STOMP: Student Teacher Outreach Mentorship Program

Merredith Portsmore, Chris Rogers, Melissa Pickering
Tufts University

Abstract

The Student Teacher Outreach Mentorship Program (STOMP) at Tufts University brings engineering students to educational settings to support engineering education. In December 2000, Massachusetts incorporated engineering into its state science and technology frameworks. Educators are now working to integrate these new standards into their classroom teachings. Many educators are not familiar with engineering concepts so they are working hard to learn new concepts at the same time as they are implementing projects and teachings to address the frameworks in their settings. STOMP students, engineering undergraduate and graduate students, serve as a support mechanism for these educators by helping students with hands-on projects, resolving technical issues with equipment, answering engineering questions, doing research on topics, and helping to brainstorm activities. The program has been very successful in facilitating engineering education in 10 local classrooms in grades K-9. STOMP student – teacher partnerships have resulted in some fabulous new curriculum units including a 4th grade unit entitled "Egyptians as Engineers" and a middle school unit entitled "Make your own CD – Learning Digital Logic." The STOMP program also strives to help engineering students understand the educational system and to encourage their involvement, as future members of industry, in K-12 education. This paper will detail the creation and implementation of a project of this nature as well as highlight the difficulties and successes experienced to date.

Introduction

The mission of the Center For Engineering Education (CEEO) at Tufts University is to make engineering part of K-12 education. Engineers apply math and science knowledge to create products or processes. Giving students design challenges that require their knowledge of math and science motivates their math and science learning and also helps them to gain an understanding of what engineering is. Children naturally like to explore and to build. Engineering projects capitalize on those interests and hence engage and interest students.

Massachusetts has recently recognized the importance and power of engineering and has incorporated it into the state science and technology frameworks.[1] (Frameworks are the basis for the state's standardized tests) Many educators are not familiar with engineering concepts so they are working hard to learn new concepts at the same time as they are implementing projects and teachings to address the frameworks in their classes. Engineering projects, while often more rewarding, are also more demanding and resource intensive than lectures and worksheets.

To help support teachers, Tufts University's Center For Engineering Outreach, with support from the LLL Foundation, has developed the Student Teacher Outreach Mentorship Program (STOMP). The idea of STOMP is to pair engineering students, graduate and undergraduate, with K-12 educators. The STOMP students serve as a support mechanism for these educators by helping students with hands-on projects, resolving technical issues with equipment, answering engineering questions, doing research on topics, and helping to brainstorm activities. They also work with teachers in off school hours to help them with their engineering knowledge. Aside from helping to support education, the STOMP program aims to promote citizenship in the engineering students by helping them to understand the educational system and to encourage their involvement, as future members of industry, in K-12 education.

Getting Started

The STOMP program is open to any engineering student who is interested. STOMP is not a volunteer program but a paid position. The program recruits from engineering classes and through campus advertisements. Extra effort is made to recruit minorities and females to help serve as role models. The program has easily met its self imposed 50% female quota during the first two years but is still striving to attract more minorities. Students receive hourly wages for their work in and out of the classroom. Ideally, students work between 6 and 8 hours a week in the program splitting that time between actual classroom work, outside meetings with the teacher, development work, and meetings and seminars. Prior to funding many students were eager to volunteer their time for the classroom but couldn't volunteer the additional hours for outside activities because of a need to work. Making STOMP a job helps students make a bigger commitment which benefits all. The program had 10 students its first year and has 15 students this year with a goal of 20 for next year.

Before entering the classroom, it is important for STOMP students to understand the curriculum standards outlined for the appropriate grade level, and subsequently highlight those concepts in the classroom projects. As the standards for each age vary, the one concept that is consistent for all ages is the engineering design process. The classroom projects are executed in this structured process, so that the students develop the habit of (1) identifying the problem/task; (2) outlining/designing the solution on paper; (3) constructing and testing the solution; (4) analyzing the results of the tests, and then discussing how to make improvements for future designs. With these four steps in mind, the teacher and STOMP student can require the kids to keep an engineering log, where their project drawings and reflections of project results are recorded. This log will serve not only to teach the design process, but also provide for a greater possibility that the kids will remember the highlighted concepts.

Introducing the engineering design process and more specific physics concepts to a dynamic young age group can be challenging in itself, aside from the usual inconsistencies that exist in the classroom. Having the kids work on projects in pairs allows them to overcome their intimidations of the new material, as well as stimulate their creativity. However, occasionally lack of confidence remains an issue, and in this instance the teacher or STOMP student can provide a physical example that the group may replicate, gaining the satisfaction of a working solution, and thus develop confidence for subsequent projects. At the opposite end of the spectrum, the few kids who quickly design and construct a solution need small project extensions in order to provide them with a challenge. For example, if a group easily constructed a stable Lego chair for a stuffed bear, their extended challenge would be to construct an ottoman.

