Live Long and Prosper: A Robotics-Based Recruitment and Retention Program

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Abstract

Increasing student enrollment and retention are issues given considerable importance in most institutions of higher education and are issues that many Applied Engineering or Engineering Technology programs grapple with on a continuing basis. With a myriad of potential strategies and limited available resources, finding solutions that produce documentable results can be daunting. One of the challenges associated with student enrollment in engineering-related programs lies in the limited number of P-12 students that develop interest in pursuing such careers. Challenges often associated with retention are the supposed large number of college students that are underprepared for engineering-related courses and the lack of project based learning for students early in their college careers.

This paper explores a comprehensive, robotics-based program that attempts to address these challenges by integrating multiple initiatives at the P-12 and undergraduate levels. The program includes teacher training and support for robotics education in P-12 systems. College students engage in service learning activities and robotic design for competition. The program aspires to enhance both recruitment and retention of qualified students for engineering-related undergraduate programs. This paper reviews the development and implementation of the program and discusses early results (both evidentiary and perceived).

Introduction

The literature describes several strategies that have been employed in efforts to increase the number of P-12 students interested in engineering-related careers. Participation in school-based

activities is often suggested as a method to increase participation. Feldman *et al* [1] completed an extensive review of contemporary literature and concluded that participation in school-based extracurricular activities has many positive influences on the development and outcomes of adolescent and young adults. DeJarnette [2] concludes that providing early exposure to science, technology, engineering, and math (STEM) initiatives will improve recruitment. Another strategy described in a 2011 publication by Dischino *et al* [3] encourages project based learning (PBL) by providing professional development for in-service teachers and creating a model course in PBL methodology for pre-service middle and high school teachers. Rhoads *et al* [4] provide a model for after-school science clubs based on university and K-5 partnership. Another strategy detailed in a 2014 publication by Michaeli *et al* [5] provides a review of published literature regarding the use of robotics in schools. Their study is aimed towards determining how robotic education may be used to positively influence outcomes of girls' knowledge, interests, self -efficacy, and attitudes related to careers in engineering but provided much data that confirmed the validity of such initiatives in general. Heaverlo, in her 2011 dissertation paper [6], provides evidence that extracurricular STEM activities are significant in increasing the confidence and interest in math and science for female students.

Challenges often associated with retention are the estimated large number of college students that are underprepared for engineering-related courses and the lack of project based learning for students early in their college careers. Nationally, P-12 schools are implementing more engineering-related opportunities for students in response to the growing need for highly trained individuals in Science, Technology, Engineering, and Math (STEM) fields, In spite of this, the percentage of students exposed to engineering-related classes and activities is still very small. Barker *et al* [7] examined the impact of service learning on the engagement of Hispanic students in computing and STEM subjects, and the result was an increase in both recruitment and retention of students in STEM courses. In a 2012 white paper publication [8], the American Society for Engineering Education related best practices and strategies for retaining students in engineering-related fields. Service-based learning opportunities ranked as one of the best practices for increasing retention.

The establishment of a robotics team by an Applied Engineering Department at a regional University provided the impetus for the development of a comprehensive robotics-based P-12 education program that is explored in this paper. The robotics-based strategy for recruitment and retention is, in reality, a positive consequence of initiating a robotics team for undergraduate students.

The Association for Technology, Management, and Applied Engineering (ATMAE) hosts a robotics competition at its national conference each year and our institution made the decision in 2010 to establish a robotics club with intentions of competing annually at the ATMAE conference. The club performed well and has placed first in the national competition in two of the past five years. The excitement surrounding the initial activities (and success) of the robotics

club led the Department to develop a much broader plan that continues to have a positive impact on recruitment and retention. The current program encompasses P-12 teacher STEM training based on a robotics-based curricula, and ongoing support for competitive robotics programs in P-12 schools. These activities serve to increase the number of P-12 students that might consider engineering-related careers in general, and specifically, the applied engineering programs at our institution. The service-based learning associated with support of the robotics competitions increases the engagement of the college students to aid in retention.

Teacher Training

The Department of Applied Engineering was able to partner with the JSU Inservice Education Center to develop a program that provides a one-week robotics training program for individuals teaching in 3rd through 12th grades. The emergence of a Math and Science Partnership (MSP) grant provided the financing needed to support the partnership. The Inservice Education Center was already engaged in some extensive math-based training for teachers that needed to be expanded and the addition of robotics training provided much needed engineering based instruction.

