Work in Progress: The Impacts of Scholarships on Engineering Students' Motivation

Ms. Emily Bovee, Michigan State University

Emily A. Bovee is a doctoral candidate in Educational Psychology and Educational Technology at Michigan State University. Her current research is focused on understanding and supporting college student success, particularly in engineering disciplines.

Ms. Amalia Krystal Lira, Michigan State University

Amalia (Krystal) Lira is a doctoral student in Educational Psychology and Educational Technology at Michigan State University. She is interested in addressing STEM attrition among underrepresented racial and ethnic minority students using motivational frameworks.

Mr. Harrison Douglas Lawson, Michigan State University

I completed my undergraduate Chemical Engineering degree at the University of Pittsburgh. I am currently a graduate student at Michigan State University pursuing a Ph.D. in Chemical Engineering. My research is biology and education focused. After graduating, I aspire to continue working with education programs and join a university as teaching faculty.

Dr. Daina Briedis, Michigan State University

DAINA BRIEDIS is a faculty member in the Department of Chemical Engineering and Materials Science at Michigan State University and Assistant Dean for Student Advancement and Program Assessment in the College of Engineering. Dr. Briedis is involved in research in the study of motivation in engineering students. She has been involved in NSF-funded research in the areas of integration of computation in engineering curricula and in developing comprehensive strategies to retain early engineering students. She is active nationally and internationally in engineering accreditation and is a Fellow of ABET, ASEE, and the AIChE.

Lisa Linnenbrink-Garcia, Michigan State University

Dr. Lisa Linnenbrink-Garcia is a professor of Educational Psychology in the Department of Counseling, Educational Psychology, and Special Education at Michigan State University. She received her Ph.D. in Education and Psychology from the University of Michigan, Ann Arbor. Her research focuses on the development of achievement motivation in educational settings and the interplay among motivation, emotions, and learning, especially in STEM fields.

Dr. S. Patrick Walton, Michigan State University

S. Patrick Walton received his B.ChE. from Georgia Tech, where he began his biomedical research career in the Cardiovascular Fluid Dynamics Laboratory. He then attended MIT where he earned his M.S. and Sc.D. while working jointly with researchers at the Shriners Burns Hospital and Massachusetts General Hospital. While at MIT, he was awarded a Shell Foundation Fellowship and was an NIH biotechnology Predoctoral Trainee. Upon completion of his doctoral studies, he joined the Stanford University Genome Technology Center, receiving an NIH Kirschstein post-doctoral fellowship. He joined Michigan State University in 2004 and his research is focused on the development of parallel analytical methods and the engineering of active nucleic acids (e.g., siRNAs) through mechanism-based design. He has been recognized for his accomplishments in both teaching and research, receiving the MSU Teacher-Scholar award, the College of Engineering Withrow Teaching Excellence Award, and being named an MSU Lilly Teaching Fellow.

WIP: The Impacts of Scholarships on Engineering Students' Motivation

This work in progress paper describes our initial efforts in examining how receiving a scholarship influences engineering students' motivation. A student's persistence and success in engineering depends on multiple academic, institutional, and personal factors. That said, engineering students, like all students, cannot persist to graduation if they cannot pay their tuition and living expenses. As such, financial need and socioeconomic status are significant factors in determining the likelihood of a student graduating from an engineering program [1]. Moreover, average student loan debt is increasing nationally [2], [3], and engineering students are often required to pay premium tuition, creating a substantial obstacle for low-income students [4]. Low-income students are also more likely to take on debt than their counterparts [1], [5]. There is evidence that receiving financial aid is related to increased academic achievement and persistence [5], but the precise nature of the relation between financial aid and persistence is unclear. Although student loans are readily available, receiving student loan aid had a statistically significant negative effect on persistence for high-need (Pell-eligible) students [6]. Thus, it is important to examine whether scholarships - as opposed to loan aid - exert a unique effect on student persistence in engineering, as a variety of programs, including federally-funded programs such as the NSF Scholarships in STEM (S-STEM) program, have sought to enhance engineering student persistence and success by providing scholarships to offset student expenses.

