Board 336: Math to Makerspace: Evolution of a Bridge Program to Support Cohort Development

Prof. Jill Davishahl, Western Washington University

Jill Davishahl is Assistant Professor and First Year Programs Director in the Engineering + Design department at Western Washington University. Jill's teaching, service, and research activities focus on enhancing the first year student experience by providing the foundational technical skills, student engagement opportunities, and professional skill development necessary to improve success in the major, with emphasis on supporting traditionally underserved student populations. Her current research focuses on creating inclusive and equitable learning environments through the development and implementation of strategies geared towards increasing student sense of belonging.

Dr. Sura Alqudah, Western Washington University

Dr. Sura Al-Qudah is an assistant professor in the Engineering and Design Department at Western Washington University. She received her Ph.D. and M.S. in Industrial and Systems Engineering from State University of New York at Binghamton in August 2014 and

Dr. Joseph Arthur Brobst, Old Dominion University

Joe Brobst holds a BS in Biological Sciences, MA in Curriculum and Instruction, and Ed.D. in Educational Leadership, all from the University of Delaware. Formerly a high school biology teacher, he is now an educational research and program evaluation specialist with experience on a broad range of projects funded by NSF, US Department of Education, ONR, and NIH and with participants ranging from elementary school to higher education. Much of his work focuses on broadening participation in STEM.

Dr. Elizabeth Litzler, University of Washington

Elizabeth Litzler, Ph.D., is the director of the University of Washington Center for Evaluation and Research for STEM Equity (UW CERSE) and an affiliate assistant professor of sociology. She has been at UW working on STEM Equity issues for more than 17 years. Dr. Litzler is a member of ASEE, 2020-2021 chair of the ASEE Commission on Diversity, Equity, and Inclusion, and a former board member of the Women in Engineering ProActive Network (WEPAN). Her research interests include the educational climate for students, faculty, and staff in science and engineering, assets based approaches to STEM equity, and gender and race stratification in education and the workforce. She was awarded the 2020 WEPAN Founders Award.

Prof. Andrew G. Klein, Western Washington University

Andrew G. Klein is a professor in Electrical Engineering at Western Washington University (WWU), having joined in 2014 with a joint appointment to the department of Engineering and Design (Electrical Engineering Program) and the graduate faculty of Comput

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Introduction

This paper shares the evolution of a summer bridge program designed to support National Science Foundation S-STEM scholarship students as they transition to college. The bridge program, taught before the start of the fall quarter, is a week-long intensive course designed to provide incoming first-year students with a strong and focused start to college life. The aim is to provide a venue to help students socially and academically integrate into the campus community. Over the course of 4 years, the summer bridge program evolved from a lecture-heavy math-focused course to a project-based makerspace experience. In its final form, the bridge program combines positive attributes of its former iterations and balances preparing students for college socially and academically.

Background

Western Washington University (WWU) is a public institution with approximately 16,000 full-time undergraduate students, 160 academic programs, and a vibrant campus community. The Engineering & Design Department (ENGD) offers three undergraduate-only engineering programs: Electrical and Computer Engineering (EECE), Manufacturing Engineering (MFGE), and Polymer Materials Engineering (PME). The Becoming Engaged Engineering Scholars (BEES) S-STEM scholarship program, funded by the National Science Foundation, provides academic and financial support to 4 cohorts of low-income undergraduate students interested in majoring in engineering. The BEES program supports Scholars for the first two years of their study at WWU. BEES program cohorts are small (12 max), and students are supported through a series of co-curricular and curricular elements, including a summer bridge program, cohort course structure, multilevel mentoring, project opportunities, and social events [1].

This paper focuses on one component of the BEES support elements: the summer bridge program. Regarding student support structures, participation in summer bridge programs is associated with increased retention rates among STEM [2]. WWU has an existing campus-wide summer bridge program called “Viking Launch,” where participating students arrive one week early for an intensive study and preparation experience in their chosen discipline. All the WWU Viking Launch bridge programs consist of several common programmatic elements known to improve student success [3], combined with discipline-specific learning. These common elements include social gatherings, organized meals for cohort members, workshops focused on student success, financial literacy, study skills, and tutoring services available on campus. Consistent with other research on bridge programs [4] [5], Viking Launch has been shown to affect first-year retention at WWU positively. Furthermore, the Viking Launch program was a successful component of the BEES project and was shown to have a positive impact on sense of belonging for scholarship students, especially women [6].

Math-Focused Summer Bridge Program – Iteration 1 & 2

The first two iterations of the summer bridge program were titled "Engineering Calculus Prep" and were taught in the fall of 2019 and 2020. In the fall of 2019, the course was taught in person in a classroom, and in Fall of 2020 the class was taught online. Both course iterations included an intensive review of mathematics geared toward preparing students for calculus. In addition, the content included an introduction to spatial visualization skills, a review of campus resources, and a field trip to a local industry site (fall 2019 only). Students met with faculty for 5-6 hours per day, and class time was spent primarily on lecture and problem-solving sessions. The course instructor was from the math department and was not connected directly with the project. The course description and outcomes are listed below.

Course Description: An intensive review of pre-calculus mathematics for engineering students. The course will include hands-on activities and a field trip.

