

K-12 Redux: Sending College Students Back (In) to Schools

Elizabeth Parry, Dr. Laura J. Bottomley
Science Surround, NC State University/NC State University

Abstract:

The purpose of this paper is to communicate effective ways graduate and undergraduate college students, particularly those in science and engineering, can be utilized as resources in K-12 schools. Recruitment at middle and high schools is a tried and true way for university students to enhance an engineering college's appeal. But there are a number of other ways the engineering student can be a significant resource to both K-12 students and teachers, all the while improving their own marketability to prospective employers.

A great need for math, science and technology expertise exists in public schools today. Especially in the general math and science areas of the K-8 arena, instructional effectiveness is widely variable. In the early grades, teachers are fairly comfortable in the life science areas they teach. However, when students move on to the areas of physics (motion, energy, etc), the teacher's comfort level drops considerably. Engineers are taught from day one that integration of math and science into problem solving is necessary. Therefore, engineers bring to the classroom this natural ability to integrate subject areas together. The engineering student's strengths partner quite effectively with the teacher's more familiar areas of expertise such as language arts and social studies, to give the student's an integrated, "big picture" view of curriculum areas.

This paper discusses the experiences gained through operation of an NSF GK-12 grant, as well as other community service programs administered by the North Carolina State University College of Engineering Outreach department. Specific ideas and their implementation will be discussed, and the benefits to the university, the public schools and the engineering student will be clearly identified.

Introduction:

In today's technologically competitive world, it is more important than ever to educate our students well in the areas of critical problem solving and subject integration.¹ Paradoxically, K-12 students are often taught various core subjects in isolation, i.e. they have a language arts class, then mathematics, then social studies and finally science. In the state of North Carolina, the situation is even more critical due to high stakes testing in grades K-8 in language arts and mathematics only. That leaves science and social studies to be taught when there is time, a luxury not often present in today's public schools. Aside from the time issue, K-8 teachers in particular graduate with little experience in "hands-on, minds on" science instruction, instead learning science as taught from textbooks. In lower elementary grades, the curriculum consists primarily of life science subjects such as plants/seeds, life cycles, habitats, etc. The more abstract subjects of physics beginning in grade three are harder to teach, especially with the limited science training the teacher usually possesses. The combination of testing pressure and a

lower comfort level in the sciences means students are shortchanged in science education in our state.

On the other hand, universities are always looking for ways to impact recruitment, and engineering schools in particular are acutely aware of the need to heavily recruit, especially in underrepresented groups. Most universities have outreach activities, largely focused on high school, and in recent years, middle school students. But outreach often involves a short visit, with a high level overview of the potential careers in engineering and science. There is an enormous opportunity for engineering schools to help fill the void in science instruction by serving as science, math and technology resources, and demonstrating through example the natural integration of core curriculum subjects.² These objectives can be achieved through extended outreach commitments and community service programs.

The role of the university:

The university's role in matching the skills of the engineering student with K-12 classroom teachers is crucial to the success of the partnership. Ideally, stipends for students would be made available to insure the student's ongoing commitment to the teacher and school they work with. In addition, managing the relationship, from initial contact to oversight and problem resolution, is a role that could be served by the university's outreach department. It would also be the responsibility of the university to develop low cost lessons and material lists, to have the greatest chance of the effort being reused. Dissemination of the output of the partnerships is also crucial to maximize the effort. Finally, the university might be called upon to provide materials and /or expertise not normally available to public schools.

The university, in turn, receives the benefit of having a consistent presence in the public schools, and through the work of the students, a natural public relations boon for the community. Indirectly, recruitment would be positively affected, and good will certainly increased. Through careful recruitment and placement of engineering students, underrepresented groups will have role models to work with on a regular basis, thereby increasing the chance of recruiting more of these students to science, technology, engineering and math (STEM) careers.

