Teaming for the Future with Purdue’s Science Bound Initiative: A Cooperative Program Involving University, Secondary Schools, and Local Industries to Increase Diversity in Engineering and Technology Programs

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Abstract – The need to attract more minority students to Science, Engineering and Technology programs is well documented. Purdue University is three years into a program aimed at finding such students while they are still in middle school and keeping them involved through high school and into college. The Purdue Science Bound program is conducted in cooperation with the Indianapolis Public Schools system and a wide spectrum of industry partners. This partnership is showing evidence of making a significant difference in the way students from an urban environment look at their futures. This paper will discuss the partnership among Purdue, the Indianapolis school system, and the Indianapolis business community that makes Science Bound possible. It will also look at some of the approaches that have proven successful in helping students improve their understanding of concepts that will help them graduate and transition into their chosen careers.

Index terms – K-12 engineering programs, Minorities in engineering, Partnerships with industry, Summer enrichment programs

INTRODUCTION

In the past decade, the number of U.S. high school graduates choosing to pursue Engineering and Technology careers has dropped 35%. [1] Daryl Chubin of the American Association for the Advancement of Science and Eleanor Babco of the Commission on Professionals in Science and Technology have pointed out that if American universities cannot supply the required number and quality of Engineering and Technology (E&T) graduates, then employers will be forced to increase the trend of outsourcing their engineering needs outside the U.S., and possibly moving entire operations overseas. [2] One of the major ways that colleges can work at reversing this trend is to increase the number of minority students who pursue E&T careers. Currently only about 10% [3] of students enrolled in E&T curriculums are minorities.

PURDUE’S SCIENCE BOUND PROGRAM

As Thomas Grose recently wrote, in the American Society for Engineering Education (ASEE) Prism magazine, “Overall, America’s Engineering and Technology schools struggle to recruit and graduate minority students. That’s not necessarily for lack of trying. Low income minority students can present a special set of challenges. Despite having a lot of raw talent, they’re regularly shortchanged when it comes to learning math and science – a key requirement for engineering students – by schools that are financially strapped. And those who do make it to universities are often forced to drop out because of economic pressures and the need to begin earning a living early in life.” [4]

But in Indiana, Purdue University and the 40,000 student Indianapolis Public Schools (IPS) system have joined together to form Science Bound, a program aimed at guiding urban students into Math, Science, Engineering, and Technology careers. The objective of Science Bound has been to identify IPS students with both interest and an aptitude for such careers while they are in middle school. Then, utilizing a combined program of science oriented mentors, special activities, and enrichment programs, cultivate that interest through the high school years, and prepare them for entry into the Purdue University program of their interest. By the nature of the IPS demographics, a majority of these students are either African American or Hispanic.

One of the keys to keeping these students on track through four years of high school is proper incentive. In this case, Purdue President Martin Jischke established the objective that each student who completed the Science Bound program and was admitted to a Purdue degree program in one of the previously mentioned fields, would be offered a full tuition scholarship. This is an opportunity that few inner city

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students ever see as a possibility. So Science Bound opens new opportunities for them.

Equally necessary to the success of the program is a strong corps of local mentors, and a range of educational activities, summer camps and assistance programs. As Chubin, Babco and their co-author Gary May have written, “An effective pre-college program must (1) promote awareness of the engineering profession, (2) provide academic enrichment, (3) have trained and competent instructors, and (4) be supported by the educational system of the student participants.” [2]

CORPORATE PARTNERS

A recent ASEE Prism magazine [5] discussed the growing trend where both “industry and academia have stepped up efforts to direct students into the pipeline leading to engineering programs,” and that reaching out to K-12 students in local school systems is a fundamental part of this. Purdue’s Director of Science Bound, Wesley Campbell, has had the task of recruiting Corporate Partners from the central Indiana area. The businesses involved have all contributed in a variety of ways. They have financially supported the program, building the environment necessary for student learning, and allowing Purdue to extend the scholarship offers to students when they complete the high school program. They have also provided the funding to provide the summer camps at no charge to students, and to offer small stipends to the mentors at various IPS high schools who stay after hours and work with the Science Bound students on various projects and investigations. Beyond the purely financial aspects of the program, the corporate sponsors participate in career days, plant visits, and perhaps most importantly they provided some of their employees for one-on-one tutoring and counseling.

