

Multidisciplinary High-Impact Research for BS and MS Students

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Abstract

The objective of this project, which falls into the category of "Project-based learning: outside the classroom and/or in workshops", is to engage a significant number of undergraduate and master's students in high-impact research activities. To date more than 30 students have participated in such projects, including 5 undergraduate students who co-authored scientific publications. Several of these projects have been astoundingly successful and attracted wide media attention. Our current challenge is scaling these activities to allow a larger number of undergraduates to participate.

Introduction and Objectives

This project focuses on making research more accessible to BS and MS students in computer engineering and computer science.

The expected educational outcomes are to:

- convey the research process to a larger number of students
- increase student motivation by encouraging work on problems relevant to themselves and society at large,
- better serve students with a preference for active learning.

Developmental History of Innovation

The project is ongoing – it has been executed with students in research teams outside the classroom and as part of smaller undergraduate and graduate classes. The motivation was to provide access for BS and MS students the activities and resources in university research labs. We are now planning to expand these activities to larger undergraduate classes with 50-75 students, to make this experience accessible to a broader set of our students.

Examples of projects conducted to date are the following:

- Security and Privacy Evaluation of Automotive Wireless Systems
- Finding Parking Spaces (with GPS Navigators)

Learning Activities and Materials

I have developed a process to engage not only PhD students but also BS and MS students in high-impact research activities. This process starts with developing a research question that is engaging to the students and relevant to society at large. I prefer topics that can be investigated through an experimental methodology, because this makes it easier for BS students to establish a collaboration with more senior students. It ends with a public presentation (frequently in the form of media coverage).



Execution

So far, BS students have mostly participated in the form of summer internships, special problems courses, or capstone design courses.

To increase participation, we plan to replace lab sections, which currently consist of a series of unrelated smaller assignments, with a larger team research experiences. To ensure that students still have to deal with the most significant concepts of the class, there will also be formal assignments. We will develop assignments, however, that are integrated with the student projects.

Major Issues to Resolve

We have observed many positive effects of this approach:

- helping students choose topics of relevance to their own lives and society at large leads to a significant boost in motivation.
- students find it very satisfying to see their results presented at conferences and in the media, which in turn inspires the next generation of students.
- it can offer a path to success for students who are not well-served by the more conventional lecture and exam format.

Our key challenge is scaling these activities to allow more undergraduates to participate. Related challenges include:

- Finding large classrooms suitable for group work
- Revamping lab courses to include research components
- Ensuring that students also grapple with the basic concepts they need to learn
- How to assess the impact of research experiences

Discussion

I believe that research experience should be accessible to a larger number of students at major research universities.

I envision course lab sections replaced by larger research projects, where undergraduates work with PhD students (not just the TAs) on their projects. We are also considering a capstone research experience in addition to the traditional capstone design courses. Finding the best approach for scaling such research experiences remains an open issue.

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