AC 2007-1303: INTRODUCING ENGINEERING STUDENTS TO RESEARCH THROUGH A FIRST-YEAR ADVISING PROGRAM

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Introducing Engineering Students to Research Through A First Year Advising Program

Abstract
Over the last 20 years, recycling programs have developed throughout the United States and internationally. However, once the “recycled” material is placed at the curbside or brought to the recycling center, what happens next? Developing and implementing research efforts on the reuse of waste materials was the aim of a first-year engineering students advising option called “Window on Research and Scholarship”. In this program, students are tasked to perform research and present their results in a poster presentation. Thus, the advising program not only allowed students to get advised (weekly) by a faculty member, but to also participate in research efforts of the faculty.

This paper describes the Windows on Research and Scholarship advising program used at Tufts University and, specifically, what influence this advising program ultimately had in defining the academic path taken by them. The cohort being examined entered the institution in Fall 2004. The paper presents the various research efforts of this cohort and if these efforts lead to further progress of a particular research effort and/or initiated continued student involvement in the research. In addition, the paper assesses whether this advising option, for this particular cohort, enhanced, inspired, or dampened the prospect of them doing future research, either in extending their first-year effort or exploring new research avenues. This assessment indicates that many students did not continue to pursue research efforts beyond this initial effort, mostly because of more traditional academic restraints; e.g., course work and other extracurricular activities. However, those students who did continue to pursue research have found their academic lives enriched by the experiences.

Introduction
Tufts University has a number of unique advising programs for entering first-year students. One of the options is “Window on Research and Scholarship” program which links a small group of students with faculty advisor who will expose the students to his/her research. During the Fall 2004 semester, the lead author lead such a “windows on research and scholarship” effort that was focused on reuse options for waste materials. The objective of the program is two fold:

1. Introduce students to the processes involved in research. Specifically, it was expected that the students would be involved in hypothesis development, data collection, analysis, and synthesis.
2. Provide a regular and consistent meeting time for student advising.

This paper presents an assessment of the efficacy of this advising option for a cohort of first year students entering in the Fall 2004 semester. The advising program is briefly described and specific research efforts of the group described and summarized. Subsequent research efforts that developed from these initial efforts are also described. Finally, an assessment of the students’ advising is presented including current observations by this cohort on if and how students’ academic direction were effected by the research experience.
Window on Research and Scholarship (WORS) Advising Program

Windows on Research and Scholarship is only one of six advising option that incoming first-year students may chose to participate in at Tufts. The semester-long program assigns a small group of students (10 or less) to an advisor who meets at least once a week with them during the semester to work on a research topic(s) of interest to that advisor. Students who participate in this advising program receive one-half course credit (pass/fail grade) for their efforts. The final deliverable is for the students to develop and present a poster at the WORS Spring symposium.

As is the case for all first-year advising programs, students are assigned a new academic adviser when they must choose an engineering major at the end of their first year. They may keep their first-year advisor if their current advisor advises students in their chosen major, but this is not automatic and must be requested.

In Fall 2004, another student cohort worked on various research efforts involving material reuse. None of the projects had been undertaken by the advisor prior to the student’s efforts. The four efforts, performed by different student sub-groups, are briefly described below.

Project 1 - Harnessing the Power of Wastewater

This project looked at how organic solids in the wastewater could be used for the production of hydrogen. The project reviewed the benefits of eliminating methane production and the best option for capturing and using the methane for electricity production. Specifically, this project did a literature review on how wastewater treatment plants may be able to utilize their biogas emissions, mainly methane, to produce hydrogen that can be used on-site to produce electricity or shipped elsewhere to be consumed by hydrogen-powered vehicles or other electricity-generating fuel cells.

Project 2 - Concrete Reuse

This project’s objective was to compare the strength of concrete mortars made with normal and recycled concrete aggregates. Students used crushed concrete masonry units (CMUs), one new (< 1 yr old) and one aged (> 40 years old), to create recycled concrete “sand” (RCS) with a similar grain size distribution as normal sand. Two-inch mortar cube specimens, made from the sand, aged RCS, and new RCS aggregates, were made and tested for strength at 8 and 14 days. Wet/dry and freeze/thaw durability were evaluated via strength tests on specimens subjected to 11 wet/dry (or freeze/thaw) cycles. Figure 1 shows the results of these strength tests. Results indicated that 1) the cubes with sand aggregate were the strongest overall, 2) the cubes with old concrete aggregate were the strongest under freeze/thaw conditions, and 3) the cubes with new concrete aggregate were the weakest overall.