A major decision in developing the training was determining what type of robotics platform to use. Nationally, there are several robotics programs available for use in P-12 schools. Included among the well-known programs are: Boosting Engineering Science and Technology (BEST) Robotics, For Inspiration and Recognition of Science and Technology (FIRST), and VEX. After extensive review of each of these outstanding programs, the decision was made to base training on the VEX program. The rationale for the decision was based on several factors that made the VEX program attractive to the intended purpose of the training. VEX has more teams competing than any of the other programs, provides free curriculum for teachers that is cross-referenced to national science standards, can be integrated in a year-long curriculum, and provides standardized components that make the engineering design process less intimidating to teachers who don't have engineering backgrounds. In a 2012 publication, Hendricks *et al* [9] provided results from survey data from 341 students and 345 coaches which revealed that 94% of coaches reported increased interest in science and technology and 50% reported increased interest in math and science classes as a result of VEX robotics-based competitions.

The actual training program, being targeted at adult learners, was developed to provide maximum interaction for participating teachers. Teachers started on Day 1 by building a basic robot system and finished the week by participating in a mock tournament that simulated the experience that their students might encounter. After training, teachers were allowed continued access to development software housed at the University and could request technical assistance from the Department of Applied Engineering to support their efforts in the classroom. Teachers were provided with robotics kits that were used by the teachers during the training program.

These kits could then be loaned to the teachers for use in their classrooms.

Over a three-year period, a total of 180 K-12 teachers received training. Elementary and some middle school teachers utilized the VEX IQ platform and curriculum for training while high school teachers and most middle school teachers used the VEX VRC platform. The number of teams participating in the state for the 2013-2014 academic year were 62 VEX VRC and 10 VEX IQ; for the 2014-2015 academic year were 101 VEX VRC and 39VEX IQ; and for the 2015-2016 academic year were 132 VEX VRC and 81 VEX IQ. This exponential growth represents a 213% increase in VEX VRC and an 810% increase in VEX IQ. This phenomenal growth has allowed over 22,500 Alabama K-12 students to be exposed to a high-quality STEM curriculum delivered by well-prepared teachers.

Service Learning and Retention

The remarkable growth of VEX robotics in the state has allowed students enrolled in the applied engineering programs to become more and more invested in service-based learning as some students provide assistance to P-12 teams working on their robot designs and others provide operational expertise for schools hosting State qualifying tournaments. The Department hosts the State VEX Robotics Championships each year providing yet another opportunity for actively engaging our students in relevant service learning. Our students' high level of interaction with VEX robotics has earned them recognition within the organization and each year a group of students are selected to serve during the VEX World Championships that include more than 1000 teams from more than 30 countries. Members of the robotics team also become involved with fund raising projects and public speaking opportunities.

The high level of engagement experienced by members of the robotics team seems to have positively impacted retention. In the five years that the team has been active, every team member has either graduated and is gainfully employed, transferred as planned to a traditional engineering program at another institution, or is still actively enrolled as a student in one of the programs offered at the institution. The retention rate for the University is significantly lower with 72% of students persisting past the freshman year and only 33% reaching graduation. While conceding that students willing to become involved in extracurricular activities are to some extent more likely to persist than the general University population and that other factors may also contribute to the significantly higher retention rate, it can be argued that at least some of the difference is attributable to participation in the program.

Recruitment

An additional benefit to these service learning activities is the accessibility that is afforded for recruitment. Students participating on VEX robotics teams are likely to be interested in some type of STEM related career and as our institution has a visible presence at events all through the

school year, these students learn about the university's robotics team and the applied engineering programs. Hosting the State championships affords the students from the best teams in the State an opportunity to visit our campus and become more familiar with the facilities. There is extensive evidence that scholarship programs are very effective in recruitment and our institution has designated a scholarship program for students that meet specific ACT/SAT scores and have participated in robotics during high school. These scholarships are announced at all events.

Conclusion

Results of the teacher training have obviously increased opportunities for students to be engaged in engineering-related activities as indicated by the increase in the number of VEX teams registered in the state. This increase is depicted in Figure 1.

