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Board 429: Variations in Motivation for Learning to Use MATLAB among First-Year Engineering Students

Dr. Alison K Polasik, Campbell University

Alison Polasik, Ph.D. joined the Campbell University School of Engineering in August 2018. Previously, she was an assistant professor of practice in The Ohio State University's Materials Science & Engineering Department. She has a decade of experience teaching and designing curriculum and incorporating real-world scenarios in her courses. Her work in engineering education has been presented at conferences and published in peer-reviewed proceedings for the American Society of Engineering Education (ASEE), and North American Materials Education Symposium (NAMES), Frontiers in Education (FiE), and Materials Science and Technology (MS&T) conferences.

Variations in Motivation for Learning to Use MATLAB Among First Year Engineering Students

Abstract

Motivation can affect learning, and there will be variations in students' motivation for learning to use computational tools such as MATLAB. In this research, we seek to determine whether differences in motivation correlate with students' intended engineering major. Students from a large midwestern state university were surveyed about their interest, perceive utility value, and self-efficacy specifically for MATLAB as they were learning to use it in their first semester. Initial data for n = 174 students indicate that variations in these factors do not clearly align with intended major, gender, or prior math experience. These results will be compared to ongoing studies that focus on students in Materials Science and Engineering and Biomedical Engineering sub-disciplines. Findings will also be compared to data on students from a small private university with an interdisciplinary engineering degree. Understanding the initial motivation for learning to use computational tools and programming can help elucidate what factors might lead to reduced motivation for this increasingly critical skill.

Introduction

Computational thinking skills are widely acknowledged to be a critical component of an undergraduate engineering education and a key part of the process of forming engineers in the 21st century. Past studies investigating students' motivation for learning to use coding and programming tools have demonstrated significant variability in students' motivational factors [1]. Earlier studies with students in introductory programming courses demonstrated that students in less computationally intense degree programs often demonstrate a lower sense of self efficacy and are likely to believe that coding is unlikely to be a key part of their education or career [2] [3] [4] [5]. Many students in the United States of America have opportunities to pursue interests in computer programming through curricular or extracurricular avenues in high school, and may have varied motivation to pursue these tasks in college. This research investigates whether students enter engineering with beliefs about their fitness for computational tasks or make decisions about which major to pursue based on computational modeling? Because motivation can have a profound impact on learning, it is worth investigating whether variations in motivation for learning vital computational skills are linked to students' intended majors.

Methods

Participants were recruited from the first semester of a year-long first year engineering course at both a large midwestern state university and a small private university. From these two sites across two consecutive years, 174 first-year engineering students participated in a survey that asked about motivational factors related to their experience learning to use MATLAB. The survey included questions about self-efficacy and utility value and was adapted from a previously validated survey used with students in an introductory programming class [5]. Questions were asked on a 6-point Likert scale, and average values for each student were calculated for each motivational category to provide a semi-continuous range of values. Students were also asked to give an indirect assessment of their skill relative to their peers at MATLAB, the course, and their engineering studies overall.

Results

Students were assigned group codes based on intended major and current math level because these two characteristics in particular were thought to be linked to motivation and skill for computational modeling. Students were assigned one of five codes based on their intended major and one of five groupings based on prior math preparation.

Data visualization demonstrated no clear relationships between motivational factor scores and current math course, gender, or intended major. The data is organized in Figures 1 -3 with each data point representing a single student response.

As shown in Figure 1, results do not demonstrate a relationship between utility value and self-efficacy. Figure 1A sorts the data based on gender, and Figure 1B sorts it based on intended major. Linear regression confirms a lack of meaningful relationship between the factors.