Project 3 - Evaluation of SLA made with Ammoniated Fly Ash

The objectives of this project was to evaluate an innovative material, synthetic lightweight aggregate (SLA) composed of ammoniated fly ash and mixed plastic, to determine its influence on ammonia levels. The hypothesis was it is possible to encapsulate the ammoniated fly ash in the mixed plastic matrix so as to decrease the off-gassing of ammonia when the fly ash is exposed to moisture. Tests for pH (gives idea as
Figure 1 Results of Compressive Strength Tests for Various Concrete Mixes

<table>
<thead>
<tr>
<th>Type of Concrete</th>
<th>Sand</th>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>regular</td>
<td>2519</td>
<td>2337</td>
<td>2284</td>
</tr>
<tr>
<td>freeze/thaw</td>
<td>2247</td>
<td>2063</td>
<td>1964</td>
</tr>
<tr>
<td>wet/dry</td>
<td>1772</td>
<td>2106</td>
<td>1377</td>
</tr>
</tbody>
</table>

14 Day Strengths

- **Stress**
  - 0
  - 500
  - 1000
  - 1500
  - 2000
  - 2500
  - 3000

- **Type of Concrete**
  - Sand
  - Old
  - New

- **Weathering**
  - regular
  - freeze/thaw
  - wet/dry
to the ammonia levels in material) and electrical conductivity (indicates dissolved solutes) were used to provide a “quick” indication as to whether this SLA would lead to reduced ammonia off-gas levels. Test results, shown in Figure 2, indicated that ammonia availability is decreased as the pH of fly ash alone was significantly higher than the pH of the ammoniated SLA; from approximately 11 to approximately 7, respectively.

![pH Analysis of SLA, Fly Ash, and Mixed Plastic](image)

**Figure 2 Results of pH tests of Various Fly Ashes and SLAs**

**Project 4 – Use of SLA as Plant Substrate**

The objective of this project was to evaluate if SLAs could be used as substrates for plants with the hope of using SLAs as a lighter medium ideal for green roof systems. The hypothesis was that plants would survive in a substrate of a mixture of SLA and soil (the soil would provide sufficient nutrients to allow plants to thrive) or 100% SLA. The group compared plant growth and survival in a controlled environment in four substrates: 100% soil (forest mulch), 100% SLA, 66% soil / 33% SLA mixture, and 33% soil / 66% SLA mixture. After 6 weeks, the results indicated that plant systems utilizing SLA appeared to have beneficial properties allowing the plants to thrive. Overall, plants appeared to grow in the higher percentages of SLA.

The final deliverables included a written summary of the students’ work as well as images for the poster presentation in Spring 2005 WORS Symposium.

**Extensions of WORS Efforts**

Projects 3 and 4 served as the basis for more extensive research efforts. The results of the evaluation of ammonia release from SLA containing ammoniated fly ash were used by a graduate student who completed her thesis in Spring 2006 and a publication for a fly ash utilization conference. The use of SLA as plant substrate served as the impetus for a course on green roof systems which then lead to an EPA-sponsored P3 competition project completed in Spring 2006.
Assessment of Advising
The advising programs at Tufts are annually assessed for students’ satisfaction with the first-year advising experience. Table 1 summarizes the results of this survey, comparing the average responses for the students in the WORS advising effort described above (9 respondents) with those of all engineering students (146 respondents). The results clearly indicate that the students in this WORS effort were more satisfied with their advising experience than other students in engineering.

Student Current Views on Advising and Research
Two years after the WORS experience, the students were asked to again comment on the advising and research experience via the following questions:

Question 1. In your opinion, was(is) Windows on Research a good way of advising?

and

Question 2. Did your Windows on Research experience inspire you to do research or deter you from doing research as you continued your undergraduate career?

The questions were rated on a scale of 1 to 5, where 1 represents a low or negative response, 5 represents a high or positive response, and 3 was a neutral response. Additional comments were also requested. The following are responses from two students.

