AC 2012-3943: RECRUITMENT AND ENGAGEMENT OF UNDERGRADUATE ENGINEERING AND TECHNOLOGY STUDENTS IN INTERDISCIPLINARY RESEARCH PROJECTS

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Recruitment and Engagement of Undergraduate Engineering and Technology Students in Interdisciplinary Research Projects

Abstract

This paper discusses current recruitment and student engagement efforts by the Principal Investigator (PI). Eight undergraduate students have been successfully recruited for an interdisciplinary sensor development project. Undergraduate students from the School of Engineering and Technology (ET) were targeted for their specific majors of study. Majors of Electrical Engineering, Mechanical Engineering, and Industrial Technology Management were included in the pool. Project descriptions were written and advertised through the PI's web site and via flyers spread around the ET building. Students were also reached through classrooms via "elevator pitch" presentations by the PI. Furthermore, individual students have been encouraged to participate by expressing how their work can become valuable assets towards graduate school applications and career resumes.

Once the students were recruited, the PI informed them of the common theme for the many projects (sensors for physiological activity monitoring) and how each project would be integrated into an all-inclusive system with mutual benefit. Students were encouraged to collaborate rather than compete. Weekly group meetings were organized and students shared their findings with the group. Each student also discussed their progress at least once every few months. Students were required to send weekly reports and even daily updates on their progress via e-mail. At the end of each semester, a performance review session was organized for each individual student. Students were required to criticize their performance and propose ways for furthering opportunities. The PI provided constructive feedback and clearly explained expectations. A 360 degree survey has been implemented by the human resources department of the university where students have the same opportunity to critique the PI, anonymously. International and U.S.-based students were successfully merged to form small research sub-groups to improve productivity.

This paper outlines the details on recruitment and student engagement efforts by providing data such as survey results, student profiles, and brief project descriptions. Outcomes from student projects will be reported and future plans to improve retention will be discussed.

1. Introduction

Increasing the quality of undergraduate students while keeping the retention rates steady if not higher has been one of many challenges in undergraduate education, particularly in science and engineering fields. Therefore, the research on the student engagement in engineering research projects have been one of the main goals of National Science Foundation's education divisions. There are a numbers of requests for proposals through the agency such as "Research Experience for Undergraduates (REU)," "Research in Engineering Education," and "Research Initiation Grants in Engineering Education (RIGEE)." [1]. Research has shown that one of the most effective ways of student engagement and enrollment is to involve them in research projects. A comprehensive study showed that retention rates increased in undergraduate students who were involved in research programs [2]. The same study revealed that sophomore level students benefit the most out of those research opportunities [3]. On the other hand, another study showed that even first-year engineering students can be involved in research projects and outcomes could be very promising [4]. Students' motivation and academic performances increase as they gain active research experience [5]. When student researchers work on a project exceeding a one year span, it was shown that perceived benefits increase accordingly [5, 6]. Graduate students also benefit through more thorough examination of the material accomplished through guidance of undergraduate researchers [6]. Some studies specifically focus on practical issues and solutions on student recruitment [7, 8].

In this particular study, practical approaches to student recruitment and retention will be provided. The PI is a junior faculty at the School of Engineering and Technology, particularly in Electrical Engineering program under the College of Science and Technology of Central Michigan University (CMU). There are currently no graduate programs in the Engineering disciplines. However, the PI has involved graduate students from the Physics department and the Science of Advanced Materials' Ph.D. program. This work is very valuable for the engineering faculty where the researcher pool consists mostly of undergraduate students.

2. Project Selection

Undergraduate research projects were carefully selected and tailored to fit students' interests and backgrounds. The following views were considered:

- The project must be made easy to understand. The PI clearly defines the problem and the scope of the project, providing the student with a clear and achievable goal or set of goals.
- Applications for the particular project must be linked to real engineering or science problems.
- Individual projects must be segments of an ultimate application or product development so a "cohort" idea can be implemented.
- Prioritized project goals, milestones, and potential challenges must be determined and an initial assessment of the technical principles of the project must be assessed.

With all the considerations mentioned above, micro-scale sensor development has been selected as the main project. Project's mission was determined as:

"*To develop sensor systems those are on the order of millimeters in size, capable of transmitting its sensed data wirelessly, and embedded with thin-film power supplies, which will be used in physiological activity monitoring applications.*"

Applications were identified to track the physiology of human activity of soldiers, athletes, and senior citizens. Several projects were then defined such as temperature sensor circuit design, micro-fabrication development, wireless communication circuit design, micro-battery testing, and energy harvester prototype design, etc. Clear and measurable goals were identified and included in the submission of a conference paper, a poster presentation, and a grant proposal.

3. Recruitment Methods

Once the projects were determined, various recruitment methods were implemented simultaneously, which are listed below:

- Web site: A research intensive web page was designed to attract students [9]. Past projects were explained and outcomes were mentioned to show students that the projects are fruitful. The PI's contact information and background were also included. Student correspondence e-mails or contacts were directed to the web site for additional information.
- Fliers: A one-page flyer was designed and distributed around the Engineering and Technology Building. Students were invited to work for the abovementioned projects.

Similar fliers were also sent to colleagues in other universities for future graduate student recruitment.

- Class visits: Introductory level engineering courses as well as junior level courses were visited and students were informed about the potential hiring opportunities by the PI.
- Student interactions: PI has consistently visited computer labs to join discussions on students' own research projects. This was an effective way of informing suitable students about the job openings.

