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On the path to scholarship

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1. Introduction

When trying to promote undergraduate research, we should be mindful of the many steps needed to achieve a successful research experience for our students. It often seems that posing that perfect open problem to the student is the start of the undergraduate research experience. However, we feel that a good deal of preparation is needed to lead students to this point. In the following, we discuss the evolution of a course in our mathematics and computer science curriculum at Denison University that sets the students on the pathway to undergraduate research.

2. The evolution of a course

We are fortunate at Denison University to have an active campus-wide undergraduate research program. Every year, approximately 100 of Denison's 2000 students receive financial support to spend their summer working with Denison faculty members on a variety of research projects [**1**]. Although our joint department of mathematics and computer science had a number of summer scholars over the years, a surprising few presented their original research at regional or national meetings. In addition, virtually none of our students participated in research activities outside the department such as REUs. Nonetheless, these are two major steps leading to a successful undergraduate research experience.

In an attempt to address the first concern, in the spring of 2003, I convinced a Denison student to present his previous summer's work at the Ohio Sectional Meeting of the MAA. The student did a fine job in the end, but the process leading to this was trying and challenging for both of us. Upon reflection, I realized that our current mathematics and computer science curriculum was not preparing our students to present their technical work to a general audience. After discussing this with colleagues, it was clear we needed to make changes in our curriculum to address this issue. Initially, we decided to augment our sophomore level Introduction to

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Week	Topic(s)
1	Introduction, talk logistics, and LaTeX
2	Critiquing talks and more LaTeX
3–5	Students give a round of 5 minute talks
6	Review first round of talks; prepare for second round; Maple
7–9	Students give a round of 7 minute talks
10	Review second round of talks; prepare for the last round
11–13	Students give final round of 10 minute talks
14	Wrap-up, awards for best talks

FIGURE 1. Timeline for the oral communication lab.

Proofs course. This seemed the ideal time to instruct students on effective oral presentations skills. They were well into the major, but had adequate time left at Denison to use these skills.

After three evolutionary years, our Proofs course now includes a "lab component" which meets jointly with the computer science counterpart, Data Structures and Algorithm Analysis. The traditional courses meet three days a week with an additional two hour lab on Tuesdays. In the lab, students are instructed on orally communicating mathematical and computer science concepts at varying levels, how to use Waterloo Maple, and how to use LaTeX. Due to a lack of pedagogical materials, the author developed a series of pilot video vignettes for the course that compare and contrast various presentation techniques. A working version of these videos will be available for general use by the fall of 2007 [**3**].

Over the 14 week semester, the students obtain a thorough introduction to technical speaking without adding an additional course to the already full curriculum. This was one of the first courses at Denison, outside of the Communication Department, to fulfill the oral communication requirement for the general education package. Figure 1 provides an overview of how the 14 weeks of the semester are allocated. A separate article detailing the logistics of the course is available from the author upon request [**2**] .

The lab consists of five main components.

(1) Each student presents three talks on various topics in mathematics or computer science.
(2) Each student talk is peer reviewed by four members of the class as well as by the two instructors.
(3) Each student writes a review of each of his or her own talk after viewing a recording of the talk and reading the peer evaluations.
(4) Each student critiques five outside talks, such as department or campus-wide lectures, over the course of the semester.
(5) Each student is introduced to typesetting technical documents with LaTeX and performing basic tasks in Waterloo Maple.

3. Emerging scholars

Since the inception of this course in 2003, we have witnessed two trends in our undergraduates. First, the number of Denison students presenting their work at regional and national meetings has greatly increased. Second, there has been a marked increase in the number of Denison students attending REUs or other national programs.

As noted, prior to this course, it was rare to have a student present his or her work to an external audience. Now we average seven student presentations each spring at the Ohio Sectional Meeting of the MAA. In the past three years, nine talks by Denison students were delivered at national meetings, two winning awards based on quality of research content and delivery. In addition to external presentations, students share their work with the department and peers at our biweekly "FASt Talks" (Faculty and Student Talks). A survey of the students who completed this course in the past two years showed that of the 34 respondents, 20 were more willing to present a mathematical or computer science talk outside the department after taking this course. Upon completing his presentation at a sectional meeting, one student commented "... after Proofs and the FAsT Talk, the section talk was a breeze." Clearly, preparing the students in the art of oral presentation has given them the confidence to successfully present their work to external audiences.

In the last two years, we have had three students participate in REUs and three conduct research internships with NASA. While these numbers are not staggering, they are meaningful when we had only one student participate in an REU in the three years prior to this course. This trend seems to be a corollary of the first. As students presented at various conferences, they were exposed to other undergraduates presenting their REU findings. This encouraged our students and gave them the confidence that they could do the same. In the survey noted above, 14 students reported that they are now more likely to pursue a research project after taking this course. After presenting at a national meeting, one of our students noted "I never knew there was so much math out there! I saw really cool stuff that wasn't in any of my classes. It was brand new mathematics discovered by students like me!" She ultimately attended a strong REU, presented her work at MathFest, and is now in graduate school.

4. Concluding remarks

We hope our experiment in setting students on the pathway to undergraduate research inspires others to do the same. Not all schools have REUs or research programs like Denison. Nonetheless, we need to think of creative ways to expose students to interesting mathematics and computer science topics that will excite them and encourage them down this path.

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References

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