
AC 2011-195: STIMULATING K-12 STUDENT INTEREST THROUGH INDUSTRY, ENGINEERING COLLEGE AND K-12 SCHOOL PARTNERSHIPS

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Stimulating K-12 Student Interest through Industry, Engineering College and K-12 School Partnerships

Abstract

Industries that employ engineers have an interest in supporting the children of their communities through pipeline programs to encourage K-12 students to develop interest and excel in mathematics, science, technology, and engineering. This can be accomplished by supporting the efforts of local K-12 schools to encourage students to pursue careers in STEM fields. We have found that industry often has funding and a base of volunteers but may lack the knowledge, staff, and other means to effectively work with K-12 schools to accomplish these STEM education goals.

This gap can be bridged through partnerships with engineering colleges at local institutions of higher education. The engineering college has the human resources and skills to support K-12 school STEM education programs. Thus, industry funding and interest in engagement can be channeled through the engineering college, which can provide needed support through K-12 school contact and oversight by engineering faculty, student and teacher mentoring through support by graduate students, and administration of funds. Thus the K-12 schools receive support and seed money to build a program that engages students in learning applications of science and mathematics as well as participating in competitions with students from other schools in a fun and stimulating environment. Without such support, these activities often would not take place.

Results from the application of this model will be presented. A project was funded by the philanthropic foundation of a large corporation to provide services to K-12 schools in stimulating student interest in the STEM fields that the corporation wished to target. The engineering college and each local K-12 school district worked in partnership to determine the best way to utilize the funds for maximum benefit in STEM education for that district. This naturally varied between districts based on the size of the school and the interest of teachers. In this case, the bulk of the funding directly supported high schools and middle schools for participation in the two highly effective and well documented Science Olympiad and First Robotics competitions.

A graduate student was provided to each school, with a stipend and tuition paid from a corporate foundation grant. A faculty member was tasked with maintaining contact with the schools to assess changing needs and to be a liaison between the engineering college, the schools, and the graduate students.

Assessment of the effectiveness of the role of the college of engineering as a bridge between the corporate foundation and the K-12 schools was based on the impact observed on STEM programs in each of the K-12 districts. This was measured by the student STEM engagement activities that otherwise would not have occurred. As an example, over the 3 year term of the grant, one First Robotics team grew from 7 student participants to 27, including students from nearby schools and home-schooled students who would not otherwise have had the opportunity to be involved. Assessment of the effectiveness of Science Olympiad and First Robotics

programs was deemed unnecessary as these programs have a long history of success and other comprehensive assessments have been made.

This project can serve as a model for institutions who are interested in creating a pipeline program in partnership with their local industry and K-12 communities. The authors will share our experiences in balancing the interests and needs of the participating organizations.

Introduction

Our nation's technological and economic future depends on the quality and quantity of applied science graduates. Post-secondary success of students in Science, Technology, Engineering and Mathematics (STEM) fields depends on how well these students are prepared in mathematics and science while in high school, middle school, and even elementary school. Student success goes hand-in-hand with their interest in these subjects as well as their perception of what they can accomplish with the knowledge gained. Both post-secondary institutions and industrial corporations benefit from the success of these students. Therefore, both have a vested interest in the children of their communities and are in a position to help cultivate an interest in science and technology. Frequently, however, both stumble when facing the questions: How can each provide help; and are their efforts more beneficial when combined or when they work independently? A model for creating effective partnerships is presented, discussed and illustrated in this paper.

Motivation for the Project

Students seeking to become professionals in a STEM field must have the motivation to pursue an intellectually demanding career, actively seek the knowledge required to succeed, and possess the skills necessary to excel in their education and their career. This aptitude is evidenced by life-long habits that begin in their K-12 education. Unfortunately, high school students in the United States typically perform below the international average in both science and mathematics. In fact, performance decreases as students progress through their secondary education. Studies show that fourth and eighth grade students perform at or slightly above the international average¹. Twelfth graders, however, fell far below the international average and statistically outperformed very few of their international peers². Such statistics would seem to indicate that not only ability but also interest in mathematics and science deteriorates as American students advance in their K-12 education.