STOMP students also need a basic understanding of the educational system and developmental abilities of children. This information is provided to them via semimonthly meetings/seminars. The meetings also serve a forum for discussing ways to deal with problems, brainstorming ideas for projects, and creating a community of participants. In addition, meetings allow students to be trained to use any specific hardware or curriculum that is in use in their classroom. The STOMP program helps supports basic engineering projects (scissors, paper clip and tape) as well as higher end systems such as the Paxton Patterson labs. As Tufts is a major developer of LEGO's ROBOLAB system, the STOMP program heavily utilizes the RCX and LEGO components in engineering projects. STOMP students have access to a library of LEGOs, laptops, and other equipment to lend to classes they work with. Tying the lending library to STOMP students ensure that the materials are made good use of and can be reclaimed if they are not being used.

In Action

One of the advantages of engineering projects is that it is easy to incorporate social studies, math, and science units into projects, thus causing little disruption in a teachers established lesson plan. STOMP students have collaborated with two fourth grade teachers in Lincoln Massachusetts' elementary school to develop a project on pyramid construction, thus interweaving the Ancient Egypt unit with engineering principles. The project consisted of two challenges and was executed in four one-hour sessions. Each group was challenged to build a Lego vehicle powerful enough to drive up an inclined plane and pull a weighted sled. While this simulated the process of hauling stones up a pyramid side, the kids were also learning about gears, friction, and forces. Wherever possible, visual demonstrations and references to familiar phenomenon were used to support these concepts. For example, to illustrate the advantage of inclined planes, the stretch of a rubber band was compared with directly lifting versus dragging a given weight load. The importance of minimal friction on the sled was related to a snow toboggan, and the kids were able to identify an ideal sled as possessing two runners. Once all vehicles and sleds were built, each system was tested for the maximum amount of weight it could haul to the pyramid top. Finally, to incorporate math and appropriately conclude the entire project, each system's maximum weight was displayed in a bar graph.

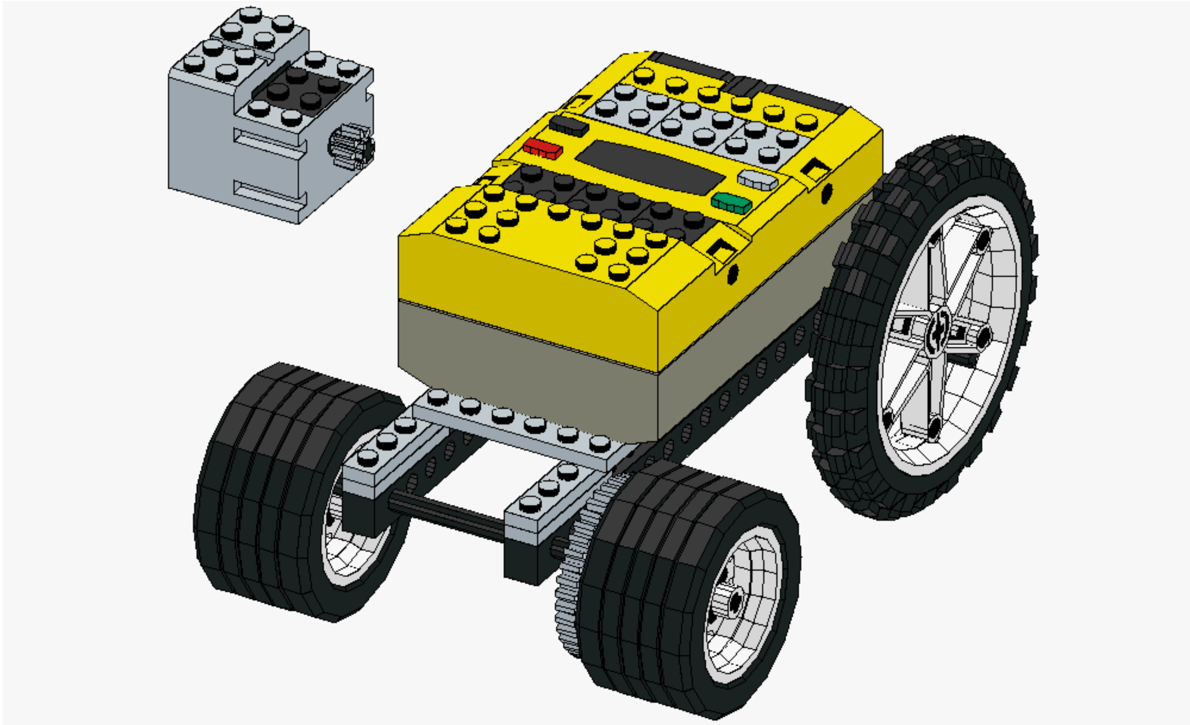

FIGURE 1: A sample vehicle created by a STOMP student for the worksheets that supported the Egyptian as Engineering project

STOMP students working in a middle school in Medford, Massachusetts have supported the 6^{th}-8^{th} grade technology program. Here, they have helped the teacher refine existing curriculum that addresses different types of engineering by adding more practical, real world examples. They also created ROBOLAB/LEGO based units that helped students to understand concepts that were difficult to understand via other means. "Make your own CD – Learning Digital Logic" was a unit they created where students created their own large CDs and LEGO robots to drive around them and play music based on the pattern they drove over. Students were enthusiastic about the project and able to explore science concepts while being creative.

