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WIP: Reflections from a Multidisciplinary, Cohort-Based First-Year Seminar for Low-income, Academically Talented First-Year Engineering Students

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Introduction

This work-in-progress paper explores student reflections from a multidisciplinary, cohort-based, first-year engineering seminar designed for a cohort of students participating in a scholarship program. This paper offers a brief overview of the Scholarship program, which is designed to support low-income, academically talented engineering students. We offer a description of the scholarship section of the FYE seminar and offer preliminary themes from an analysis of Scholars' responses to an end-of-class written reflection to address our research question: *What is the experience of first-year, low-income, academically talented students in a cohort-based, multidisciplinary first-year engineering seminar?* Through our analysis, we aim to cultivate an initial understanding of the Scholars' experience engaging in an FYE seminar as a cohort during their first semester and identify opportunities for improving Scholarship programming.

Background

Students from low-income backgrounds demonstrate interest in pursuing an engineering career to "contribute to the well-being of their communities" through engineering and for the professional and financial opportunities it can afford, among other reasons [1, p. 4]. However, low-income students face barriers in pursuing engineering, such as others' lack of belief in the student's pursuit of a STEM education, their motivations and interests not being supported in STEM education, and the financial impacts of pursuing STEM education [2]. Furthermore, a "deficit discourse" pervades the experience of low-income students, which results in "othering" this group of students [10, p. 5]. Researchers urge educators to challenge this narrative [3, p. 5] by elevating low-income students' unique experiences and contributions [4], [5].

Cohort-based programs can support low-income, academically talented students' engineering identity development (through a "community of peers") [6] and can offer a structure for more equitable educational experiences [7]. Cohort models can offer students community-building opportunities with peers who share similar experiences. Lewis et al.'s [8] review found that peers and role models can support academic belonging by promoting belonging in the social context surrounding educational experiences. Moreover, Hansen et al. [7] found that underrepresented STEM students who participated in a cohort-based program with academic, co-curricular, and professional development components demonstrated increased persistence.

Scholarship Program Structure

Scholars in the Scholarship Program at Urban University are offered a multifaceted support system to support persistence, increase graduation rates, and prepare the Scholars for post-graduation success through financial, academic, and professional support. This scholarship

program was designed to meet the unmet financial needs of academically talented students who applied to the College of Engineering (COE) at Urban University through support from an NSF S-STEM grant. Urban University's COE has received five S-STEM awards in the past 20 years. In the most recent two S-STEM projects, Scholar cohort-building has been a key intervention method. More details about the prior implementation of the S-STEM-funded Scholarship Program can be found in [9]. Below is a brief overview of the Scholarship program's structure.

Summer Bridge Program. The Scholarship Program began with a week-long residential Summer Bridge Program (SBP). The SBP welcomed Scholars to Urban University and sought to foster community among the Scholars. Scholars engaged with faculty and staff from each COE department, participated in community-building activities, took field trips to local attractions, and connected with undergraduate student leaders. Each day of the SBP ended with an opportunity for Scholars to reflect on their experience with their Scholarship cohort and the undergraduate student leaders. All students stayed in a common residence hall during the SBP to foster unstructured community-building opportunities. For more details about Scholar recruitment and the SBP, please see [10].

Advising and Mentoring. Each Scholar was matched to a dedicated faculty advisor and meet regularly. They will continue meeting throughout their undergraduate careers. In addition, students will have the opportunity to connect with industry mentors starting their second year.

Cohort-Based First-Year Seminar. All engineering students at Urban University are required to complete a FYE Seminar. The FYE Seminar is an 8-week course for students in a common major, facilitated by two current students in at least their second year at Urban University. This course engages students in academic, professional, and personal development. The course ends with a three-week in-class engineering project. The FYE seminar is taken by all students in their first semester and thus serves as a natural opportunity for Scholar cohort building. The seminar follows the Summer Bridge Program offered to the Scholars in the summer before their first semester, where the cohort-building activities began.

