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Board 147: Work-in-Progress: The Effect of Summarizing a Research Article on Students' Area of Robotics Interest

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Work-in-Progress: The Effect of Summarizing a Research Article on Students' Area of Robotics Interest

1 Background

The need for capable, ethical robotics engineers is growing with the industry valued at 32.32 billion in 2021 with anticipated growth of 12.1% from 2022 to 2030 [1], and projected 17,900 mechanical engineering job openings each year [2]. It is imperative that undergraduate and graduate programs prepare engineers for industry positions in robotics, and that they include and encourage diverse groups of students to enter the field.

Additionally, diversity among engineers in general is limited, starting with bachelor's and being further exacerbated when entering engineering professions. For example, 22% of engineering bachelor degrees in 2021 were given to women [3], but they constitute 16% of working professionals in the field [4]. Additionally, Hispanic and Black populations are underrepresented in the engineering/STEM workforce relative to the general workforce: 11% of the total workforce is Black, but only 5% of the engineering workforce, and 17% of the total workforce is Hispanic, but only 8% of the STEM workforce [3]. Addressing the issues that create these disparities is multifaceted, but beginning with educational interventions for students that enhance their self efficacy for further pursuing engineering post graduate is a start.

Prior research has indicated the need to increase self efficacy in engineering students, especially from these diverse backgrounds, to help students see themselves as engineers after graduation [5]. Critically, studies have shown students transition from interest in engineering, to seeing engineering as an option, and finally choosing to become an engineer in a very short period of time [6]. Additionally, short interventions (like a one-day versus multi-day experience) have been shown to have similar outcomes for attracting diverse students to technology careers [7]. We envision our intervention operating as a vicarious experience [8], which enhances self-efficacy.

In robotics, research from educators indicates that robotics education has a unique opportunity to promote diverse participation, including meaningful applications, tactile robotic systems, and well scaled projects. Still, they indicate a need for further research on identifying and developing diversity, equity, and inclusion of the field [9].

One way universities expose students to robotics disciplines is through research experiences

[10]. For example, the NSF REU Sites program supports undergraduates as they do research projects at a host institution. Research experiences allow students to develop skills of synthesizing information and thinking about the state-of-the-art for a field. Generally, engineering students choose research topics based on their previous experience, especially when they are intrinsically motivated [11]. We believe more exposure to cutting-edge research enables students to see themselves working in and understand their options for a career in robotics. Additionally, it is hypothesized that this impact may be larger for diverse students with less exposure to working and research opportunities in robotics outside of class.

While some research experiences require multiple months or semesters of student time commitment [10], we seek to understand whether a smaller intervention has an effect on robotics student preferences for specialized areas.

2 Methods

Participants in this study were from the only Introduction to Robotics course offered at Duke University ($N = 46$). Participants ranged from third year undergraduates to first year graduate students.

The intervention in this experiment is assigning a research paper in a particular topic in robotics. Anecdotal feedback from previous semesters has indicated that students enjoy having multiple homework assignments throughout the semester when they are asked to look up a paper related to a particular field covered in the robotics class, *e.g.* finding a paper in the field of manipulation and mobility after a manipulation lecture. The hypothesis of this work is that the topic that is assigned would affect the students relative interest in the subject and in pursuing a job or internship in the field after the course has ended. During the semester, students were asked to look up papers of the same subject for the first half of the semester. In the second half of the semester, students were grouped into the topics of either motion planning or control when being asked to look up papers in the subject. These homework prompts can be found in the appendix.

Students were asked three times during the semester (beginning, during midterm feedback, during final feedback) for their levels of interest in robotics areas (five-point Likert scale), specifically, motion planning, control, human-robot interaction, and medical robotics. They were also asked if their interest in these topics leads them to pursue a post graduate job in this field, as many were in the job market for internships and full time positions. A demographic survey was also distributed with the final feedback survey to gather data including education levels of the parents of participants and diversity characteristics. All of these surveys are attached as an appendix to the work.

Expected results included having a measurable understanding of the effect of both giving research papers on their interest in a topic generally and for pursuing a potential career in the field. Anecdotal evidence suggests students enjoy the process of reading about aspects of

robotics that are novel to the field, which we may not get to touch on in class except through this exercise. Still, we cannot verify the full extent of how this intervention affects their interest relative to before the class. Additionally, the before and after surveys and thematic choices were intentionally chosen to not overlap with other potentially conflating interventions/unique experiences of the course. These included alumni group panel, and guest speakers of faculty and local robotic startup founder.

To assess this in the study, if there is sufficient parametric data collected in future years, a paired t-test will be used to assess significance of the intervention. If the data are nonparametric, a single or paired sample sign test would be used to test the effect of the intervention and potential paired demographic effects of the intervention based on pre/post survey data.

3 Reflections

As IRB consent was sent out very late in the semester, a limited number of students completed it, relative to the surveys throughout the semester. Therefore, there was insufficient data to analyze statistically for this work. Still, this experience of surveying students throughout the semester (see attached surveys) helped the researchers/educators identify the interests of students in relative areas of robotics and how they changed throughout the semester. Future work will include standardizing all three surveys, soliciting additional feedback from educational professionals in tailoring our questions, and collecting further longitudinal data with IRBs distributed earlier, for additional leanings and measured impact. Additionally, further guidance in class for how to choose papers from IEEE will be included to help students select appropriately challenging topics.

4 Conclusions

Increasing the pipeline of diverse roboticists starts, in part, with impressionable experiences in introductory robotics classes. Assigning research paper reviews could help students understand the opportunities post-graduation in robotics and the challenges that are yet to be solved. The objective of this work is to outline a method to measure the impact of a simple intervention that can be incorporated into homework assessment in many different styled classes in robotics.

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A Homework prompts

A.1 Homework 3

Find and attach one paper on a robotics topic of your interest. Review it by describing:

- The purpose and results of the work (3 sentences)
- What you found interesting and/or wish to learn more about in the class this semester (1–2 sentences)

Note: Great resources for robotics papers include IEEE in general (specifically IEEE ICRA conference papers are limited to 6 pages). While I recommend a paper that has some application of a physical robotic system, related concentrations of controls, perception, motion planning, simulation, and human-robot interaction are all great key words and aspects of robotics to use in your search.

A.2 Homework 12

Find and attach one paper on the topic of [*robot control* or *motion planning*] by describing:

- The purpose and results of the work (3 sentences)
- What you found interesting and/or wish to learn more about in the class this semester (1–2 sentences)

Note: Great resources for robotics papers include IEEE in general (specifically IEEE ICRA conference papers are limited to 6 pages).

B Survey questions

B.1 Initial question

The problem in robotics that most interests me now is... (It's OK if you change your mind later.)

[free text]

B.2 Midterm survey question

Please indicate your interest level in the following robotics topics.

- motion planning

- control
- perception/sensing/vision
- Human-robot interaction
- medical robotics
- manipulation/mobility

[5-point Likert matrix on scale of “not interesting at all” to “extremely interesting”

B.3 Final survey question

Please indicate your interest level in the following robotics topics.

- motion planning
- control
- perception/sensing/vision
- Human-robot interaction
- medical robotics
- manipulation/mobility

[5-point Likert matrix on scale of “not interesting at all” to “extremely interesting”