Figure 2: CDs created by students in Medford, MA

STOMP students support a wide range of classrooms and locations. They helped to design and support a project on Medieval Engineering for 5^{th} graders that involves creating their own engineering company that manufactures drawbridges and portcullises. They support introducing engineering by infusing it into physical science labs in a 9^{th} grade honors course in Everett, MA. They have been instrumental in designing the curriculum and helping implement a new year-long 4th grade engineering class in the Josiah Quincy Elementary School in Boston's Chinatown. They also aid 1st and 2nd grade teachers in Lincoln, MA implement a hands-on LEGO based engineering curriculum aimed at giving students early exposure to engineering. All of the curriculum created by STOMP students is available at the CEEO's site – http://www.ceeo.tufts.edu/robolabatceeo.

The feedback from teachers has been tremendously positive. They enjoy having someone to collaborate with and feel the STOMP volunteers bring an energy and excitement to the class. The number of engineering projects and level of difficulty of projects attempted is increased by having STOMP volunteers in the classroom. The STOMP students feedback has also been good. The students enjoy their classroom experiences and feel rewarded by their work. Most of the difficulties they report, discussed in the next section, are related to creating a better environment for helping students and teachers learn engineering. More formal assessment of STOMP students, and teachers is being implemented this year through surveys and interviews.

Difficulties

While overall the STOMP program has successfully operated for nearly two years, there are still areas to be improved upon. One of the main problems is the infrequency and inconsistency of sessions. While it is understandably difficult for teachers to schedule an adequate time block three to five days per week for engineering education, it is also hard to make the program worthwhile with only one weekly 45-minute session. Another difficulty encountered is the tendency of some of the teachers to rely too heavily on the STOMP student in teaching the material. While the students may have stronger foundations in engineering, the teachers should instruct so that they can become more familiar with the material to confidently teach on their own in the future. The STOMP students act only as aids to jumpstart the teachers' engineering education, as they help design projects, provide worksheets, demonstrations and suggestions.

It is difficult to assess the program's effectiveness with only the teacher and kids as sources of feedback, and the latter is most unreliable. Whether the kids actually grasp the overall concepts remains unknown. For example, many fourth grade students constructed Lego vehicles by automatically placing a lone gear on the axle behind each wheel. While the kids' nodding heads may indicate their understanding of gears, it is apparent that rather than viewing gears as a mechanism to efficiently transfer motion, they associate a gear as an item to always accompany a wheel like an axle. A variety of projects and more frequent class sessions should alleviate such misconceptions.

The program also presents some logistical difficulties. Tufts is located in a suburb of Boston and transportation and timing can be difficult. A significant portion of Tufts engineering courses are scheduled during standard K-12 hours making it sometime difficult for students to find enough time to travel to a site, do a project, and get back in time for their next class. Also, as Tufts is on a semester system, new classes in January make adjustments and changes in STOMP students necessary. To overcome this, we have worked on building a large pool of students and focusing on schools in close proximity to Tufts. The programs popularity has also prompted some programs to offer to provide transportation for students.

Under the initial guise of the program, individual students would be paired with a single teacher. This proves to be successful in many cases. However, large classes, ambitious projects, and very inexperienced teachers often dictate that 2 students be paired with a teacher to handle the workload and/or students. The pairing of STOMP students to work in a classroom has been very successful. STOMP students enjoy having another person to reflect on the situation and to work on projects with. It also helps to increase the consistency of the support – if one student has another commitment the other can still attend.

Future Directions

While STOMP continues to evolve, the general model has been very successful. We want to continue to grow the pool of engineers at Tufts participating at STOMP. Obviously, logistically and with the number of engineers at Tufts we cannot support all the schools in the Boston area who would like a STOMP student . We plan to take the model of the STOMP program to other universities and colleges in the Boston area with the hope of implementing similar support programs with their students. Universities in other states and as far away as New Zealand have expressed interest in establishing similar programs. We hope by the end of our initial three year funding to have significant documentation and support resources for those institutions on establishing similar programs.

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MERREDITH PORTSMORE
Merredith Portsmore is the Education & Technology Program for the Center For Engineering Educational Outreach at Tufts University. She received her B.A in English, B.S.M.E., and M.A in Education from Tufts University. Her research interests utilizing the internet to increase interest and knowledge of engineering.

CHRIS ROGERS
Chris Rogers is a professor of Mechanical Engineering at Tufts University. He got all his degrees at Stanford University. He spends much of his time either playing with LEGO bricks or looking at the behavior of particles in a turbulent airflow. Currently he is the Kenan Professor of Mechanical and Aerospace Engineering at Princeton University.

MELISSA PICKERING
Melissa Pickering is a sophomore at Tufts majoring in mechanical engineering. She has been part of STOMP since its inception. She has helped in numerous classes in the Boston area and will even help STOMP become international during her semester abroad in New Zealand.