Strategies for Embedding Scholarship in the Educational Experiences of Engineering Technology Undergraduate Students

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Abstract

The hallmark of Engineering Technology (ET) programs is its student-centered curriculum and hands-on approach to teaching. Many institutions with ET programs now require scholarship of their ET faculty in addition to their teaching duties. In many institutions that have always emphasized scholarship and research, undergraduate student education has often times taken a back seat to research. The question that arises for ET programs as we begin to engage in scholarly activities is: how do we insure that ET scholarship is student-centered similar to ET teaching and curriculum?

The benefits of scholarship to ET students include enhancement of their critical thinking, innovative, lifelong learning skills, skills that many ET employers today are looking for in our students. In this paper, the author examines issues relating to the importance of scholarship to ET undergraduate students, barriers to ET student scholarship, mechanisms for embedding scholarship in the ET curriculum, resources required to facilitate ET student scholarship, and feedback from ET student scholars who recently worked on a scholarly project with the author. The author concludes that embedding scholarship in the ET curriculum is very desirable and suggests some ways and means to facilitate and nurture student scholarship in ET.

Introduction

Several institutions with Engineering and Engineering Technology (ET) programs now require scholarship of their faculty,[1, 2, 3] including those institutions for which teaching has always been their primary focus. Since many of these institutions have mostly undergraduate programs, they also now require that faculty scholarship involve undergraduate students and be integrated into the student learning experiences in order for the scholarship to be meaningful. An example of this trend appears in the 2004 Rochester Business Journal publication marking the 175th anniversary of Rochester Institute of Technology (RIT) where the RIT Provost states,

"My hope for RIT's academic future is that we have more focus on scholarship and research while sustaining our primary focus on student learning. I would like RIT to have the reputation of being the best university in the country in integrating faculty scholarship into the student learning experience, not only by faculty incorporating the results of their scholarship in their classroom teaching but, even more importantly, through incorporating students into their scholarship."

The RIT president in the same publication states, "so we're going to make a specific point of giving every undergraduate an opportunity to do research." It is clear that there has been a

paradigm shift to more scholarship even in erstwhile teaching institutions, and faculty scholarship is here to stay. The question that remains is how to integrate faculty scholarship into the student learning experience and how to involve ET students in scholarship. Aghayere[2] articulated it this way, "[it] should be one of the goals of ET scholarship to maintain student-centeredness in scholarship by ensuring that ET scholarship involves students, enhances student learning, enhances our teaching, and enhances the critical-thinking, life-long learning, creative and innovative skills of our students. Employers seek students who possess such skills." Several engineering programs in the United States already have mechanisms developed for involving undergraduate students in research. The National Science Foundation has funded several Research-Experience-for-Undergraduate (REU) programs across the country,[4, 5, 15] but most of these programs are focused on the scholarship of discovery. Since most ET faculty scholarship is focused on the scholarship of application[1, 2], it is imperative that the ET community develop strategies to involve our undergraduate students in the scholarship that is predominant in ET. The author is aware of only one ET program[8] that has formally instituted a mechanism to promote scholarship or research for its undergraduate students through an Undergraduate Research Symposium which is essentially an annual poster session. They report an "uphill task" encountered in motivating their ET students to do research and make presentations at the symposium.

In this paper, the author examines issues relating to the importance of scholarship to ET undergraduate students and presents several mechanisms for embedding scholarship into the student learning experience, resources required for success, barriers to engaging students in scholarship, and ways and means for facilitating undergraduate scholarship. Also included is feedback from some student scholars who collaborated with the author on a scholarly project.

Why Should ET Undergraduate Students be Engaged in Scholarship?

There are several reasons why ET undergraduate students should be engaged in scholarship and these include [5, 10, 18, 19]:

- Scholarship stimulates student curiosity, critical thinking and problem-solving skills
- Scholarship enhances creativity and originality
- Scholarship enhances independent thinking and innovative skills
- Scholarship enhances lifelong learning skills
- Scholarship improves student self-confidence and student retention
- Scholarship creates additional opportunity for mentoring of students by faculty
- Scholarship enhances and nurtures student oral and written communication skills
- In ET programs without graduate students, undergraduate students are the only human resource available who can act as research assistants on scholarly projects.

