AC 2009-592: MENTORING INCOMING FRESHMNN STEM ENGINEERING STUDENTS BY SENIOR ENGINEERING STUDENTS

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Mentoring of Freshmen STEM Engineering Students by Senior Engineering Students

Abstract

For a month in the summer of 2008, six incoming freshmen STEM students (mentees) were mentored by two senior undergraduate engineering students (mentors) in a robotics based project. The project focused on the "ground-up" realization of a swarm robot prototype. It differed from most entry-level robotics projects in scope. Instead of using preassembled and pretested robotics components, the students were asked, as a team, to design their own mechanical and electrical systems under the supervision of the senior engineering student mentors. The mentees appeared to be divided as to how they felt about the program. Two students expressed that the program was difficult and were uninterested in the team environment. The other four were much more eager to be engaged in an experience like this, and worked hard to help it succeed. Since the summer program, they have been engaged with the mentors, their fellow classmates, and have had an increased confidence in their abilities to handle an engineering program. These students are currently continuing this project as undergraduate research assistants under the mentorship of the senior engineering students. The mentors expressed that they also benefitted from this program. They gained valuable experience in project and group management. They also increased their in-depth understanding of the mechanical and electrical systems through providing technical support to the incoming freshman students.

Introduction

Mentoring programs at various academic levels, k-12 through graduate studies, have been implemented to help students to overcome barriers to their academic and social success. Mentoring not only has been shown to have numerous positive impacts on students but also on mentors and schools. As it has been stated in a report, student mentoring, and the references therein, mentoring is a sustained one-to-one relationship between a caring adult and a child who needs support to achieve academic, career, social, or personal goals. Unlike natural mentoring, planned mentoring, requires matching between mentees, students receiving mentorship, and mentors through a structured program with specific objectives and goals in mind.[1]

In order to address low undergraduate retention rates, a common problem faced by engineering programs, some universities have established various mentoring programs for incoming freshman students. The common goal of these programs is to help students to cope with the difficulties encountered while transitioning from high school to university settings; and the stresses associated with pursuing the rigorous engineering program.[2-8]

The extent and approach of these mentoring programs varies. At Oregon State University, the mentoring program was designed for the entire freshman class; and it consisted of graduate students, graduating from the same institutions, serving as mentors and implementing evaluation tools: student retention records, a freshman mentor data base, and a survey to track growth in the effectiveness within the student body. The mentors focused on the individual technical mentorship through leading a lab section during each of the three terms in the freshman year. The mentor program also focused on students' self-efficacy among the incoming freshman class by using all four sources of efficacy .[2,3]

At the University of Nebraska, a pod-based mentoring program was utilized. They used an off-campus retreat, student support communities called pods, a graduate student Counseling Assistant, and more immediate feedback.[4]

The University of Tennessee employed a mentor program called "Engage." This program combined five basic engineering courses into two team-taught courses. The courses had design teams that were coached by an upperclassman.[5]

At the University of Pittsburg, a series of mentoring courses combined with academic counseling were made available to the entering students to select from.[6]

The peer mentoring program at Michigan Tech has helped retain female and underrepresented minority engineering students, while benefiting the mentors themselves academically, socially, and professionally.[7]

The University of Arkansas attributes the success of its mentoring program to several key factors: proper mentor selection (juniors and seniors), mentor training, freshman mentee training, proper mentor-mentee matching, weekly targeted one-on-one meetings with mentees, well-timed information and mentee support, proper referrals, group mentee social activities, and mentor handbook development.[8]

In our pilot mentoring program, we focused on a small number of incoming STEM freshman students who were attending a summer bridge program, during one month of summer prior to their first fall semester; and intended to major in a STEM discipline. The mentors were senior engineering students who focused on providing technical supervision of the mentee's robotic based project. The reasons for implementing this mentoring program were: Introducing incoming freshmen engineering students to the engineering processes, transition from high school to the university academic setting, and the impact of these on retention.

Observations and Results

Mentee Attitudes

During the first day, mentees' levels of excitement ranged from indifferent to high. You could tell though that while these students had chosen to be in this group, some seemed to have just

made a “lesser of two evils” type decision, and they weren’t 100% into it. On the other hand, there were some other students involved who were very eager to work on this project and were roaring to go from day one.

As time went on, the division in attitudes was clear. Some students moved from apathetic to excited, some moved from excited to apathetic, and some stayed where they originally were. But you could tell that near the end, the students were pretty solidly in one camp or the other. The mentors tried to make the project fun while still giving them a taste of engineering process and what would be expected of them in the upcoming years while pursuing their degree. It seems that this approach discouraged some and invigorated others.