Much of the Scholars' FYE Seminar experience reflected the standard sections of the FYE Seminar; however, there were three primary differences. First, the Scholars took the class as a cohort rather than with a group of students within the same major to continue building community within the cohort. This resulted in a multidisciplinary class environment. Second, the course was facilitated by a postdoctoral associate and an undergraduate TA to provide Scholars with tailored, responsive support. For example, each class ended with an "exit ticket" that would generally include: 1) questions about course content or upcoming events that might be causing stress (e.g., midterm weeks); 2) questions about how the instructor could support their engineering journey with the goal of affirming their engineering experience [4]; and 3) an opportunity to ask questions or provide other comments for the instructor. The instructor responded to individual questions by email, connecting students to campus resources when applicable. When many students asked similar questions, the instructor incorporated relevant

topics into course content when possible. This resulted in an in-class discussion about time management and study strategies and a "Special Office Hours" discussion on professional development topics. Finally, the Scholar FYE Seminar included an end-of-course reflection assignment to continue the thread of reflection-based activities in Scholarship programming, starting in the SBP. More information about the reflection is found in the Methods section.

Methodology

We provide an overview of the study context, participants, and the data collection and analysis process. This study was approved by the University of Illinois Chicago IRB (#2024-0965).

Data Collection

One component of the Scholar FYE Seminar section was an end-of-course written reflection assignment, which served as the data for this WIP project. The reflection prompt asked students to reflect on the challenges and successes they have experienced thus far in their undergraduate experience, their experience as Scholars, and their experience in the FYE Seminar. Students were asked to write at least 500 words. Data were lightly cleaned to improve overall readability.

Study Context and Participant Overview

Urban University is a large urban research university. The study participants were Scholars in a Scholarship Program at Urban University. All Scholars were first-year students and enrolled as a cohort in the required FYE Seminar at Urban University. Eleven of the 17 Scholars participated in this study. To protect participants' identities, each participant was assigned a pseudonym, and we offer aggregate demographic information due to the small sample size (Tables 1-2).

Table 1. Participant Race/Ethnicity.

Race / Ethnicity	Number of Participants
Asian	3
Black or African American	1
Hispanic or Latinx/a/o/e	6
White	1

Table 2. Participant Gender.

Gender	Number of Participants
Man	4
Woman	6
Self-described	1

Data Analysis

The researchers analyzed qualitative data from an end-of-course written reflection assignment to answer the research question. For the preliminary data analysis, the researchers engaged in an

inductive coding process, followed by a thematic analysis to capture insights from the data to answer the research questions. Thematic analysis is a way to identify "patterned responses" in a qualitative data set in a way that meaningfully contributes to addressing the research question [11, p. 82]. To answer this research question, all researchers first engaged with the data by reading the participant reflections. Then, the researchers independently developed a list of codes representing the data, assigning codes to lines of the written reflection. After coding the student reflections, the researchers met to discuss the codes and overall insights. This resulted in a list of preliminary themes that address the research question described below.

Preliminary Results

Scholars valued the cohort-based class environment for its built-in community. Scholars met one another for the first time during the Summer Bridge Program; thus, the FYE Seminar was the second time Scholars were together for Scholarship programming. Scholars shared their value in taking the FYE Seminar as a cohort, as it provided them with opportunities to learn from one another and deepen their connections with fellow Scholars. Leo summarized this idea:

> "This course […] gave one a chance to connect with my fellow [Scholars] and build even deeper connections with them. Talking to my friends during class gave me a new perspective on how others manage their studies and activities and also build their network."

Likewise, Carmen highlighted that conversations within the cohort were the "most crucial" component of the FYE Seminar experience: "The most crucial part of [FYE Seminar] was the interaction of talking to my fellow scholars. It helps create a perspective on how other people are building their networks and their tactics for dealing with studying."

Additionally, Scholars shared that the cohort structure of the course contributed to a positive classroom environment. As Amara wrote, "to have people I already established a close bond with to meet every [Day of the Week] after my most stressful day of classes was something I truly appreciated." Similarly, Daniel shared, "Having a class with all of us made me feel happy to see everyone at least once a week." Elena described, "This [FYE Seminar] course with other [Scholars] made me realize how essential it is to have a good support system, and I will say, we all communicate like a small community where everyone wants to see each other succeed!"

