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Near-Peer Mentoring and Early Exposure to Computer Science – Quantitative and Qualitative Results

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Near-Peer Mentoring and Early Exposure to Computer Science – Quantitative and Qualitative Results - Summary

Introduction

The CS/M Scholars Program at Western Washington University (WWU) is funded by an NSF Track 2 S-STEM grant (Award Number 1742110). The grant funds scholarships for low-income high-achieving students majoring in computer science or math and involves a variety of supporting activities designed to support the CS/M Scholars' academic success and prepare them for careers in the fields. The project also involves educational research with a goal of understanding the effects of program activities. The project team consists of Dr. David Hartenstine, WWU mathematics professor, Dr. Perry Fizzano, WWU computer science professor, Dr. Regina Barber DeGraaff, WWU physics instructor and WWU's College of Science and Engineering's STEM Inclusion and Outreach Specialist, and Dr. Joseph Brobst of Old Dominion University, the project's educational researcher. External evaluation of the project is done by the Center for Evaluation & Research for STEM Equity at the University of Washington. Dr. Joanna Garner began working with Dr. Brobst on research related to this project in 2019.

This summary gives a short overview of the program and reports on student demographics, but focuses primarily on the research, including both the design and findings so far. This summary closes with a brief discussion of plans for the future. Further details will be provided in the full poster presentation.

Overview

The CS/M Scholars Program supports WWU students majoring in math or computer science with scholarships averaging about $4500 per year, renewable for up to four years, and various curricular and co-curricular activities. Students are recruited from WWU's applicant pool while they are still in high school. Typically, ten to fifteen new CS/M Scholars are recruited for each incoming cohort.

All CS/M Scholars take two first-quarter seminar classes, one in math and one in computer science, taught by Hartenstine and Fizzano, respectively. During that first quarter they also take a math class, appropriate for their background. The following quarter they take a first computer programming course. During the first year, they take classes that lay the foundation for graduating with either a computer science or math degree in four years. In addition to coursework, the program also involves near-peer mentoring: first- and second-year students are mentored by junior and seniors, and the juniors and seniors are mentored by recent WWU alumni from computer science or math. We refer to the alumni mentors as Early Career Professional Mentors (ECPMs). There are also six program events each year that focus on professional development and exploration of opportunities in the fields. Many CS/M Scholars begin the program with little to no experience in computer science. The seminar class in the first quarter, the programming class in the second quarter and program events during the first year constitute what we call "early exposure to computer science."

More details about the CS/M Scholars Program, including the recruitment of the Scholars, descriptions of the first-quarter seminars and details of the mentoring program, a listing of program events and how the program design and associated research grew out of a previous S-STEM project at WWU can be found in a previous ASEE article [1].

Student Demographics

A total of 59 students have been or are currently CS/M Scholars. Twelve of these students have already graduated with a BS in math or computer science, 43 are continuing, and four students left the program. Approximately two thirds of the students are majoring or intend to major in computer science, the rest in math. Many of the students are part of an underrepresented demographic in computer science or math. Specifically, 42 (71%) identify as female or non-binary; 20 (34%) are first-generation college students; and 25 (42%) identify as students of color.

CS/M Scholars Research Study – Design and Summary of Findings to Date

Research associated with the program focuses on two main questions: 1) How and to what extent do the program features contribute to the development of students' self-efficacy, identity, and sense of belonging? and 2) How does early exposure to computer science through coursework and career awareness affect the experience of CS/M Scholars? Data sources are focus group interviews, surveys of the Scholars and a comparison group, and Scholars' written summaries of conversations with their mentors. The summary presented here draws upon the latter two data sources. The summaries written by students reflect their perceptions of the mentoring experience and along with the focus groups and surveys provide multiple points of triangulation, giving important insight into their experience with the program overall.

Survey Sample – Scholars & Comparison Students

All CS/M Scholars are invited (but not required) to join the research study as part of their participation in the program. With each new Scholars cohort, we also invite a group of Comparison students to complete the survey portion of the research study. Comparison students are WWU students and are recruited from two pools: students who applied to the program but were not selected, or who were qualified to apply but elected not to do so. To increase the sample size and corresponding reliability of the current analysis, data were pooled for the first two cohorts of Scholars and Comparison students (Fall 2018 and Fall 2019) respectively. The final sample included in the current analyses is shown in Table 1.

Table 1: Sample size by student group for pre- and post-surveys

		Pre	Post	Total
Group	Comparison	18	17	35
	Scholar	22	19	41
Total		40	36	76

Early Exposure to CS and Scholars' Developing Self-efficacy / Sense of Belonging / Identity

Because the "early exposure to computer science" sequence takes place during students' first year, analyses focused on the pre- and post-surveys that bounded this year. Items were adapted from the STEM Semantics Survey ([2]) and the STEM Career Interest Survey ([3]) and assessed students' self-efficacy, sense of belonging, and identity related to math, computer science, and STEM careers.

The first round of analyses identified all variables where Scholars' mean ratings increased over the course of their first year. Two composite variables, Computer Science Contextual Support and Math Contextual Support, were dropped because each included an item that seemed unlikely to have changed due to students' experience in the program: "I know of someone in my family who uses [CS / Math] in their career." The other item included within the Contextual Support variables was "I have a role model in a [CS / Math] career" and was retained in analyses as a stand-alone.