Although some of the students left the project, however, we feel that this mentorship afforded them to realize their interest and ability for majoring in Engineering. They were given some basic training to gain certain technical and computer skills (SolidWorks, CNC milling, soldering, etc…) that are not necessarily taught in certain courses but valuable to their professional development. Those students who stayed in the engineering program continued working on the project as undergraduate research assistants during the following Fall and Spring semester under the supervision of the mentors.

Mentee Ability

Previously, we mentioned the two camps concerning the students’ attitude. We feel that this may give some clues on their preparedness and ability concerning our expectations. The students who were excited about engineering had grasped the techniques and tools that we gave them and were able to utilize them without supervision when given a task. Those who were downtrodden needed supervision at all time while they worked on their assignment. We were not sure whether this was due to their feeling of discouragement because they couldn’t grasp the technique or vice versa.

Mentor Attitudes

At first the mentors were a bit nervous about handling the mentees because they felt that their role would have a very strong influence on the mentees perception of the engineering discipline. The mentors wanted the mentees to have fun, be productive, and be excited about engineering; and not be the ones to discourage them from moving forward. The mentors tended to be a bit ambitious concerning the project, and they felt that swarm robotics definitely serve that purpose. They felt as though it would be difficult and certainly a challenge to get everyone involved, but that it was also a quality project that everyone could be really proud of in the end. They were satisfied with the outcome of the project, and felt that the students were proud of their accomplishments.

Project Description and Control

The project chosen for this program was to design and fabricate a robotic swarm, capable of communication with other robots of the same swarm for the purpose of accomplishing a task. To do this, the project was broken into two parts: the mechanical design and the electrical design. Students were put into groups based on their professed interests. Fortunately, the students' interests were about evenly divided, allowing everyone to work on the team they wanted to.

The electrical team was headed by one of the senior students. The goals the electrical team had set were wheel motor control, communication/sensor system, and to use PCBs and SMD soldering techniques. The mechanical team was headed by the other senior student and set the goals of designing and fabricating the chassis, wheels, a controllable arm system that was capable of using different tools, tool design, and to use CAD/CAM packages and a CNC milling machine to do all fabrication.

For the duration of the project, the use of quick group meetings was used to facilitate inter-team communication and ensure all components would work together cohesively. At the end of each day, both groups would sit down and give short 5-10 minute presentations. This would allow everyone to ask the other group what would be required of them to get a certain component implemented and vice-versa. It also aided in setting the agenda for the next work day, and gave the students the night to think about ways to fix problems that arose.

During the program, the mentors took a few days to do group activities that would benefit everyone in the long term. The mentors did a day of SolidWorks, where the students went through the SolidWorks tutorials and got a feel for how to make mechanical parts. This was supplemented by mentor help for learning more complex maneuverings that would be required for the project. The mentors also introduce the mentees to the operations of the CNC mill in the shop. The last day-long hands-on training was on some circuitry and soldering. Circuit components were provided, and the students were allowed to assemble a moderately complex test circuit and solder it to a circuit board.

In the end, the electrical group managed to accomplish a majority of their tasks, with only tweaking and refinement left for the communication and sensor system. The mechanical group also accomplished most of their goals, with only the arm system left to be fully implemented.

Mentee Feedback

Following the completion of the one month program, the mentees were solicited for their feedback in a questionnaire concerning the program. The general feelings were: The program helped them with the transitioning from high school to college settings. They learned about engineering process. They enjoyed the socialization through team work. They feel that it gave them more confidence in course work that would follow. They felt that the mentoring program was very effective and strongly recommend it.

Mentor Feedback

The overall mentors' responses to a questionnaire concerning their role were: Though the mentees did not make as much progress as initially hoped for, they were able to build one robot from the ground up. The Mentors need to become more familiar with management skills in order to be more effective. One means to achieve this, they suggested, can be incoming mentors to learn from the outgoing ones. They gained valuable experience in project and group management. They also increased their in-depth understanding of the mechanical and electrical systems through providing technical support to the incoming freshman students. They felt that the lessons learned from this mentoring program helped them with their senior design process.

Conclusions

Overall, this pilot mentoring program seemed beneficial to both the mentees and the mentors.

Future work

We would like to continue this mentoring program during next summer. Also, from the lessons learned, we wish to implement the program for the entire incoming freshman class enrolled in the fall semester mentored by the entire senior engineering students enrolled in their senior design course that lasts for both fall and spring semester.

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