In addition to the socioeconomic factors at play in predicting persistence, one other major contributing factor is students' motivation for the academic discipline of engineering [7]. Expectancy-value theory is a theory of motivation that posits that students are motivated to achieve when they (1) expect that they can succeed on a task (e.g., expectancy) and (2) find the task to be important (e.g., value) [8]. Task-value can be further sub-categorized into three types of value: interest value, attainment value, and utility value. Interest value refers to a students' inherent interest in a domain or task, whereas attainment value refers to the importance of success on a task with relation to one's identity [8]. Lastly, utility value is a measure of the degree to which a pursuit is perceived as valuable in service of a future goal [8]. Expectancy for success and task-value are both related to students' persistence in STEM [9].

Indeed, expectancy and task-value are particularly important for engineering students. If engineering students do not expect that they can succeed in engineering, they are more likely to leave their major [10]. Among engineering students, expectancy predicts achievement and value predicts students' intentions to pursue an engineering career, yet both expectancy and value decline over the first year of an engineering major [11]. The current study will add to the literature by examining the intersection of financial aid and motivation. Although our cross-sectional design will not allow for prediction of persistence to graduation, it will add to our understanding of engineering student motivation and the ways that scholarships could support that.

Current Study

We hypothesize that the impacts of receiving a scholarship on the scholarship recipient may, however, go beyond simply alleviating financial stress or displacing the need to work or take out student loans. Indeed, we posit that by considering students' motivation, researchers may be able

to describe more fully the relation between scholarship receipt and persistence to graduation. Such an understanding would be beneficial for both faculty who work with engineering students and administrators who seek to support them. In this work, we apply quantitative methods to assess differences in the distribution of scholarships across race/ethnicity and gender as well as the relation of scholarship-receipt to engineering-related motivation among engineering students at a large, research-intensive university in the Midwest. Specifically, we examine two main research questions:

RQ1) What are the demographic characteristics of students who receive scholarships as compared with students who do not receive scholarships?
RQ2) For engineering students in general, how do motivational characteristics (e.g., self-efficacy, interest in engineering) differ when comparing scholarship recipients and non-recipients?

Method

Participants

Our approach uses data from surveys of engineering students at Michigan State University. Participants were 3,745 students who took a survey in spring of 2018. Of the respondents, 2,502 (67%) were male, 930 (25%) were female, and 313 (8%) did not respond or indicated "other" for their gender. The majority of the students identified as White (70%), while the rest of the students were Asian (18%), Black (5%), Hispanic/Latino (4%), multiracial (2%), American Indian or Alaska Native (less than 1%), or Native Hawaiian or Other Pacific Islander (less than 1%). While the survey reaches students who are still enrolled in engineering majors as well as students who are no longer enrolled in engineering, for the current study, we limited our sample to students who were still enrolled in engineering.

Measures

Demographics. On our survey, students self-reported their current major. Additionally, students self-reported their gender and race/ethnicity.

Scholarships. We asked two questions about scholarships. The first was a yes/no question posed as follows: "*For this academic year (2017-18), did you receive any scholarships that supported your undergraduate education (tuition, living costs, books, etc.)?*" The second question asked about the amount of the scholarship: "*Across all scholarship sources, approximately how much support did you receive for this academic year? (1 = Covers all of my tuition and living expenses, 2 = Covers my tuition only, 3 = Covers my living expenses only, 4 = Covers a portion of my expenses. Please list approximate percentage of expenses covered (1 to 100%)).*" Students only saw the second scholarship question if they answered yes to the first question.