One of the first companies to come on board as a partner in Science Bound was Bowen Engineering, an Indianapolis based full service contractor that specializes in sitework, underground utilities, concrete, mechanical and process equipment installation, with over $120 Million in annual business. Company founder and president, Bob Bowen is a Civil Engineering graduate of Purdue. Despite being actively involved in the running of his company, Bowen himself is an active participant in the program, volunteering his time as a tutor to students at one of the local high schools. “You spend a lifetime building a corporation, an organization, and work hard to make it a success,” says Bowen. “When all is said and done, you consider it a privilege to give something back.” [6]

BRINGING IT ALL TOGETHER

The Science Bound Office at Purdue has the responsibility for bringing together all the pieces necessary for success. They coordinate with the high schools in Indianapolis to make sure that each school has at least one mentor working with the Science Bound students at that school. They arrange monthly meetings for both students and parents, keeping the entire family aware of the progress of the program and focused on the goal. A number of summer enrichment programs are offered, and the Science Bound Office works to ensure that students are exposed to their appropriate areas of interest. Some of these programs serve a dual purpose of helping the students to improve the basic skills necessary for a Science, Engineering, or Technology career as well as exposing them to engineering type challenges.

One particular example of this was a month long summer program in which twenty students met with a university engineering technology professor in a modified classroom environment for four hours each day and were exposed to simple engineering concepts and simultaneously taken through a review of the math skills necessary to understand those concepts. None of the math skills were beyond the level that the students should have already seen in high school. Nonetheless, when tested at the beginning of the summer session, the students showed a definite shortfall in understanding of some of the algebra and geometry concepts. By the end of the month long class, however, significant improvements were obvious. Not unexpectedly, there was a 46% increase in comprehension of the engineering concepts, but there was also a 22% increase in accompanying math scores. [7] The full data from the pre- and post- course assessments is shown in Table I.

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Pre-Class</th>
<th>Post-Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Advantage</td>
<td>9%</td>
<td>88%</td>
</tr>
<tr>
<td>Friction</td>
<td>35%</td>
<td>78%</td>
</tr>
<tr>
<td>Structural Mechanics</td>
<td>7%</td>
<td>24%</td>
</tr>
<tr>
<td>Algebra</td>
<td>61%</td>
<td>80%</td>
</tr>
<tr>
<td>Ratios</td>
<td>83%</td>
<td>92%</td>
</tr>
<tr>
<td>Geometry</td>
<td>49%</td>
<td>85%</td>
</tr>
</tbody>
</table>

Table I
Comparison of Pre- and Post- Class Assessment Results for the Summer Program

Approaches used in the achievement of these improvements involved showing the students that the math skills they sometimes avoid in school have interesting real world applications that do interest them. One example was introducing students to how mechanical advantage can be used to make their life easier, utilizing a number of common devices that students have access to in their everyday lives, such as pliers, wrenches, pulleys, or jacks. The means of determining and maximizing the mechanical advantage were discussed. However, in order to effectively use these new found skills to make their lives easier, the students had to know how to apply concepts of ratios and algebraic reasoning. One topic involved a discussion of driving a car, and determining whether the car could make it around a corner at a certain speed rather than sliding into the ditch. The analysis of this situation involved use of vectors and geometry. These two concepts were areas where the students were obviously struggling. After relating the math to useful engineering type topics, their scores on the geometry part of the assessment increased an impressive 36%.