The role of the engineering student

As engineering students, we are taught from the beginning to approach problems in a logical, integrative way. For example, given the problem of devising a means to cross a river, an engineer would use the approach of providing a method that meets the needs of the populations on either side, takes into account the river and its characteristics, and does it all with safety and cost in mind. The needs of the users are the social studies aspect of the problem, and math and science are used throughout the process. Language arts skills such as reading and writing are inherent in such an exercise as well. But the engineer is taught to keep the end result in focus, and at no time would the problem's solution be considered in terms of one aspect. In the classroom, however, the tendency would be to break the problem down into areas of study. For example, the peoples on either side of the river might be studied in social studies. The crossing solution, be it bridge or ferry, would be designed in math class, and potentially discussed in science. It would be an exception if students were required to do additional research or writing

as part of the design exercise. The blame for this study in isolation lies not in any one particular arena, but rather is part of our embedded approach to K-8 education.

Enter the engineering student. The potential for positive affect is tremendous. Through a regular volunteer or university paid position, the student would collaborate with the teacher to integrate science and math into other core curriculum subjects. For example, if the fifth grade were studying Central and South America in Social Studies, the engineering student-teacher team might develop a lab exercise on the atmospheric effect of deforestation in those areas. Simple exercises showing how carbon dioxide affects our breathable air would clearly demonstrate the adverse effect of rain forest depletion, and would serve as instructional delivery of one of the fifth grade science strands about ecosystems and balance. Students can research why the rainforests are being cut down and debate, based on what they've learned, the pros and cons of the deforestation from the local standpoint. A writing exercise might involve letters to government officials in those countries, or requests for information from scientific or environmental groups about the worldwide impact of this local practice. Therefore, a classroom experience with a phenomenon heretofore only read about brings home the idea of why students in the United States should care about what happens elsewhere in the world.

In addition to providing integration expertise, the engineering student brings to the school a high level of comfort and familiarity with science, math and technology.³ In Wake County, technology in the schools is only now becoming more common, and the time to learn how to seize on the potential of the Internet for lesson augmentation and research is rare. In some of our schools, elective classes explore specific technology areas such as multimedia and Web Page creation. As a result of all of these conditions, technology is an underutilized area for teachers. In addition, most of Wake County's schools rely on heterogeneous classroom mixtures that, while giving the students a well-rounded cohort of skills to work within, present a challenge for the teacher in terms of differentiated instruction. NCSU engineering students work as small group and individual math tutors for both low and high performing students. The need is acute in higher math in upper elementary and middle school, because teachers are restricted by time and parents are less confident of their own abilities in those areas. Technology, as stated, is another area of opportunity. From effective use of the Internet, to providing ideas for topic illustration, to actually teaming with a teacher to teach a Web Page Creation elective for students in grades 3-5, our engineering students are proving to be a valuable resource to our teachers. Finally, NCSU students are developing, with guidance from curriculum experts known to the schools, inquiry-based, integrated science lessons for teacher delivery.

From an extracurricular standpoint, there are opportunities for engineering students to work as mentors on science fair projects and Science Olympiad teams. The role model aspect in these often-voluntary events is crucial, especially for underrepresented groups. In some schools, certain grade levels are required to complete a project as a major part of their science grade. To those students who do not have the help at home or resources to get help, the mentoring of a college student could make all the difference between passing or failing science. The engineering students work with the K-8 students and take them through the scientific process to completion of a display board detailing the project. Aside from the reality of completing an assignment, the student is able to place his/her project alongside those of classmates, and the positive affect on self-esteem with the completion of the project is immeasurable. There are

additional extracurricular opportunities for the students to become a partner with the school and its Parent-Teacher organization in the implementation of a family math, science or technology night. This is an excellent opportunity to bring the university's investment in the K-12 school to the forefront of the school community, while at the same time increasing awareness of the practical application of science, technology, engineering and math and their career potential.

For the engineering student, the benefits of an outreach partnership are many. If a paid position, there is the obvious monetary gain. But from a non-monetary standpoint, students will gain an appreciation of clear communication; the opportunity to reinforce STEM concepts previously learned, as well as further opportunity to practically apply concepts learned at university. In addition, the potential to improve upon communication skills is enormous; if a college student can clearly explain the phenomena of physics to an elementary student, then later communication with industry colleagues will be easy! The NCSU students who have participated in the GK-12 Engineering Fellows program have unanimously reported that interviewing companies were keenly interested in their experiences in K-12 schools.