Why do students lose interest in STEM subjects? One possibility is the lack of quality teaching in mathematics and science. Nationally, as many as 60% of high school students taking physical science classes and 30% taking mathematics classes are taught by a teacher who did not major in science or mathematics in college³. Curricula which lack focus and superficially cover too many topics may fail to engage students. Young people may also lack role models outside of the school setting who can encourage them to pursue education in STEM fields and provide an example of the practical advantages of doing so. This is particularly true of students coming from socio-economically disadvantaged backgrounds. A study of students in the West Michigan region indicates that it is also not made clear how a STEM career can be of benefit to others⁴.

In order for students to succeed, they must be motivated to increase both their skill set and their interest in technical endeavors. They must have not only an understanding of basic principles, but knowledge of applications where these principles can be used. There are many avenues where students can be involved in practical applications of science and technology, which will in turn motivate their desire to acquire the necessary knowledge. However, in a time of highly structured and crowded curricula, many school systems do not have teachers motivated to investigate these opportunities (which often extend well beyond the typical school day) or the financial resources required to see such endeavors to fruition.

A Model for an Industry, Engineering College, K-12 Schools Partnerships

Our model for an effective partnership to stimulate K-12 participation in STEM extra-curricular activities between industry, engineering college, and K-12 schools is shown in Figure 1.

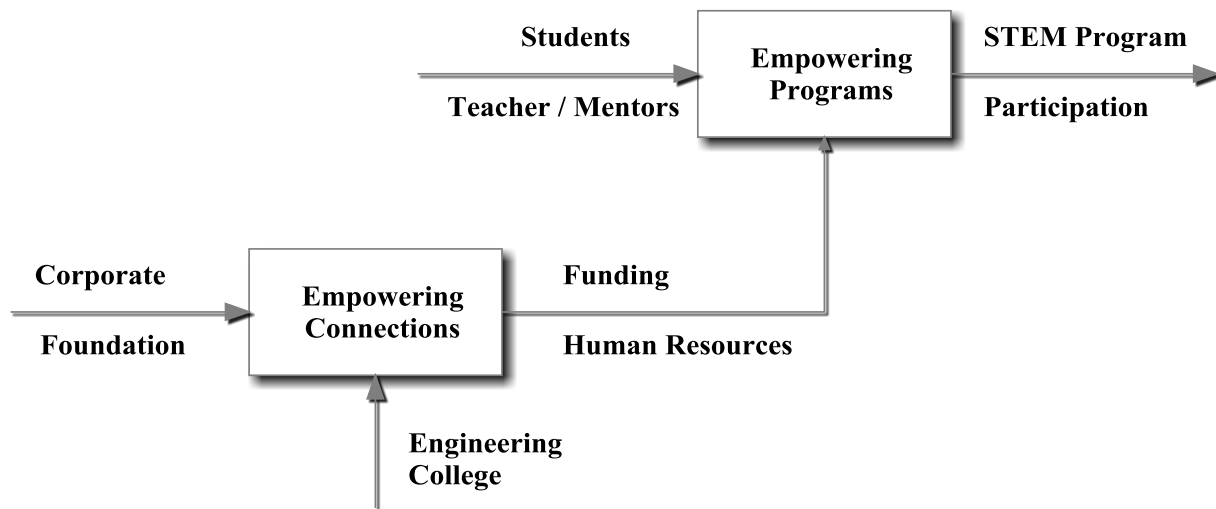


Figure 1: Model of Industry, Engineering College, K-12 School Partnership

A corporate foundation finds a mechanism for empowering K-12 extra-curricular STEM programs using the resources of an engineering college. As a result, funding and human resource support can be used to empower student groups and their teachers / mentors to start and more effectively participate in extra-curricular STEM programs such as National Science Olympiad and FIRST Robotics. Human resource support includes funds administration, assistance with mentoring, and assistance with program participation such as engaging community sponsors and parents. How funding and human resources are used depends on the individual needs of each school.