Course Objectives:

- Review pre-calculus mathematics topics.
- Practice by applying pre-calculus to engineering problems.
- Meet and interact with engineers at local engineering companies.
- Explore campus resources (e.g., Learning Commons, Campus Wellness, Career Services).

Student Feedback:

Student feedback was gathered as part of an end-of-the-quarter survey and focus group sessions with the external evaluator. Three consistent themes were seen in the feedback: 1. Students found the instructor's teaching style to be effective, 2. Students found it challenging to work on math problems for long periods of time, and 3. Students developed connections with their cohort. Table 1 below summarizes some student comments from the evaluations and focus groups.

Table 1: BEES comments on Math-Focused Summer Bridge Program (2019 & 2020)

Positive Student Feedback	Negative Student Feedback
"Methods of teaching good, and the field trip was interesting."	"[it is] hard to work 4 hours on math."
"I liked how we reviewed past [math] topics that I kind of forgot."	"It would be easier if the classes weren't so long."
"Viking launch was probably the time when I got to know everyone in [the program] probably the most because we were always meeting up every day for pretty significant amount of time."	"I found it really difficult to concentrate on a single subject for an extended period of time day in and day out."
"I enjoyed getting to meet the people that I would have in my classes for at least that first quarter. I feel like it would've been harder to approach them in an actual classroom where you're interacting with a lot of different people."	"Having more breaks in the class might help [improve the course], along with having more hands-on group assignments or projects."

Faculty Review & Reflection

After the first two iterations of the summer bridge program, the faculty Co-PI's reviewed and revised the curriculum to focus on supporting student cohort development and developing student sense of belonging in the engineering program. After reviewing student feedback and having a discussion with the math department faculty who taught the previous versions of the course, the following course changes were proposed:

1. Increase opportunities for hands-on learning and activities;
2. Focus on the development of strong cohort connections;
3. Teach the course in the engineering building;
4. Have an engineering instructor (ideally one of the project PIs) teach the course.

Makerspace Focused Summer Bridge Program - Iteration 3 & 4

The second two iterations of the summer bridge program, titled "Engineering Exploration," were taught in Fall 2021 and 2022 (both in-person). The students met in the engineering department makerspace, and the class was taught by engineering faculty (who were also PI's on the project). The course includes a series of hands-on activities focused on "making," with lots of open project work time where students were encouraged to socialize and develop personal connections. In the context of the course, students learned how to 3D print, laser cut, sew, and vinyl cut. In addition, course content included spatial visualization, study skills, tours of department labs, and connections to campus resources. The 2021 iteration of the course included math content focused on preparation for calculus. This was not included in the 2022 iteration because a few students in the course were not entering the program calculus-ready. The course description and outcomes are listed below.

Course Description: Students will be introduced to engineering through participation in hands-on activities utilizing the tools, equipment, and resources available in the Engineering and Design Makerspace. Focus will be placed on technical skill development, exploratory design, 3D spatial visualization, cohort building and workspace norms.

Course Learning Outcomes:

At the conclusion of this course, students will be able to

- Evaluate their prior knowledge of makerspace tools and resources
- Identify technical skills necessary to successfully participate in "make-do-build" experiences
- Utilize skills learned in the makerspace to participate in an exploratory design project or activity.
- Explain the role of makerspace norms in creating an inclusive makerspace culture
- Describe campus resources available to students (e.g., Learning Commons, Campus Wellness, Career Services)

Student Feedback:

Student feedback was gathered as part of the project focus group sessions with the external evaluator. The main themes seen in the feedback were related to 1. Development of cohort connections, and 2. Connection to engineering resources (makerspace, faculty, equipment), both of which help to develop a strong sense of belonging. Selected students' comments are summarized below.

Student comments:

- "It definitely felt like [working in the makerspace] was what I came here to do, like that's what I came to the engineering department for that sort of thing."
- "I had worked together with some people just helping them out with their own projects. And so I feel that strengthened the feeling of the community in our cohort."
- "We all got along doing our projects pretty well and we all shared knowledge we had picked up along the way to coming to Western and helping with CAD and all that kind of stuff. I think that really helped us feel connected."
- "If we didn't work in the Makerspace, I definitely would've been way too nervous to go in there and try it out myself. So just having, just to be students in there for the first week, it was really cool to get started in there. And now I'm totally comfortable just going in and using the machines and tools."
- "It was really nice having something that felt creative along with the math and the spatial visualization. It just made it feel all together and all put in one place. And it made it less anxiety inducing, actually. It just felt comfortable in there. And it was really nice."

Conclusion

In the early years, the bridge program focused on an intensive math review with the goal of preparing students for their first quarter of calculus. This approach left little time for students to connect socially, explore campus, or participate in any hands-on projects or activities. In its final form, the bridge program combines the positive attributes of its former iterations and successfully balances preparing students for college socially and academically. Through hands-on maker projects, tours of campus and department labs, math reviews, and opportunities to connect socially, the updated bridge program seeks to better support the S-STEM scholars during their transition to college.

Acknowledgement – This material is based upon work supported by the National Science Foundation S-STEM program under Grant No. 1834139. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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