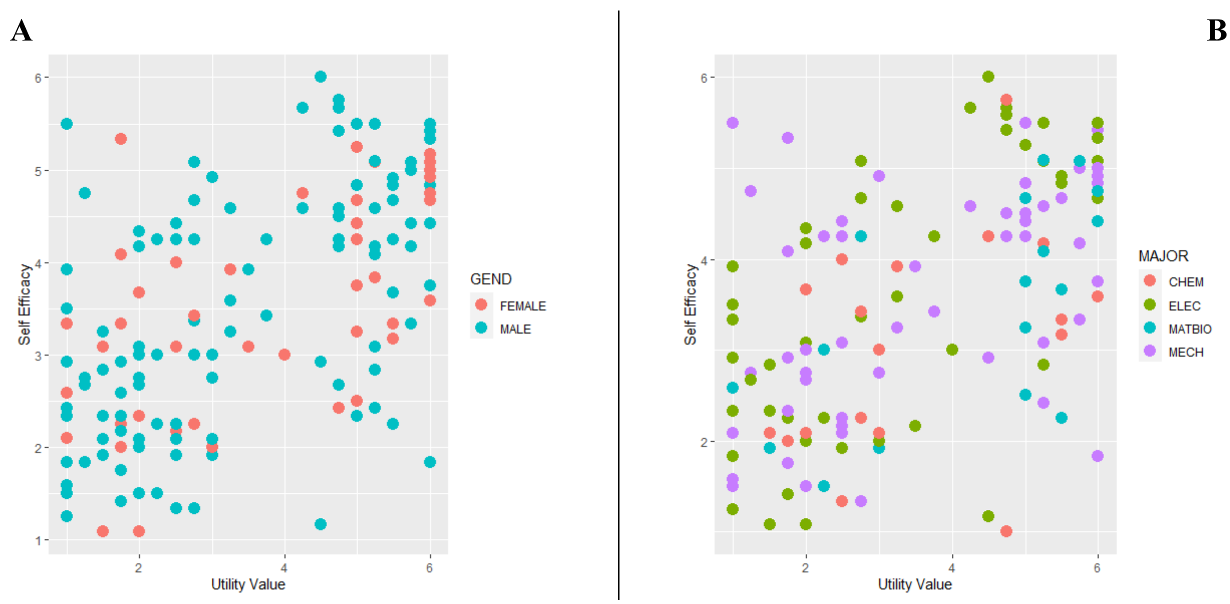

Figure 1: Linear Regression analyses for utility value and self-efficacy do not demonstrate a correlation between the two motivational factors.

Figures 2 organizes box-and-whisker plots of utility value, self-efficacy, and indirect skill by intended major. For this, the participants who were not in these groups were removed.

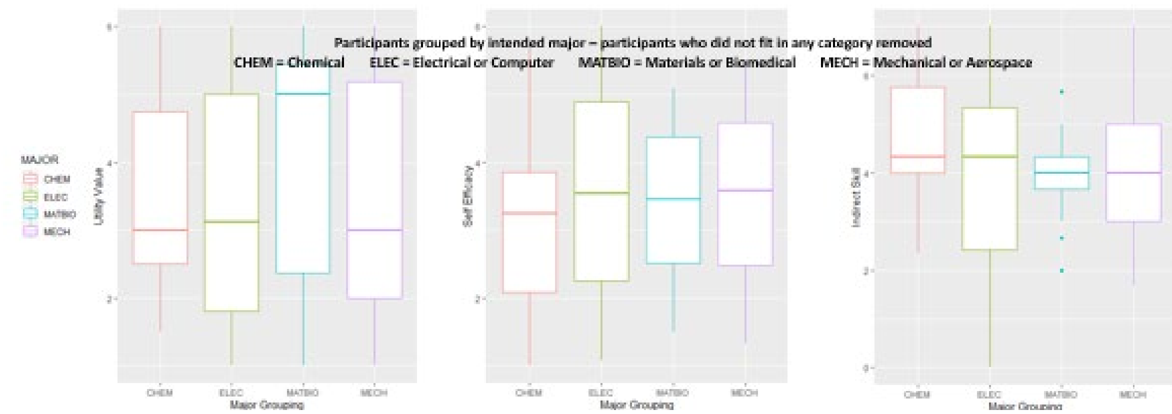

Figure 2: Utility Value, Self-Efficacy, and Skill separated by intended major. Students who did not indicate a preference for any of the noted majors were not included in this chart.

Figure 3 organizes box-and-whisker plots of utility value, self-efficacy, and indirect skill by current math class. Two-way ANOVA analyses corresponding to data in both figures 2 and 3 confirm that there is no statistically significant difference in the means with a 95% confidence interval.

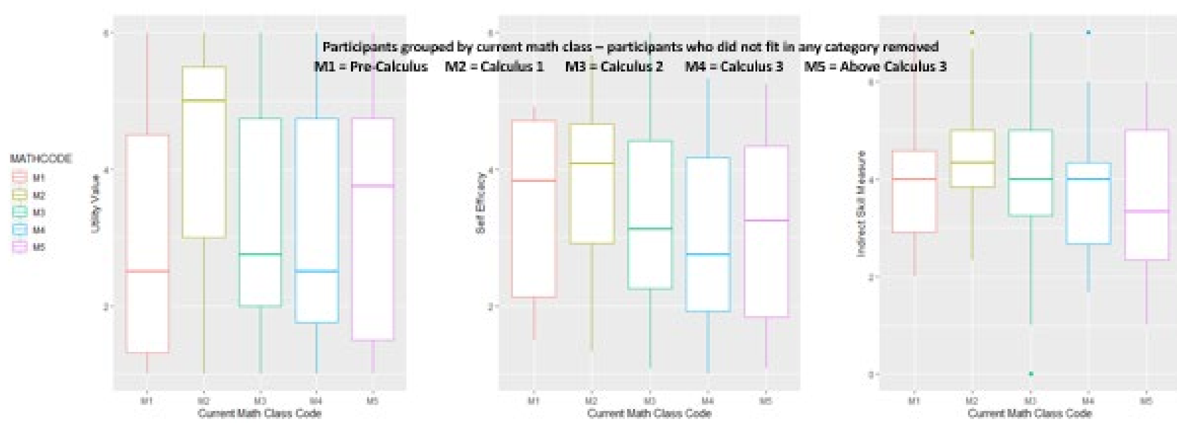

Figure 3: Utility Value, Self-Efficacy, and Skill separated by math class code.