Evolution of a Partnership

As has been previously indicated, both post-secondary institutions and industrial corporations have an interest in ensuring that the children of their communities successfully pursue careers in STEM fields. Faculty at post-secondary institutions have substantial experience in teaching and guiding students, which can be put to good use in interacting with and mentoring K-12 teachers.

College students may be available to provide mentoring for the K-12 students and to supply additional technical support on projects. Administrative help can be provided.

However, neither the K-12 schools nor the post-secondary institutions are typically capable of supplying the financial means for supporting STEM-related co-curricular activities that engage students and encourage them to further explore these fields. Industry, on the other hand, often has funding but may not know how to build relationships with the school systems nor have the staff available to consistently interact with the K-12 schools. This is the situation that we found to exist in the west Michigan region. This led to a partnership between Alcoa Foundation and Grand Valley State University (GVSU).

The beginning of the relationship between these two partners began with the establishment of the STEPS (Science, Technology and Engineering Preview Summer) camp for 7th grade girls. This camp has an aviation theme. Initially, the Alcoa Foundation agreed to be one of the sponsors of this camp through financial support. After the first year of the camp, the Alcoa Foundation representatives were impressed by the activity and volunteered to also provide facility tours and on-site activities that have become a major component of the camp. Alcoa Foundation has been one of the major sponsors of this program for several years now.

Based upon the success of the STEPS camp partnership with Alcoa Foundation, GVSU was asked to consider developing a program that would match the mission of the Alcoa Foundation Regional Impact Grant Program. This program targets improving the communities in which Alcoa Foundation has facilities. There are three such communities within the geographic distance that GVSU can support: Whitehall / Montague, Michigan; Fruitport, Michigan; and Mattawan, Michigan.

Discussions with the representatives of Alcoa Foundation led to the concept of improving K-12 STEM education in these communities through co-curricular activities. This would build upon the experience that the Padnos College of Engineering and Computing (PCEC) of GVSU already had in place through involvement in several programs including FIRST Robotics, Science Olympiad, the Electrathon, and MathCounts.

It was proposed that GVSU would approach the high school in each of the three communities, discuss the well established high impact program opportunities, identify the program that would be the best fit (as determined by the high school faculty and staff), and then provide assistance to create or expand those programs. The assistance has taken the form of financial support as well as technical and organizational support (via graduate assistants and faculty). A single School of Engineering (SOE) faculty member managed the project with administrative support from the PCEC Dean's Office.

The initial objectives of the project included the motivation of high school and middle school students to participate in educational activities with the goal of stimulating their interest in and expanding their knowledge base in STEM topics. The two most appropriate activities were identified to be the FIRST Robotics competition and the National Science Olympiad. In addition, educational tools and connection with curricula to support the teams was to be provided, along with role models for the students.

This process is extremely sensitive to the needs of the individual school system. There cannot be a one-size-fits-all template for how the interaction can and should occur. A school must be willing to participate on many levels. The school administration must actively endorse the project, or interested teachers will not be encouraged and supported. If the administration is excited about the opportunity, but no teachers can be found willing to take on the project, it becomes an exercise in futility. The schools must be approached to identify their needs. The common interests of the school and the sponsor (Alcoa Foundation) in terms of activities and outcomes must be determined.

The Model in Application

One community that Alcoa Foundation was interested in supporting was Fruitport, MI, which is about 45 minutes west of GVSU. A teacher in the Industrial Technology Department at Fruitport High School actively and enthusiastically led a group of students in participating in the First Robotics competition. The group started a new team with 7 students in their first year, and grew to 27 students on the team by 2009. Included in this group were students from nearby schools who did not have a team, and even a home-schooled student. In addition to getting the students excited about technology, there was also an emphasis on team building and acceptance of personal differences, which are also very important aspects of the engineering discipline. They also were involved in the local Memorial Day Parade, taught a LEGO class for Middle School students, and took their robot to the premiere of the movie *Wall-E* at a nearby cinema. The entire group of students was certified in CPR as part of safety training, went on tours of local companies, and made presentations of their work. Fruitport High School was actively involved in looking for other ways to supplement the money through other fundraisers. GVSU supported this activity by providing an engineering graduate student 20 hours per week to help the teacher mentor the team as well as financial support to help defray FIRST Robotics expenses.