<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>WORS</th>
<th>All Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall, how satisfied were you with your first-year advisor?</td>
<td>3.56</td>
<td>3.12</td>
</tr>
<tr>
<td>Scale of 1 (very dissatisfied) to 4 (very satisfied)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How helpful was your advisor during your first semester at Tufts?</td>
<td>3.41</td>
<td>2.83</td>
</tr>
<tr>
<td>Scale of 1 (Not at all helpful) to 4 (very helpful)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How satisfied was I with the assistance provided by my advisor for the following issues:</td>
<td>3.60</td>
<td>3.07</td>
</tr>
<tr>
<td>Scale of 1 (very dissatisfied) to 4 (very satisfied)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How to obtain Advanced Placement credit.</td>
<td>3.78</td>
<td>3.22</td>
</tr>
<tr>
<td>Important deadlines and dates.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Merits of choosing pass/fail option.</td>
<td>3.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Appropriate level of math course to take.</td>
<td>3.57</td>
<td>3.17</td>
</tr>
<tr>
<td>How to improve my study skills.</td>
<td>3.25</td>
<td>3.05</td>
</tr>
<tr>
<td>How to obtain assistance for dealing with personal problems.</td>
<td>3.33</td>
<td>2.89</td>
</tr>
<tr>
<td>Possible choices of majors.</td>
<td>3.29</td>
<td>3.02</td>
</tr>
<tr>
<td>The need to develop well-balanced course schedules.</td>
<td>3.22</td>
<td>3.10</td>
</tr>
</tbody>
</table>

Source: Office of Institutional Research, Tufts
Question 1. In your opinion, was (is) Windows on Research and Scholarship a good way of advising?

Response A

“5 - I think Windows on Research is a wonderful way of advising. It combines access to both a professor and the peer advisors in the context of not only getting answers to all the stupid but necessary questions that freshman ask, but also learning about some aspect of the field of engineering. I think the program is quite well-designed. I thought it worked well to have advisors, both a professor and peer advisors, to help us through all the confusion that freshmen must deal with. I liked meeting regularly and knowing that I would have the opportunity each week to ask questions about anything and everything. By combining the research exposure with the advising, we were often able to conduct lengthy discussions that combined what we were studying with our class work and general engineering college experience. Overall, I found the experience to fulfill its goals (of advising us as freshmen and expose us to one particular area of research) and would recommend continuing the program for future freshmen.”

Response B.

“4 - I think the Windows on Research was really fun and a low key way to be introduced to research, but I'm sure it actually enhanced my freshman advising experience. I got friendly faces, an interesting, educational experience, and some guidance on classes, all of which were great. However I do wish I had been in an advising experience that had allowed me to make a connection and stay with the advisor. Overall, the Windows on Research class was a much better experience than many freshman advising experiences because I was interested in what we were doing and got to see my advisor and fellow advisees every week.”

Question 2. Did your Windows on Research experience inspire you to do research or deter you from doing research as you continued your undergraduate career?

Response A.

“4 - I never had much interest in research before college and I didn’t expect to gain interest during college, so who knows why I even enrolled in this program, but I did, and I am glad that I did. It was interesting to see some aspects of the field of research in engineering, especially as a freshman, when I didn’t know too much of anything about engineering. It was also a very helpful way to form a connection to the advising professor by learning a whole lot about their area of expertise and some of the work and research that they conduct. Therefore, I think the program is a valuable experience for students, regardless of their initial level of interest in engineering. That being said, it is probably most beneficial when a student is able to find an advising program topic that is particularly interesting to him or her.”
Response B

“5 - After the conclusion of the Windows on Research class, my group and I actually continued to do a bit of research with another professor. That experience did not pan out, but Windows made me aware that I could realistically be involved in research as an undergrad. I had always thought of research as somewhat intimidating and unattainable until at least graduate school. My experience in Windows made research a real, concrete possibility which I intend to take advantage of while at Tufts.”

Discussion and Conclusions
Initially, this WORS effort was seen as a way to introduce students to the “world of research”. However, it became apparent that many of the students were already “in tune” with what they wanted to and forged new research directions, some of which continued for some time after the WORS efforts were done. It could be said that some of these efforts constitute a complete graduate-level research effort (as illustrated by Project 3, the evaluation of ammoniated SLA). However, when appropriately tasked and controlled, the effort, no matter how minor, can provide enough data to lead to a more rigorous continuation of the effort.

One of the difficulties with the concept of WORS is that first-year students, who have essential no experience with research or post-secondary academics, are expected to actively participate in research. In the various projects, the research tasks were simply devised and executed so that students felt as if they were contributing to a significant research effort while connecting with their academic adviser.

The lead author plans to continue to use WORS as his first-year advising program of choice. He also hopes to continue the use these students to continue the projects long after the official advising period is complete.

Acknowledgements
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Bibliography