These results indicate that variations in motivation to learn computational methods and programming among first-year engineering students are not clearly attributable to major, gender, or mathematics preparation.

Discussion and Future Work

This study began with the hypothesis that variations motivation to learn computational tools among engineering students in their third and fourth years of study could be tracked back to skills, motivation, and mindset at the beginning of their engineering studies. The survey data from the past three years of study does not support this hypothesis. Interviews with these students comprise a second part of this study, and preliminary results indicate that the majority of students agree that computational modeling is "just an important part of all engineering". It is possible that students do not ENTER with significant variability in motivation, but their opinions of computational modeling can change as they move through their curriculum. A supplementary investigation is using the same survey to understand the motivation of first year and third year students at another large midwestern university, and preliminary results from this analysis will also be presented at this conference in another paper.

References

[1] B. D. Jones *et al*, "An analysis of motivation constructs with first-year engineering students: Relationships among expectancies, values, achievement, and career plans," *J Eng Educ,* vol. 99, *(4),* pp. 319-336, 2010.

[2] V. G. Renumol, D. Janakiram and S. Jayaprakash, "Identification of cognitive processes of effective and ineffective students during computer programming," *ACM Transactions on Computing Education (TOCE),* vol. 10, *(3),* pp. 1-21, 2010.

[3] S. Bergin and R. Reilly, "Predicting introductory programming performance: A multi-institutional multivariate study," *Computer Science Education,* vol. 16, *(4),* pp. 303-323, 2006.

[4] M. Thuné and A. Eckerdal, "Analysis of Students' learning of computer programming in a computer laboratory context," *Null,* vol. 44, *(5),* pp. 769-786, 2019. Available: https://doi.org/10.1080/03043797.2018.1544609. DOI: 10.1080/03043797.2018.1544609.

[5] V. Ramalingam and S. Wiedenbeck, "Development and Validation of Scores on a Computer Programming Self-Efficacy Scale and Group Analyses of Novice Programmer Self-Efficacy," *Journal of Educational Computing Research,* vol. 19, *(4),* pp. 367-381, 1998. Available: https://journals.sagepub.com/doi/full/10.2190/C670-Y3C8-LTJ1-CT3P. DOI: 10.2190/C670-Y3C8-LTJ1-CT3P.

Appendix – Survey Questions

	Motivation Factors – Survey Categories and Questions		
	Question Stems	***1***	***6***
Utility Value	**How much do you agree with the following statement?** *Note: a 7th option, "I have no opinion", was also offered. These responses were not included in the averages* 1 - In order to successfully complete my engineering degree, I will need to develop the skills to use computational programs such as MATLAB. 2 - In order to successfully complete my engineering degree, it is important hat I learn how to write/code programs similar to those used in MATLAB. 3 - To be a successful engineer, I will need to develop the skill to use computational programs (such as MATLAB) to solve problems. 4 - Developing computational skills will offer me a wider range of employment options	Strongly Disagree	Strongly Agree
Self Efficacy	**How confident are you that you could do the following tasks?** 1 – Write Syntactically correct lines in MATLAB (without errors in spelling or order of commands). 2 – Understand the structure of a MATLAB script if appropriate comments were included by the writer (comments are the notes preceded by % that give information about the next section of code). 3 – Understand the structure of a MATLAB script if it were NOT commented. 4 – Write logically correct sections of a MATLAB script (where all of the commands are in the correct order to do the task). 5 – Write a small MATLAB script (5 – 25 lines) to solve a simple problem that is familiar to me. 6 –Write a medium sized MATLAB script (40 – 100 lines) to solve a problem that is familiar to me. 7 – Write a long MATLAB script (more than 120 lines) with nested commands (for example, calculations within a loop) to solve a problem that is familiar to me. 8 – Make use of a pre-written MATLAB script, making minor modifications, as necessary. 9 – Debug (correct all the errors) as I write my program. 10 – Manage my time efficiently if I had a pressing deadline on a MATLAB project. 12 – Find a way to concentrate on my program, even when there were many distractions around me. 13 – Find ways of motivating myself to work on a MATLAB assignment, even if the problem area was of no interest to me.	Not at all Confident	Extremely Confident
Indirect Skill Assessment	**Compared to other first year engineering students, how would you rate your skill at the following tasks?** 1 – Writing scripts in MATLAB 2 – MATLAB tasks in ENGR 1181 3 – Overall performance in engineering classes	1 Far Below Avg.	7 Far Above Avg.