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Increasing Diversity and Enhancing the Curriculum within Engineering Technology at RIT

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Abstract

Many colleges and universities have put forth a considerable effort to improve their curricula and increase diversity within their student body. It is in these colleges and universities best interest to improve the preparation of students, namely women and other underrepresented groups, in science, technology, engineering, and mathematics (STEM) through curriculum development and other activities such as research. Much of this effort is brought to fruition by acquiring grant funds that can be used to explore new teaching methods and increase underrepresented enrollment. Summer research opportunities can also be used to accomplish the goal of improving the curriculum and increasing diversity. This paper will describe some of the activities that have been completed to increase diversity and improve the curriculum at the Rochester Institute of Technology in the Manufacturing and Mechanical Engineering Technology Department and will identify some of the effort that will take place in the future. An overview of what the students accomplished will be given as well.

Introduction

The Rochester Institute of Technology (or RIT), founded in 1829, is primarily a technical institute located in Rochester, New York. The institute also has international campuses in Eastern Europe and Dubai. Currently the student body comprises 14,753 undergraduates and 2,899 graduates for a total of 17,652. Within this 17,652, there are 11,761 males and 5,891 females. Simple math shows the ratio of males to females is 2:1. RIT has also a little over 2000 students that fall into underrepresented groups. Nationally, there are many efforts underway to increase underrepresented students at colleges and university. This also includes females. There is also a national effort to increase enrollments in Science, Technology, Engineering, and Math (or STEM) programs. Although increasing STEM enrollment is a national effort, a special effort is being put forth by many to increase STEM enrollment among underrepresented groups. RIT is such university that is putting a concerted effort to increase underrepresented enrollment. This effort will show the participation of one faculty member in increasing enrollment of underrepresented students. As a point of clarity, the author of this effort uses the government terminology “underrepresented” in lieu of the word “minority” which many, including the author of this effort, find to be offensive.

CAST & the Manufacturing and Mechanical Engineering Technology Department

The College of Applied Science and Technology (or CAST) was established in 1972. It is one of the largest colleges on campus enrolling approximately one fifth of the students at RIT. The
college offers a myriad of dynamic programs ranging from human resource development to engineering technology. The Manufacturing and Mechanical Engineering Technology / Packaging Science (MMET/PS) department has 899 students in the engineering technology disciplines and packaging science. It is the largest department at the institute. Currently, the MMET/PS department is approximately 8% female which is an improvement from previous years.

**Outreach**

During the summer mostly and during the academic year there are many opportunities on campus to become involved with outreach efforts. As a faculty member willing to participate in various activities, the first thing you must do is identify the activities that are going to be occurring. Upon determining what programs will occur you must have an available ‘outlet’ that can plug into the activity. One of the charges of the author is to instruct the Robotics in Manufacturing course. As a result, there are many opportunities to tailor robotics discussions and demonstrations for various age groups and educational levels.

**Women In Technology**

Women In Technology (or WIT) is an organization in CAST established in 2005 to retain female engineering technology students. The overarching goal of WIT is to increase the number of female graduate students in engineering technology programs which has subsequently grew to include packaging science and multi-disciplinary students as well. WIT has activities throughout the year. With many of these activities volunteers are needed to assist. Recently the director of WIT posted a survey soliciting volunteers to assist with outreach and recruitment. Many of these activities can serve as service to the institute, the college, the department and the community. There may also be opportunity for grant writing and scholarly publications. Some of the activities WIT has had in the past include Girl Scouts in Technology and participating in Imagine RIT.

**Grade School Students**

During the summer and during the academic year there were several opportunities to participate in programs that brought grade school students to the institute. These students were underrepresented and had varying educational levels. Their day on campus typically included tours and presentations. The ‘outlet’ the author provided was an introduction to robotics and some robotic demonstrations. There was an opportunity for the students to utilize some of the robotics and there were asked to fill out surveys to measure the effectiveness of the program. More detail is given about these programs below.

**NSBE Zone Conference**

This past October, the National Society for Black Engineers (or NSBE) hosted an upstate zone conference with an overall theme of “Finding the Fun in Work”. The college NSBE chapter brought in the high school student chapter members located in the upstate zone. They had an 8 hour agenda with various topics like the college and graduate panel where the high school got to
discuss higher education with present undergraduate and graduate students of underrepresented groups. There was also a section on managing money and college 101. The author of this effort presented a section on robotics in the 21st century. With this section the student were able to see a presentation on robotics, see a demonstration, and utilize robotics. The students were also able to ask questions about robotics as well as other issues associated with robotics, college, STEM majors, and being an underrepresented student. The goal of this program was to get underrepresented student interested in going to college and majoring in a STEM discipline.