It should be noted that not all students are good candidates to participate in scholarly activities. The intent should not be to require every ET undergraduate student to participate in scholarly activities, but to provide opportunity to participate if they are qualified and choose to.

Barriers to Engaging ET Undergraduate Students in Scholarship

According to Gonzalez et al[9], it takes "at least twice" as much time for faculty to mentor undergraduate students in the area of scholarship and research than it takes with graduate students. Students participating in scholarly or research projects should be made aware of the uncertainties of scholarship in order to prepare them to deal well with the inevitable "dead ends" they may encounter in the course of the project. Some of the barriers to engaging ET undergraduate students in scholarship include the following:

- ET undergraduate students typically carry heavy course loads, thus it may be difficult for them to balance coursework and scholarly projects.[10]

- Undergraduate students may lack the necessary prerequisite advanced courses needed to engage in scholarly activities.

- ET undergraduate programs may lack the continuity necessary for scholarship because of co-op programs where students take time from school to work in the industry. At RIT, for example, ET students are required to complete 5 co-op blocks of 10 weeks each. The duration of time that these students have to work on scholarly projects with faculty is likely to be too short for them to take ownership of the project. [10] The number of co-op blocks may have to be reduced in order to facilitate student scholarship.

- Lack of faculty time to mentor undergraduate students in the area of scholarship while still carrying a full teaching load.

Mechanisms for Embedding Scholarship in the Curriculum

Many engineering programs have developed mechanisms to facilitate student scholarship; similar or modified models could be adopted in ET to embed scholarship within the curriculum while taking into account the practice-oriented and applied flavor of ET programs. Some strategies that could be adopted in ET to embed scholarship within the ET curriculum include the following:

- Develop special topics or independent study courses[11, 12] that students can take for credit. Examples of independent study projects could include, but is not limited to, case studies, development of design aids, and laboratory testing. Students would typically be required to prepare and submit a proposal to the faculty mentor and the department chair for approval. Independent study projects could be used as an elective course. Students could be required to present a seminar to faculty and peers and prepare a scholarly paper on their work. [12] To provide greater publicity for the projects, faculty should be encouraged to publish a list of potential projects and scholarly works for undergraduate students at the beginning of the fall term.

- Organize seminars that review procedures for independent study, data collection and analysis, testing, writing and presenting scholarly work.[19]

- Include scholarship components in existing courses by requiring research project reports on instructor-selected topics or topics of interest to the student as part of the course. One example is to require students to review and critique technical papers pertaining to the course[13] or to write a case study report on a topic pertinent to the course. This will help to hone student skills and give them exposure on what is and what is not a good scholarly paper.

- Develop product innovation courses with the aim of encouraging students to develop patentable physical products.

- Introduce laboratory testing courses where students can test hypotheses and new/innovative materials and structures.[5]

- Develop Capstone Projects that involve industrial partners and realworld projects within the community.

- Develop honors or scholars program for outstanding students where an honors thesis is required as part of the graduation requirements. [12] Students have to maintain a prescribed grade point average to qualify and continue in the program

- Develop an annual student scholarship symposium[8] with awards and prizes for the top three presentations or posters and develop a website where student scholarship can be further disseminated.[2] This provides opportunities to celebrate student accomplishment and provides a venue for sharing student scholarship.

- Provide funding for employment of undergraduate research or scholarship assistants to work on scholarly projects with faculty with the intent of producing a scholarly product at the end of the project. In this case, students do not receive academic credit for the work done, but are paid to do the work. Seed funding for such programs could be provided by the university with the hope that future funding can be secured through overhead money that the university receives from external grant awards. One example of this approach is the Lafayette University Excel Scholars program.[12]

Resources Required to Facilitate Student Scholarship

To nurture the growth of student scholarship in ET, adequate resources and support must be provided to both faculty and students. Some of the resources required in order to facilitate and encourage student scholarship include [17, 18, 19]:

- Provide summer funding or mini-grants to faculty for mentoring and engaging students in scholarship

- Provide rewards such as release time or stipends for faculty who supervise student theses and engage students in scholarly activities