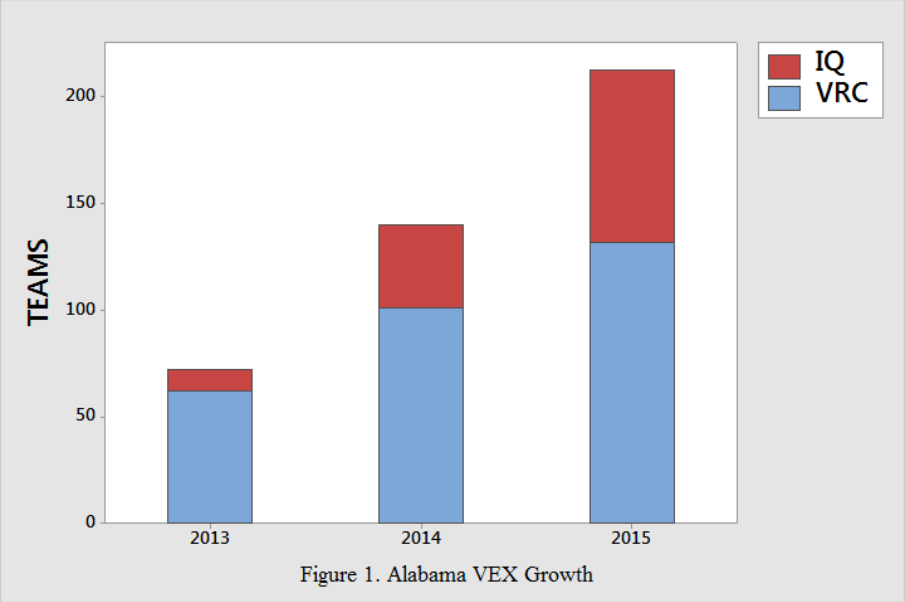

Figure 1. Alabama VEX Growth

The increased retention of students involved in the program relative to the general university population is considered significant since previous research shows that retaining current students is less costly than recruiting new students.[10]

Finally, the growth of the robotics team over the past five years indicates that students recognize the benefits of program participation. This growth is shown in Figure 2.

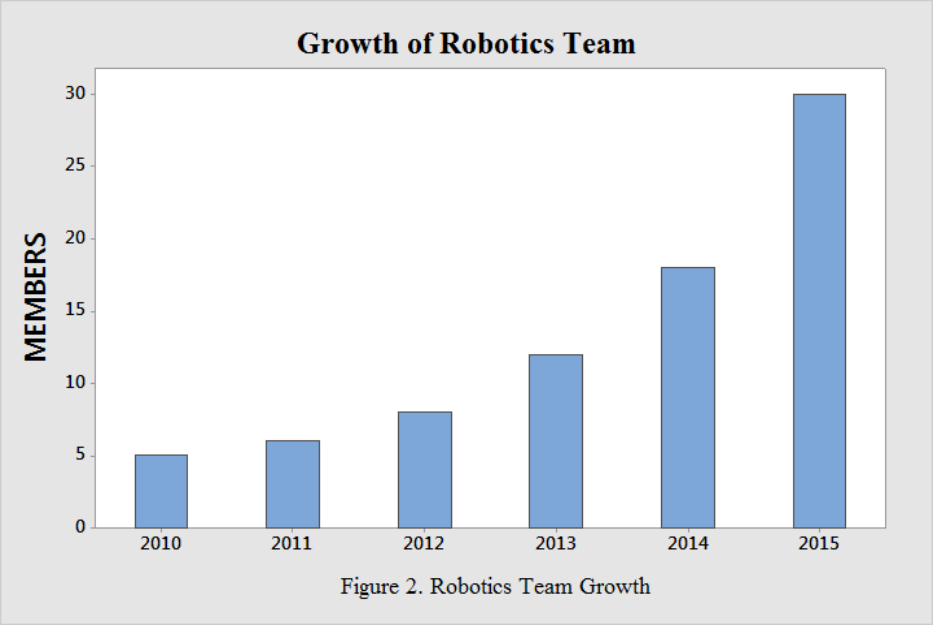

Figure 2. Robotics Team Growth

Data for impact on enrollment is not yet available although there is informal evidence (increased phone calls, emails, etc) that suggests that the program is causing high school students involved in the VEX program to consider the applied engineering programs. Longitudinal study will be required to determine the effect (if any) of participation in VEX robotics as a primary factor in subsequent enrollment in engineering-related programs in Alabama as many of the students won't be making college decisions for several years.

Overall, initial results look promising and are sufficient to warrant continuation of the program.

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Biographies

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