Motivation. Five questions measured engineering self-efficacy (α = .88). A sample item for engineering self-efficacy is "*I can do a good job on almost all my engineering coursework if I do not give up.*" Five questions measured engineering interest (α = .91). A sample item for engineering interest is "*Engineering is exciting to me.*" Five questions measured attainment value (α = .85). A sample item for attainment value is "*Being good in engineering is an important part*

of who I am." Finally, four questions measured utility value (α = .87). A sample item for utility value is "*Engineering is valuable because it will help me in the future.*"

Descriptive Analysis

We examined the distribution of the variables to answer the question of what percentage of students received a scholarship. Of the 3,745 students in our study, 38 percent (*n* = 1,334) received a scholarship, whereas 62 percent (*n* = 2,141) did not. Of the 1,334 students who received a scholarship, 1,301 responded to the follow-up question asking about the amount of total funds they received. The great majority of students received a partial scholarship (*n* = 914, 70%), while some students received scholarships to cover all their tuition and living expenses (*n* = 205, 16%), other students received scholarships to cover tuition only (*n* = 143, 11%), and still other students received scholarships to cover living expenses only (*n* = 39, 3%).

Primary Analyses

For our first research question, we were interested in the racial/ethnic and gender composition of the scholarship recipients as compared to students who did not receive a scholarship. To answer this question, we conducted two chi-square tests to examine the racial/ethnic and gender composition of the scholarship and non-scholarship groups. For our second research question, we were interested in examining whether there were mean differences in motivation based on whether or not a student had received a scholarship. While we cannot infer causation, it is interesting to consider whether the variables are related, and future research is planned to explore these relations using sophisticated statistical techniques. We conducted a series of independent t-tests to compare mean levels of multiple forms of motivation between students who had received a scholarship and those who had not.

Results

Research Question 1

With respect to research question 1, a chi-square test indicated that there were statistically significant differences in scholarship receipt based on gender, χ^2 (2, 3412) = 10.34, *p* = .006, *phi* = .055. Forty-three percent of women received a scholarship, whereas 37% of men received a scholarship. The *phi* value indicates a small effect size. A chi-square test also indicated significant differences in scholarship receipt as a function of race/ethnicity, χ^2 (7, 3351) = 67.69, *p* < .001, *phi* = .142. Students from racial/ethnic groups traditionally underrepresented in engineering (Black, Latino/a) were more likely to receive scholarships than their White or Asian counterparts. Specifically, 59% of Black students, 48% of multiracial students from underrepresented groups, and 46% of Latino students received a scholarship, whereas only 40% of White students, 39% of multiracial students not from underrepresented groups, and 27% of Asian students received a scholarship. The pattern of standardized residuals suggests that fewer Asian students than expected received a scholarship (*z* = -4.6) and more Black students than expected received a scholarship (*z* = 4.0). The total number of American Indian or Alaska Native and Native Hawaiian or other Pacific Islander students was too low to draw meaningful conclusions about racial differences in scholarship receipt. The source of these racial/ethnic differences is unknown. For instance, they might reflect different levels of opportunity for scholarships or differential application processes for scholarships, as we did not measure whether students had applied for, but not received, a scholarship. The *phi* value indicates that this overall effect size for the distribution of scholarships across race/ethnicity was small.

Research Question 2

With respect to research question 2, there were statistically significant differences in motivation between scholarship recipients and non-recipients. More specifically, independent samples t-tests revealed that scholarship recipients had statistically significantly higher mean levels of engineering self-efficacy, interest, and utility value than non-recipients (see Table 1). There were no statistically significant differences in mean levels of attainment value between these two groups (see Table 1).

Conclusion

Our results suggest differences in scholarship receipt based on gender and race. These differences could have originated from a variety of potential sources. Perhaps the scholarships for which students applied had criteria based on these variables (e.g., a scholarship given with preference to students involved in women-in-engineering programs). We also observed mean differences in motivation based on scholarship receipt. While this cannot be interpreted as causal because the motivation and scholarship indicators were measured concurrently, it is possible that students with higher motivation were more likely to get scholarships. However, it may also be the case that students who receive a scholarship have a subsequent boost in motivation. Future research should explore the possibility of a bidirectional relation between motivation and scholarship receipt. In our future work, we hope to examine differential effects of need-based and merit-based scholarships.