The students were also involved in inquiry based learning. The final project of the summer session was to build a structure of balsa wood, capable of supporting the most load

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using the least structural weight (appearance and sound use of engineering concepts also factored into the rubric that determined the optimum structure). Before they began any construction, they were allowed to use different shapes and dimensions of balsa wood materials and a load application mechanism to determine what types of beams held the most load. Some teams even constructed composite beams of their own design to further analyze this relationship. Students and instructors then worked together to plot and analyze the data, extrapolating relationships that helped the students understand the optimum use of the available materials.

Once construction of the final projects began, it was obvious that the students had gained insight into how to choose their materials and how to build their structures. On the final day, one of them held an impressive 70 pounds. The Science Bound program is currently in its third year. Of those no longer involved, 21% moved out of the program. The first students selected for the program, each year roughly one hundred new eighth grade students entered the program. The program was tested. An aerospace representative from Rolls-Royce Corporation had the following reaction, “The camp appeared to be received by the students with enthusiasm. This despite their “giving” of a month of their summer to it. They definitely showed that they had learned a lot and were able to apply that learning and talk about it.”

Perhaps the most promising aspect of the summer program was the qualitative gain that the instructors saw in student self-confidence. Several students who showed doubts in their own abilities at the beginning of the month, were leading the way at the end of the month, and speaking encouragingly about their fall math and science classes. The results from the following semester showed that 67% of the students from this summer program experienced improved grade point averages.

A SUCCESS STORY IN THE MAKING

The Science Bound program is currently in its third year. Each year roughly one hundred new eighth grade students enter the program. The first students selected for the program, are now entering their sophomore year of high school. At this time, 55% of the initial group of students have stayed with the program. Of those no longer involved, 21% moved out of the school district and 24% dropped out due to changes in interest or academic performance.

The things that have brought about the success of the Science Bound program are not unique to Indianapolis or to Purdue. They could be implemented anywhere. The key factors are:

♦ Select students with both the aptitude and the interest necessary for a career in Science, Engineering, or Technology. It is not enough to just choose students who test well on math and science aptitude tests. If their desire is to be a musician or an artist, no amount of science aptitude will see them through the selection process. The selection process must find those students that want to succeed in such careers.

♦ Provide school mentors that are active and involved. There needs to be someone at each school who is working with the students in the program, meeting with them regularly and developing after-school activities that further develop their interest in pursuing their career path. These mentors, by virtue of their position in the student’s school, also serve as an “early warning” system to detect when one of the students is struggling.

♦ Supply a support system that students and parents can fall back on when the going gets tough. High school students are going through a tremendous number of changes. It is not surprising that a great many of them struggle at some point during their secondary school years. This problem is only exacerbated when dealing with minority students from urban neighborhoods. For the program to be successful, there needs to be a safety net, a mechanism that the students can call on when they feel themselves falling behind in a subject. The support system also needs to be one that the parents can reach out to when they see their students struggling, or when they, themselves, do not know how to deal with a situation.

♦ Offer interesting enrichment programs. These programs should provide the students a taste of what it would be like to be an engineer or scientist. This strengthens their interest in staying the course with the program, and also helps them refine their ideas of exactly which career path interests them.

♦ Provide positive role models who are accessible to the students. Students need people in the industry that they can relate to, learn from, and call upon when they need help or advice. This also gives them a solid vision of what their life could be like if they complete the program and reach their ultimate career goal. The necessity for these students to connect with such individuals cannot be understated. Finding people who are willing and available to put in the time necessary may be difficult, but it is as important as any other aspect of the program.

CONCLUSION

The fields of Engineering and Technology can only benefit from an increase in the diversity of students who chose those career paths. Programs such as Purdue’s Science Bound that tie together university resources, corporate support, and public school system involvement with the common goal of bringing more urban high school graduates into technical fields may present the best means of achieving an increase in number, and better balance of diversity, in Engineering and Technology graduates in the coming decades.

REFERENCES