The role of the public schools

Certainly, the public schools involved in these outreach partnerships have much to gain. In order to take full advantage, the school must be open to recognizing the value add of the engineering student, especially in terms of the natural integration engineers do, as well as STEM expertise. In addition, the student and the university must be aware of the skills the professional teachers bring to the partnership. Teachers are experts in learning styles, communication, differentiation and classroom management, in addition to pedagogy and curriculum training. It is crucial that both parties to the partnership are aware of and committed to the reality that the teacher and student are on equal footing. Too many times, universities approach public schools with ideas for providing help, only to make it clear that "help" is defined by the university, often in isolation of what the schools need. By the same token, teachers must be aware of the tendency to become territorial about curriculum and lesson plans, and to remain open minded about the potential of the partnership.

If the relationship has been properly initiated and set up, the management aspect of the partnership should be minimal. The goal of the university, the engineering student and the school must be to minimize the additional responsibilities placed on the classroom teacher. To that end, it is imperative that each school have a single point of contact, preferably in administration or instructional resource, who will serve as the liaison between the school's staff and the engineering student, and also between the school and the university. This on site coordinator would be responsible for scheduling the student's classroom time with willing teachers, and would serve as the first line of problem resolution. In addition, the onsite coordinator will communicate regularly with the university coordinator to insure maximum efficacy is reached. If the partnership is established and managed in this manner, the school stands to gain much in terms of additional help in science, math and technology, as well as content area expertise in STEM. Classroom teachers should gain an appreciation and knowledge of integration of science into other curriculum areas, and also additional experience in utilizing inquiry based, integrative lessons. Students at the school are the benefactors of focused attention by another caring adult, as well as exposure to role models in science, math and engineering.

Ideally, students will also see university as a natural extension of their schooling upon graduation.

Challenges

Society today pushes down decisions previously encountered in late stages of a student's K-12 educational experience. In Wake County, students must decide on a career path at the end of eighth grade! High school class schedules are designed to support this "career path", whether it be university, trade school, business and technology, engineering, etc. Conventional wisdom has allowed that recruitment by engineering colleges must now take place at the middle school level. However, our anecdotal experience with over 3000 Wake County students shows that it is somewhere around third or fourth grade that students, girls in particular, decide whether they like math and/or science.⁴ Therefore, while it may be middle school when students begin to hone in on future career paths, if a student has already decided they dislike or have no affinity for math or science, they are highly unlikely to choose an STEM career. The challenge is clear: positive exposure to STEM students and an engineering university early in elementary school can alter or delay this decision.

Conclusions

The benefits of extended outreach partnerships are many, and apply to all partners-the university, the engineering student and the K-12 public school. Sharing the expertise gained in an engineering curriculum fills a void in public education, and the engineering student's strengths match quite effectively with the teacher's more familiar areas of expertise such as language arts and social studies, giving the K-12 students an integrated, "big picture" view of the curriculum areas. The university has an ongoing presence in the schools, increasing both the school's and the community's level of familiarity with the college. The university is perceived as a partner, and one interested in community service to educate the K-12 population. Of course, it is hoped that long term relationships between the K-12 community and the university will result in increased student enrollment in the future, especially in STEM fields in general and underrepresented groups in particular. Finally, the engineering students have the opportunity to practically apply what they have learned, and to improve communication and relationship skills prior to entering the work force.⁵ Clearly, the university investment in such a partnership is more involved and focused than typical "career day" one time visits, but the long term payoff in terms of community good will, potential recruitment and general awareness of STEM careers makes the investment more palatable.

References

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ELIZABETH PARRY received her B.Sc. in Engineering Management/Mechanical Engineering from the University of Missouri-Rolla in 1983. After ten years of industry and management experience with IBM Corporation, Ms. Parry became a partner in Science Surround, an informal science education business. In addition, she consults with NC State University on K-12 science issues, and is the assistant director of outreach.

LAURA J. BOTTOMLEY is the Director of the Women in Engineering and Outreach Programs at North Carolina State University and co-owner of Science Surround, a science education business for children. Dr. Bottomley received her Ph.D. in electrical engineering from North Carolina State University in 1992, and her MSEE and BSEE from Virginia Tech in 1984 and 1985, respectively. She has worked at AT&T Bell Labs and Duke University.