**Project Lead The Way**

Over the summer there was a two part program, Project Lead The Way (or PLTW), that brings teachers into the institute to learn different teaching methods and styles in attempt to get them to incorporate the knowledge gained in their lesson plans. PLTW is a STEM education innovator in middle and high schools across the country. One set of teachers come in one day and another set visit another day\(^2\). One of the highlights of the program is that it allows faculty to demonstrate different teaching methodologies and it also allows students to demonstrate research that they have completed in an open forum seminar. This dual program allowed the author to have two of his underrepresented students participate in the research seminar and the open discussions. Many of the teachers that participated felt that the mixture of students that they were able to engage in conversation and see their research allowed for them to go back from whence they came and offer encouragement in directions they might not have initially thought. This information was ascertained from surveys. Some of the results of the surveys will be given later in this effort.

**Research: Funded & Non-Funded**

There are many opportunities available through funding organizations such as the National Science Foundation that offer grant funds for research in education. Within many of these solicitations there are sections that allow and/or encourage participation and recruitment of underrepresented groups. As a faculty member at a college, there is also opportunity for you to develop programs that involve research and recruitment of underrepresented groups.

**Louis Stokes Alliance for Minority Participation (LSAMP)**

The Louis Stokes Alliances for Minority Participation (or LSAMP) seeks to broaden participation in research topics within STEM education related to retention and persistence of students from populations underrepresented in STEM majors and careers. There is an aim of transforming STEM education through innovative recruitment and retention strategies\(^3\). LSAMP is manifested at this institute through the use of recruiting students from underrepresented groups to perform research during the summer months. The research that is performed has a tendency to keep the student interested in their STEM programs almost acting as a retention mechanism. Typically the faculty submits a proposal then the administrators of the LSAMP program tries to identify students that may be interested in that type of research. The author of this effort was fortunate to have one choose the research proposed and one student chose the faculty member to be the advisor of his own chosen research topic.
The student that chose the author of this effort as his summer research proposal wrote a proposal involving how to determine obsolescence. Typically when obsolescence is taught in a course, the concept that it is important for a company to put their own products into obsolescence and not have your competitor develop a new product to garner some of your market share. The student hypothesized that if there was a mechanism in place for an enterprise to put its own products in obsolescence then in theory they would be better off from a market perspective. The research involved identifying some best practices for obsolescence to determine if an algorithm could be developed for a manufacturer to put their own product offering in obsolescence once they had a develop the next generation product. Such algorithms already existed so the student shifted the research focus to studying said algorithms to determine if planned obsolescence was in fact a detriment to society. The research attracted more students that were interested in the business aspect of engineering technology. The student researcher investigated the electronics manufacturing industry and their planned obsolescence strategies. They researched technological, functional, perceived, and instantaneous planned obsolescence. One of the interesting conclusions drawn from this effort was that technological planned obsolescence negatively impacted the waste stream through an increase in electronics waste (or e-waste) within municipal solid waste (MSW). At the end of the summer the student presented his research at a summer research seminar. The interest drawn from this research allowed a group of students to lay the foundation for a sustainable engineering research “club”.

The proposal that the author of this effort submitted was on using Lego Mindstorms to introduce the concept of green robotics. The Lego Mindstorms could be used as an instructional tool to aid in the understanding of programming industrial robots and the task that robots can perform. While learning the programming of the Mindstorms the student also researched the concept of green. The research had many objectives: 1) Learn green concepts so as to incorporate them into Green Robotics 2) Build and program as many different Lego Mindstorms robots as possible. As the research begun, it became very clear that accomplish both objects may have been too aggressive for a student that had just completed his freshman year. The research advisor scaled back the research to concentrate on building and programming many different Lego Mindstorms robots. The student was instructed to build, program, execute, and document a standard operating procedure (or SOP) for each robot that was built. Each robot set comes with instructions for two robots. The student completed building close to 7 different configurations before the summer ended. While constructing the seventh configuration the summer ended. In conjunction with building, programming, and executing each robot configuration the student also had create a short presentation on each robot. The compiled presentation of each robot configuration also had an introduction to green robotics. With the presentation and the ability to demonstrate different robot configuration, this became a module that could be plugged into many different programs for recruitment and retention of underrepresented students.

Figures 1 and 2 shows one of the LSAMP summer research students giving a presentation to a group of grade school student groups that visited the university. The second figure specifically shows the students being able to execute the program within some of the Lego Mindstorms robots themselves. Allowing the grade school students to utilize the Mindstorms themselves lead to a favorable review of the demonstration within the survey provided.
Figure 1: Green Robotics with Lego Mindstorms

Figure 2: Students Utilizing Lego Mindsorms
S-STEM

Currently, the author of this effort is a co-principal investigator (or co-PI) on a NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) funded grant. This grant has a primary focus of supporting scholarships for academically talented students demonstrating financial need, enabling them to enter the STEM workforce or attending a STEM graduate program. As a co-PI, the author of this effort is responsible for aiding in the selection of scholarship recipients, reporting demographic information about student scholars, and managing the S-STEM project at the institute. The principal investigators have created a pamphlet to attract attention and awareness to the availability of the scholarships.