- Provide funding for faculty to add scholarship components to existing courses
- Encourage the college curriculum committee to add scholarship components to new courses
- Provide funding for student travel to present at conferences
- Provide summer fellowship funding for students to work on scholarly projects with the hope of producing a scholarly publication or product

Student Scholars Feedback

We have previously discussed several reasons why student scholarship is desirable in ET. The author has had the privilege of mentoring four civil engineering technology students on a scholarly project. As the faculty advisor to the RIT steel bridge design team, we felt that it would be interesting to find out what impact, if any, student design teams like the steel bridge or concrete canoe teams have on student educational experiences. The students designed a survey instrument for alumni and current students, analyzed the data collected, and collaborated with the author to write and publish a scholarly paper on this subject which was presented at the 2003 ASEE conference in Nashville. [14] Since this was the first time these students had participated in a scholarly activity, the author was interested in feedback from these student scholars on their experiences. The students were asked to maintain a journal of their experiences from the beginning of the project. Three of the four students provided feedback to the author at the end of the project. Their responses confirm some of the reasons presented earlier on why it is desirable to embed scholarship in ET students' learning experiences. Their responses are summarized below:

Valerie Siriani, who is now in graduate school writes,

"This was a learning experience unprecedented by any activity any of us had participated in prior to working together. We got past all of our challenges, enjoyed our time together and eventually put out an outstanding product. We were able to build working relationships with each other on top of already existing friendships."

"This was a rewarding experience which I am pleased that I had the opportunity to participate in. It has undoubtedly helped improve my writing skills, confidence in my own abilities, and my teamwork skills. I would say that this experience is equal to, if not more beneficial than, the concrete canoe or steel bridge design teams."

Matt Lefevre writes,

"In all, the whole experience was outstanding…and I hope that other students have the same opportunity in the future."

Jim Lindholm writes,

"This experience was great. What really impressed me a lot [about the ASEE conference] was that we were one of the few students from a technology program to present a paper. I felt very proud to be a part of that."

Similar comments to those of the three students above have been expressed by undergraduate engineering and science students involved in research.[16, 19]

Summary

In this paper, the author has highlighted the increased emphasis on embedding scholarship into the learning experiences of ET students at institutions with ET programs. Also presented are: reasons why ET students should be engaged in scholarship, the barriers to engaging ET students in scholarship, the resources required and mechanisms for embedding scholarship in the ET curriculum. In summary, some ways and means for facilitating and nurturing student scholarship in ET are listed below:

- The ET department should prepare a brochure listing potential scholarly and independent study projects suitable for undergraduate students and the associated faculty mentor. This brochure should be made available to students at the start of the fall term. A meeting of students in each ET department could also be arranged where potential scholarship or research opportunities can be presented.

- Faculty mentors must carefully define the scope of the scholarly work because of the limited knowledge and skills of most ET undergraduate students.[6] The project timeline and deadlines must be identified by the faculty mentor. Given the heavy course loads carried by ET undergraduate students, it may be more efficient to schedule the more rigorous part of the work for the summer sessions when students are less busy with coursework.

- Schedules for regular meetings between the faculty mentor and student must be established.[10]

- Faculty mentors must help the student to keep his/her focus and be available to help with some of the data analysis and interpretation that may be required.

- Faculty mentors should ensure that the student continues to maintain a proper balance between his/her coursework and the scholarly work to insure that they do not neglect their coursework.

- To encourage ET faculty participation, efforts should be made to reward faculty for mentoring and supervising a certain number of student scholarly or independent projects. This must be done if scholarship is to become part of the ET undergraduate student's

educational experience and because the mentoring role is a teaching activity. In lieu of course release time for faculty, alternative ways for compensating faculty who participate in these programs should be explored. Possible ways include an additional stipend, increased travel grants, and release time from service activities.[7]

- Encourage ET undergraduate student participation in scholarly activities through:

    - undergraduate scholarship symposiums where monetary awards are made for meritorious papers/presentations.

    - summer fellowships for scholarly projects that pays the student a comparable stipend to that paid in the industry.

    - providing scholarship support funding for students during the academic year that pays the student a stipend for participating in a scholarly project that will result in a scholarly product or publication.

    - Publishing a list of potential independent study or scholarly projects for which students can work with a faculty mentor and earn academic credit while producing a scholarly product.

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