Not all school districts have the desire or the support to launch new initiatives and participate to the extent that Fruitport High School did. This, of course, does not imply that meaningful and helpful programs cannot be implemented. Whenever assistance to a school system is given, their needs must always be kept in mind.

In Whitehall / Montague, MI, another community targeted by the project, no assistance in the form of a graduate student was accepted. A science teacher at the high school led a Science Olympiad team. Money provided by Alcoa Foundation via GVSU was used to support travel, fees and equipment. The team finished 4th in the regional competition (Michigan Region A). In addition, they entered the West Michigan Rocket Competition in 2009, and the Middle School Science Olympiad team went on to the state competition. Involvement in the project enabled the teachers in the Montague Area Public School to extend their imagination as to what they could accomplish once the proper resources were in place. They employed better quality materials. Additionally, improved travel arrangements (bus rental instead of individual cars) resulted in greater team excitement and cohesion and particularly better performance by team members who were more rested. Finally, they also succeeded in making their program more sustainable by involving more teachers in the project.

A third targeted community, Mattawan, MI, near Kalamazoo, initially expressed interest in the FIRST program. It became apparent, however, that this interest was from the principal rather than the teachers willing to help, and a Science Olympiad team was crafted instead. In 2009, the Mattawan High School Science Olympiad team finished 6th out of 9 teams in the Region B tournament, and the Middle school team finished in 4th place, which was their best performance in years. As at Montague, GVSU provided financial support as well as a 20 hour per week graduate student from Computer Information Systems. This student worked to solicit support for the team from local business and civic groups.

The schools were very satisfied with the improvement in their programs and thankful for the support that was provided. Alcoa Foundation was also kept engaged at all points. Reports of the schools' activities were provided to the company semi-annually, and presentations were made to the Board of the corporation. Alcoa Foundation was also involved in presenting the checks for support funds to the schools at school board meetings. This provided even closer ties between the corporation and the schools.

Assessment

The effectiveness of the engineering college bridge between a corporation and K-12 school districts was measured by increased student participation in STEM-related co-curricular activities, specifically FIRST Robotics and Science Olympiad. Our findings included:

- A First Robotics team that grew from 7 to 27 students in one year, including home-schooled students and students at another school without a team.
- Two new Science Olympiad Teams

In addition, the competitive success of these teams is an indication of the effectiveness of this program.

- One new Science Olympiad team finished 4th in a regional competition and went on to a state competition.
- A second new Science Olympiad team finished 6th out of 9 teams in a regional competition.
- An existing Science Olympiad team improved significantly to a 4th place finish.

Additional assessment of the impact of the First Robotics and Science Olympiad programs seems unnecessary as these programs have a long history of success. In addition, assessments of these programs have already been completed. Brandeis University⁵ conducted a comprehensive assessment of the First Robotics program and concluded: “the data generated in this study present strong evidence that FIRST is meeting its goals of providing a positive and engaging developmental experience for young people and is succeeding in its efforts to increase the interest and involvement of participating youth in the fields of science and technology.” A similar study⁶ concerning Science Olympiad concluded: “Based on all findings across years, we strongly suggest use of the Science Olympiad collaboration-competition model at middle school and high school levels to enhance student motivation to learn and apply science, engineering and mathematics concepts and skills.”

Summary

Creating a pipeline of future college-level STEM students requires engaging K-12 students in STEM activities. School systems may be inhibited from so doing by a lack of financial resources and staff time. Local industry, interested in developing and hiring STEM educated college graduates, will support K-12 pipeline activities, but they are often not prepared to do it alone. Schools of engineering can provide the connection between K-12 schools and local industry. By teaming up, the strengths of all constituents are leveraged for maximum benefit. This connection includes making K-12 schools aware of possible STEM activities, being the conduit for industry financial support and providing additional staffing, including mentors for students engaged in these activities. The K-12 schools have been extremely satisfied with their interactions with the college student mentors, with nothing but words of praise for them. The performance of all the teams was significantly enhanced by the interaction. Also, the corporate sponsor was very thankful for the changes they observed in the schools in their targeted communities.

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