4. Engagement Methods

From the very beginning, students were given clear expectations, i.e. work schedule, goals, and the research methods. Each student was asked to provide a resume and had a short interview about expectations and goals. Students were also asked what they wanted out of their experience. Students were expected to write frequent reports (almost every day starting from the first day of employment), keeping the PI and other students up to date on the progress of each project. Research reports have been particularly helpful by guiding the research projects on relevant and productive path. The reports also aided in efficient supervision of students and projects. Furthermore, students had the chance to improve their writing skills and organize their thoughts about project's progress. In addition to daily reports, weekly reports were also requested. Weekly reports summarize their progress and define goals for the following week. The PI diligently provided feedback on these reports to confirm their progress and provide helpful guidance. The PI spent an hour every week in assessing students' progress and developing every following week's plan.

Weekly group meetings were scheduled and limited to one hour. These meetings became one of the driving forces of the research efforts for individual student researchers. The PI was able to convey to the team the week's goals and the successes of the project as a whole. Students were encouraged to help their teammates as a professional courtesy, by offering some of their resources to assist in the progress of others' projects goals. Weekly group meetings became a catalyst for efficient research and a benefit to the group in several ways: (1) Students learn research techniques from their peers rapidly. (2) Reduce time investment required by PI for supervision. (3) Peer interactions motivate the students by establishing a support system. Collaboration among the student researchers was the seed for research cohorts.

Another important aspect of the management was the scheduling of deadlines. Students were always asked to finish a task in a specific time period. Timelines were agreed on by both the PI and the student. PI always followed up the deadlines by allocating a notebook where all the deadlines, student tasks, and short/long term goals were written. This notebook was updated every week (if not every other day) and students were given feedback. Students were encouraged to write grant proposals and disseminate their results.

Since September 2010, 10 undergraduate students and 5 graduate students have been recruited either for a semester or more to include the summer semester period. Table 1 summarizes the student enrollment in various projects.

Table 1: Student recruitments for individual semesters.

	Sophomores	Juniors	Seniors	MS	PhD
Fall 2010	1	1	-	-	-
Spring 2011	2	2	1	1	2
Summer 2011	2	1	1	2	2
Fall 2011	-	3	3	2	1
Spring 2012	2	4	2	3	2

5. 360 Degree Feedback Surveys

In order to assess the PI's strengths and weaknesses in terms of group management and probe student researchers' perception of the team in general, an online anonymous survey, called 360 degree feedback survey, was utilized. The survey was conducted by the university's Human Resources (HR) department. Students were e-mailed to voluntarily participate in the survey and notified that names will be kept anonymous by the HR and only the results will be shared with the PI. Survey I and II were completed in spring and fall 2011, respectively. Six areas of management skills were investigated; communication, coaching, performance management, support and respect, project management, and management style. Exact same questions were asked. Ten and eight students participated in the Surveys I and II, respectively, resulting an average of 90%.

Table 2 shows the results of both surveys. It can be seen that the performances in coaching and project management were evaluated to be progressing. This is a clear indication that PI's investment on professional development program trainings of over 50 hours paid off very well. Human Resource's workshops and programs were beneficial and very helpful: namely leadership

excellence, project management, time management, emotional intelligence, and the power of vision.

	1. survey	2. survey
Communication	4.950	5.000
Coaching	4.902	4.926
Performance Management	4.720	4.420
Support and Respect	4.980	4.972
Project Management	4.898	4.966
Management Style	4.963	4.927

In each survey, students were also asked the areas of strength and growth of the PI. From written comments, following words stood out in the strengths area: team approach, friendly, understanding, tasks, and project. It was clear that students were very comfortable in a team-based approach that would eventually lead to specific tasks of a bigger project. One of the important feedbacks was the time constraints that the PI had. This is, however, indispensable since the PI is also involved in teaching and other service activities. PI has set up certain times for the week where he can spend time with research students, which deemed to be helpful.

Following up on the surveys, one on one meetings were set up between the students and the PI for performance reviews. The following preparation guidelines were e-mailed to each student prior to this meeting:

"*Prior to our meeting, I want you to think about;*

- *A brief self-evaluation of your work up until now,*
- *Your strengths,*
- *Areas that you think you can/should improve on,*
- *Sources you would need to improve your research (training, supplies, any other forms of help, etc.)*
- *Your expectations from your future research? (we will discuss your schedule; classes, vacation, etc.)*
- *Do you have a rough plan in your mind in terms of project tasks to achieve your goals?*

Then I will give you a feedback about what I think on these questions and we will discuss our future plan."

Students' reception to the performance reviews exceeded the PIs expectations and led to more effective and efficient management techniques and research arrangements. While students were given credit for their accomplishments on the spot in a public setting, performance review sessions provided a place for any criticisms. Students had the opportunity to hear from the PI reports for their performances, possible areas to improve on and probable areas or attitudes that work out very well. These sessions also provided a very good feedback for the PI and engaged students in the research projects better. Students were more enthusiastic and better motivated after the reviews.

6. Conclusion

In this report, successful student recruitment methods were given for the junior faculty who target mostly undergraduate engineering students. Surveys, group meetings, broad announcement, project selection, and pairing up students together, led to a dynamic research group formation. Although the initial time investment could be overwhelming, careful time planning and continuous follow-up helped use the time efficiently. It was very helpful to be involved in professional development programs and their effects on the research group surveys were prominent.

7. Acknowledgements

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