application process. Successful applicants were accepted as mentors and were trained in classroom management, mentorship, and teaching techniques appropriate for the program. Undergraduate students, often from underrepresented groups willing to serve as mentors for elementary students that did not have relatives available to participate, went through a similar application process and received training prior to working alongside students.

SEBA Program Overview

Students were engaged in SEBA activities three times each week. Instruction was provided to participating students for 16 weeks over the course of two semesters. A typical week of program instruction would engage students after school for two days, for 75-minutes each day, and Saturdays for 2 hours. The partnership between local schools and the university, as well as student and community organizations, created suitable environments for providing hands-on instruction to students on a variety of topics. Each week the program followed a similar pattern, involving a warm-up discussion about a professional from a STEM field, a thematic main activity, and a closing portion that encouraged review and reflection. At select points in the program, a field trip was incorporated that allowed students to visit university labs, science museums, or engineering open houses.

SEBA Project Outcomes

Over the course of the project multiple measures were used to assess student attitudes, engagement, and the overall impact that teaching assistants, parents, and mentors had on students' perspective of STEM. Feedback about the program design, implementation, content, and outcomes was obtained from school staff, parents, program coordinators, and university faculty and program participants. For the purpose of this discussion, we are reporting on the data collected during the second full year of the program. The focus is on student survey responses and interviews conducted during the final week of the program. These measures helped

document student growth in terms of interest and engagement at school, STEM-related career preferences, and confidence associated with succeeding in STEM.

Increased Interest and Involvement at School

As part of the exit survey at the end of the second year, the 24 student-respondents were asked to evaluate changes in their interest and involvement using simple "yes" or "no" questions, then were asked follow-up questions to explain their reasoning. Student responses revealed that 23 (95.8%) were more interested in science. Twenty-two students (91.7%) reported that they were more confident in their science and math classes, and 21 (87.5%) indicated that they participated more in their science and math classes at school after participating in SEBA. When asked follow-up questions one student stated that he "didn't use to like science but when we did the activities at St. Elmo Brady [they] made me more confident to do it" (P1, STEM Magnet, 4th). One student added that they raised their hand more in class, and another reported that he regularly shared what he had learned from the program with his class at school.

STEM-Related Career Interest

One of the key features of the SEBA program was the focus on STEM professionals, through historical profiles and as contributors to the program, to show students what careers were available in the STEM fields. One student praised this component of the program stating, "I think the program helped me because you helped me introduce a part of what I wanted to do in life." (P2, STEM Magnet, 5th). The pre-survey revealed that 18 of 22 (81.8%) students were interested in a STEM career, while on the post-survey 21 of 24 (87.5%) indicated a similar interest. A second finding of interest from the paired pre- and post-survey results was a recognizable shift in student identification from a general interest in STEM to interest in specific STEM fields when asked to indicate what careers they planned to pursue. For example, one 5th grade student (P3) from STEM Magnet, indicated on the pre-survey that he is interested in becoming an engineer, while on the post-survey he indicates interest in civil engineering or chemistry. Similarly, a 4th grade student (P4) from STEM Magnet, indicated on the pre-survey an interest in engineering, dancing, or teaching. On the post survey, he reported that he was interested in electrical, civil, or environmental engineering.

Role Models in STEM

An added benefit of emphasizing STEM professionals from underrepresented groups in the SEBA program, was to provide students with the ability to interact with relatable role models from STEM fields, in addition to the mentors and parents. P9, a 5th grade student from STEM Magnet, commented that ". . . [African American scientists] are really setting the example for us to be like them," he went on to note the importance of seeing "what they went through throughout their life to get where they are now. . ." Other students, such as P4, were attentive to this issue explaining that "I think we can learn from each other better because I think we would have similar experiences." P5, a 4th grade student from Midwest Elementary, confidently added "if they look like me then I can probably do what they did."

Fathers as Role Models

From survey results and interview responses it was clear that many students recognized, and appreciated, how the fathers served as role models in the program. Twenty-two students (91.7%) reported on the final survey that they enjoyed and learned from having fathers involved with the program. Comments from students illustrate how the fathers involved acted as positive influence on students' interest in science. This is highlighted by P6 (4th grade, Midwest Elementary) comments explaining why he enjoyed having fathers in the programs by saying, "we get to learn more about them and they like science." P7, a 4th grade student from Midwest Elementary, admitted that ". . . at first I didn't want to do science but my dad had to get me to do it and then when I started doing it, it started getting fun." The impact that the fathers in the program had extended to students who did not have a father actively involved. For example, P8 (5th grade STEM Magnet student whose father did not participate in the program) indicated that the participating fathers, "showed me how to act" in these types of environments.

Success of the SEBA Program Approach

It is the earnest hope of the authors that other schools and communities who aspire to create programs, similar to SEBA, can learn from organization and approach outlined here. A main goal for SEBA is to establish partnerships between universities and schools that extend to the relationships between students, parents, mentors, teaching assistants, and faculty. The SEBA program provides a valuable service to underrepresented students in the community by supporting their STEM learning, and has been well received by parents and administrators alike. The success of this program hinges on its ability to bridge the gap between the university and the community, leveraging both resources and expertise, to make this complementary learning program freely available to students. Bridging this divide would not have been possible without strong commitments from the schools involved in the program, and the willingness of teaching assistants, mentors, and parents to donate their time and enthusiasm. Well-trained staff members, and the cooperating schools, created a safe environment for children to learn, reinforce basic skills and explore new ideas. Most importantly, SEBA provides the opportunity for family learning and development through STEM.

Moving forward SEBA will continue to provide opportunities for new partnerships and relationships to develop among families, community leaders and organizations. Parents and mentors will hopefully continue to develop a strong network of support through parent meetings and SEBA events. Now into its 3rd year, there are plans in place to grow the program in terms of participants, and to increase the amount of parental involvement. To accommodate this growth, we are currently reaching out to other benefactors for support, and recruiting additional teaching assistants and mentors.

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