Table 1

T-test comparing mean levels of motivation across scholarship and non-scholarship students

	Scholarship				
	Yes M (SD)	No M (SD)	*t*	*df*	*Cohen's d*
Engineering self-efficacy	**3.90**	**3.80**	4.15***	3380	0.14
	(0.69)	(0.70)			
Interest	**4.06**	**4.01**	2.50*	3413	0.08
	(0.65)	(0.68)			
Attainment Value	3.89	3.88	0.50	3399	n/a
	(0.66)	(0.64)			
Utility Value	**4.35**	**4.29**	2.66**	3450	0.10
	(0.58)	(0.60)			

*Note: Significant results are in bold and indicated with asterisks on the t-statistics: * $p < .05$, ** $p < .01$, *** $p < .001$. The assumption of equality of variances was fulfilled for all constructs; so those degrees of freedom are reported.*

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References

[1] R. H. Fenske, J. D. Porter, and C. P. DuBrock, "Tracking financial aid and persistence of women, minority, and needy students in science, engineering, and mathematics," *Res. High. Educ.*, vol. 41, no. 1, pp. 67–94, 2000.

[2] C. Avery and S. Turner, "Student loans: Do college students borrow too much—Or not enough?," *J. Econ. Perspect.*, vol. 26, no. 1, pp. 165–192, Feb. 2012.

[3] D. V. Price, "Educational debt burden among student borrowers: An analysis of the baccalaureate & beyond panel 1997 follow-up," *Res. High. Educ.*, vol. 45, no. 7, pp. 701–737, Nov. 2004.

[4] George-Jackson, C.E., Rincon, B. & G. Martinez, M. (2012). Low-income students in Engineering: Considering financial aid and differential tuition. Journal of Student Financial Aid, 42(2), 4–24.

[5] A. F. Cabrera, A. Nora, and M. B. Castañeda, "The role of finances in the persistence process: A structural model," *Res. High. Educ.*, vol. 33, no. 5, pp. 571–593, Oct. 1992.

[6] S. Herzog, "Financial aid and college persistence: Do student loans help or hurt?," *Res. High. Educ.*, vol. 59, no. 3, pp. 273–301, May 2018.

[7] C. Van Soom and V. Donche, "Profiling first-year students in STEM programs based on autonomous motivation and academic self-concept and relationship with academic achievement," *PLoS One*, vol. 9, no. 11, Nov. 2014.

[8] J. Eccles, T. F. Adler, R. Futterman, S. B. Goff, C. M. Kaczala, J. L. Meece, and C. Midgley, "Expectancies, values, and academic behaviors." in *Achievement and achievement motivation*, J. T. Spence (Ed.), San Francisco: W. H. Freeman, 1983, pp. 75-146.

[9] M. Wang and J. Degol, "Motivational pathways to STEM career choices: Using expectancy–value perspective to understand individual and gender differences in STEM fields," *Developmental Review*, vol. 4, no. 33, pp. 304-340, Jan. 2013.

[10] J. A. Raelin, M. B. Bailey, J. Hamann, L. K. Pendleton, R. Reisberg, and D. L. Whitman, "The gendered effect of cooperative education, contextual support, and self-efficacy on undergraduate retention," *J. Eng. Educ.*, vol. 103, no. 4, pp. 599–624, Oct. 2014.

[11] B. D. Jones, M. C. Paretti, S. F. Hein, and T. W. Knott, "An analysis of motivation constructs with first-year engineering students: Relationships among expectancies, values, achievement, and career plans," *J. Eng. Educ.*, vol. 99, no. 4, pp. 319–336, Oct. 2010.