TUES

Also currently, the author of this effort is a co-principal investigator (or co-PI) on a NSF Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (or TUES) funded grant. The TUES program seeks to improve the quality of STEM education for undergraduate students. Typically, funded proposals should have the potential to transform undergraduate STEM education. The proposal the principal investigators had accepted for funding seeks to transform undergraduate education within the Manufacturing and Mechanical Engineering Technology program by introducing POGIL into the curriculum. Several courses have been identified to enhance and add POGIL. The author of the effort is responsible for green robotics and POGIL. This funded proposal also allows for hiring an underrepresented student to perform summer research. A summer student was hired specifically to concentrate on green robotics. This research is ongoing with the student in the middle of constructing a manuscript based on the research she performed.

Survey Statistics

A survey was administered to the student pre- and post-outreach program. The students completed the survey at the beginning of an outreach program then there were given the exact same survey with two additional questions at the end of the program. The surveys utilized a basic Likert scale. The scale consisted of Strongly Disagree, Disagree, Neutral, Agree, or Strongly Agree.

On July 20, 2011, twenty-four grade school students from underrepresented groups visited the institute for the Liberty Partnership of the K-12 Office at RIT. The PIs of the TUES effort, entitled Green Plastics Manufacturing Technology or gPMT, took the opportunity to have the students participate in an outreach program while they were visiting campus. Between 1:15 and 2:45 pm the students were broken up into three groups to attend three separate workshops. There was a workshop on rapid prototyping, plastics, and robotics. Each of these workshops had a presentation component and a hands-on component. The results of the outreach program are given below.
Table 1. Survey Statistics for gPMT Outreach Program

From the survey the major findings were as follows:
After participating in the gPMT outreach workshop-

- Students who agreed or strongly agreed with “Plastics can be environmentally friendly materials” increased from 50% to 85%.
- Students who agreed or strongly agreed with “I know about the Green Plastics and Engineering Technology Programs at RIT” increased from 8% to 72% while those who disagreed or strongly disagreed with this statement decreased from 67% to zero.
- Students who agreed or strongly agreed with “I am interested in attending RIT” increased from 17% to 46%.
- 81% felt this activity should be continued for other groups.
- 69% said they would participate in activity like this again.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Before</th>
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<th>After</th>
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<tbody>
<tr>
<td></td>
<td>Disagree or Strongly Disagree</td>
<td>Neutral</td>
<td>Agree or Strongly agree</td>
</tr>
<tr>
<td>Plastics can be environmentally friendly materials</td>
<td>17%</td>
<td>33%</td>
<td>50%</td>
</tr>
<tr>
<td>I know about the Green Plastics and Engineering Technology Programs at RIT</td>
<td>67%</td>
<td>25%</td>
<td>8%</td>
</tr>
<tr>
<td>I am interested in studying engineering technology in college.</td>
<td>58%</td>
<td>17%</td>
<td>25%</td>
</tr>
<tr>
<td>I am interested in attending RIT.</td>
<td>25%</td>
<td>58%</td>
<td>17%</td>
</tr>
<tr>
<td>This activity should be continued for other groups.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I would participate in this activity like this again.</td>
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<tr>
<td>The student leaders for the activity were enthusiastic</td>
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77% felt the student leaders were enthusiastic, prepared and knowledgeable. It should be noted that one student indicated the student leaders deserved a 10 (the highest rating was a 4) and another gave them a 5/4.

Students who agreed or strongly agreed with “I am interested in studying engineering technology in college” decreased from 12% to 25%. However, those who disagreed or strongly disagreed decreased from 58% to 50% and the number who were neutral increased from 17% to 38%.

The students were also asked to provide additional feedback in the form of comments if they were so inclined. Some of that information is given below.

One new thing I learned:

- Plastics are good for the environment (5)
- Comment related to plastics (5)
  - Most things are made of plastic
  - They can be sorted by number (2)
  - Plastics breaking
  - Can make biodegradable plastic
  - Plastics can be more than one layer
- Computer graphics (3)
- 3D Printer (3)
- Robots are everywhere (2)
- You can make a mixer
- Chocolate

The most interesting thing I saw today:

- Robots (12)
- Plastics Lab (4)
- Chocolate/ computer activity (3)
- Hot dog machine
- Different engineering
- Dryer taking water drips off
- Plastic melted and then back to solid
- Everything

Survey statistics, observations, and major findings similar to above exist for each outreach program the author of this effort participated in over the course four quarters. Since the numbers appear favorable, there is hope that such an outreach program would increase the enrollment of underrepresented students.
Conclusion

There are considerable amount of activities ongoing at RIT within the CAST college to enhance the curriculum and recruit and retain underrepresented students using mechanisms already in place and creating new ones. This effort highlights some of the said activities that the author is currently an active participant. These activities, in theory, should increase enrollment of underrepresented students with a goal of retaining them through graduation.

Future Considerations

Refinement of the Robotics in Manufacturing course will be allowed for given the introduction of POGIL into the robotics laboratory. The Lego Mindstorms will be used in POGIL teams and to complete POGIL exercises. As the second quarter is closing out, the author of this effort is currently contemplating this summer in terms of research and advising students. Proposals for LSAMP will be submitted in March. Recruitment of another student for TUES will be ongoing.

Acknowledgments

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References

1. http://www.rit.edu/cast/wit/