Because pre- and post-group survey respondent groups were not identical, a one-way analysis of variance (ANOVA) was used (rather than paired samples T test) to determine if Scholars' pre- and post-means differed significantly on any variables. The difference was significant for the following (post-means were higher for each): "I have a role model in a computer science career" – $F(1,38) = 5.20$, $p = 0.028$; effect size (eta squared) = 0.12; Computer science self-efficacy – $F(1,35) = 11.7$, $p = 0.002$; effect size (eta squared) = 0.251. For all other variables where Scholars made a gain from pre to post, the difference in means was not statistically significant. There were some variables where the Scholars' group mean *decreased* from pre to post, but none of these changes were statistically significant either.

Based on simple difference-in-difference calculations, Scholars outgained comparison students from pre to post on multiple variables. To determine whether these differential gains were significant, a series of multifactorial ANOVAs were run with dummy codes for group (Comparison = 0, Scholars = 1) and time (Pre = 0, Post = 1) input as independent variables (fixed effects) and post survey outcomes from surveys included as the dependent variable. Each analysis looked at whether the group*time interaction included in the regression model was significant – i.e., is a significantly higher mean expected for a post survey score drawn from a member of the Scholars group? Ultimately, these group*time interactions were not significant in any of the models, indicating that differences in pre-post gains between Scholars and Comparison students did not rise to the level of statistical significance.

Finally, a series of independent samples T tests were conducted to compare Scholars and Comparison students' means on the post survey only. Significant differences between Scholars and Comparison students were found for the following variables: "I have a role model in a CS career" – $t(29) = -2.301$, $p = .029$ (2-tailed), Hedges' $g = 0.83$; STEM Career Semantics Composite – $t(34) = -2.057$, $p = .047$ (2-tailed); Hedges' $g = 0.67$. There were no significant differences between Scholars and Comparison post survey means for any of the other variables tested.

In summary, survey findings to date suggest that the early exposure to computer science sequence leads to significant increases in Scholar's computer science self-efficacy and awareness of role models in computer science. Additionally, by the end of their first year, Scholars appear more likely to have identified role models in computer science and to have higher general interest in STEM careers than Comparison students.

Mentoring and Scholars' Academic and Career Identity Development

Scholars in the program meet monthly during the academic year with near-peer mentors, with those in the early years of their degree paired with upper division undergraduates and those upper division undergraduates paired with Early Career Professional Mentors (ECPMs). Program faculty members provide mentor-mentee pairs with discussion prompts; suggested topics for conversation have included: "how to be a successful student", "what qualities do you seek in a mentor", "what role have extracurricular activities played in your development", and "how do you set goals". Some conversation prompts refer to upcoming or recently completed program events (e.g., panel discussions). After each mentoring conversation, mentees are asked to reflect on the discussion and write a short (100-200 word) summary and then post the summary on a program Canvas page. These written summaries formed the primary data set for the mentoring portion of the research study.

In our first set of analyses, we selected a purposefully diverse sample of three mentoring pair cases from the 2018-19 academic year, each consisting of a Scholar mentee and an ECPM and examined 16 mentoring conversation summaries that reflected interactions between mentees and mentors. The Dynamic Systems Model of Role Identity ([4]) was applied to these cases to determine the extent to which mentoring conversations provided a fruitful context for students' identity exploration and development. Our analyses indicate that near-peer mentoring relationships provide safe spaces for students' identity exploration and the development of commitments towards career paths and life goals. Across all three cases, students explored beliefs, self-perceptions, goals, and action possibilities in collaboration with their mentors. These findings suggest that near-peer mentoring interventions that require relatively little time and resources can still have meaningful impacts promoting undergraduate student retention in computer science and mathematics. A full description of our theoretical orientation, case selection, analyses, and findings are presented elsewhere ([5]).

Plans for the Future

Analysis of survey and focus group data will continue during the remaining years of the project. The results of academic year 2020-21 will be of particular interest since during this time, WWU was almost completely online due to the COVID-19 pandemic. The first-quarter seminars, student-faculty contact during program events, and the support of mentors will likely lead to greater differences between the CS/M Scholars and the comparison group. If analysis is completed by Summer 2021, these results will be presented in the poster.

Additional analyses of cases of mentor-mentee pairs are planned. There is also the potential for longitudinal analyses of mentees' identity development across multiple program years. Of particular interest is whether (and how) the structure and/or focus of discussion during mentoring

conversations may have shifted due to the COVID-19 pandemic and transition to purely virtual interactions among Scholars, faculty, and ECPMs.

Expanding the near-peer mentoring program to WWU students outside of the CS/M Scholars program is under way in WWU's computer science department, with plans for doing the same for WWU math majors. A complete description of the near-peer mentoring aspect of the CS/M Scholars program along with a discussion on scaling it to larger groups or otherwise adapting it will appear in a future publication.

References

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[5] J. Brobst, J. Garner, D. Hartenstine, P. Fizzano, and R. Barber DeGraaff, "Professional identity exploration and commitment development by STEM undergraduates from underrepresented groups during near-peer mentoring," presented at American Educational Research Association 2021 Annual Meeting, Virtual Online, Apr. 8-12, 2021.