All sections of the FYE Seminar at Urban University are structured with a small class size; however, this was something that Scholars perceived as a benefit of taking the FYE Seminar as a cohort. For example, Leo shared, "I really enjoyed how small the class was because it allowed me to feel more connected to the people around me and the material." Avery expanded on this idea, sharing how it helped bridge the transition from high school to university:

> "Being in a classroom where I know everyone has helped lessen the drastic change from high school to college by acting as a kind of bridge where the structure is based on college, but the general atmosphere is highly similar to that of a high school classroom.

> This could only really be achieved by the [Scholarship Program], through which I met all of my classmates over the summer as we were all preparing to enter [Urban University], and college for the first time."

Scholars perceived the FYE Seminar course topics as largely beneficial to their first semester. Urban University's FYE Seminar course curriculum aims to prepare incoming students with academic and professional skills essential to pursuing an engineering education and connect students to campus. In general, students expressed value in these topics. Scholars named specific course topics that they believed to be important to their FYE Seminar experience (and beyond). The course topics and the number of scholars who explicitly discussed that topic in their reflections are found in Table 3.

Table 3. Course Topics Scholars Perceived as Important to FYE Seminar Experience.

Course Topic Named as Beneficial from FYE Seminar Experience	Number of Students Who Mentioned Topic in their Reflection
Identifying Resources & Getting Involved on Campus	5
Professional Skills	4
Engineering Major Exploration & Course Planning	3
Implicit Bias Training	2
Teamwork	2
Time management	2
Career Pathways	1
Engaging with Cultural Events	1

Furthermore, the Scholars shared their understanding of the role that they will play in their undergraduate engineering careers. In the Scholars' words: "The lessons in this class are valuable for my undergraduate career as an engineer" (Olivia); "This course helped me to understand what it takes to be a good engineering student" (Leo); "I've been using everything I've learned from the [FYE Seminar] to navigate my journey as a [Urban University] student and a future [engineering discipline] engineer" (Aurora); and “[The FYE Seminar was] a preparation for my path to becoming an engineer” (Lucas). Elena offered an additional perspective on how the FYE Seminar prompted her to think beyond the first year: "It [i.e., the FYE Seminar] truly makes me think about the future, how it all begins with a simple engineering introduction class, and then it becomes something way bigger."

While Scholars generally found most course topics important, they also offered some course topics that they believed were less important to the course. Two students shared that learning about different cultures felt least important, and one shared that implicit bias was the least important topic covered in the FYE Seminar. These three students shared that they felt this way because they had engaged with these topics outside of the FYE Seminar. Two students noted that the group project was least important, as most groups ran out of time to complete it; however, these students shared that the project still allowed students to practice teamwork skills and have fun in class.

Scholars also shared secondary learnings that they gleaned from their FYE Seminar experience. Notably, three Scholars discussed how the FYE Seminar course encouraged Scholars to step out of their comfort zone. Sofia provided an example regarding talking with professors:

> "I have learned how to stay on track, plan and prepare for my future, and properly communicate with others, especially professors. I learned that I should get myself involved and talk to professors, and I have done this and loved it. Although the first interaction with a professor was intimidating, it made me feel so much more comfortable to go and ask questions or reach out whenever I am in doubt about everything. It also made me want to go to class more and actually pay attention, especially in classes where I may struggle a bit more to do this. […] Doing things for the first time is what I often find hardest, but once I do it once, it's easy for me to go back. Although these are all things that I wanted to do, the class just served as a guide on what to do and to not delay."

Scholars recognized how their support system extended beyond the FYE Seminar. Scholars shared their appreciation of the cohort structure, financial support, and mentoring opportunities offered by the Scholarship program. While this theme includes components related to but beyond the FYE Seminar, we still include it as a theme as it describes the Scholarship experience surrounding the FYE Seminar.

The first theme details how cohort-based programming impacted Scholars' FYE Seminar experience; however, Scholars also discussed how the cohort model impacted their educational experience beyond the FYE Seminar. This was the support most discussed among Scholars. Maria wrote, "They [the Scholars] gave me a built-in study group, new friendships, and a new family. I will continue to associate myself with people who bring me positivity and challenge me as a scholar." Aurora gave additional context regarding the value of shared experience:

> "I have really enjoyed being in contact with other freshman engineering students that deal with very similar issues that I do. The other members of the [Scholarship Program] are also Pell-eligible, so not only do we deal with the normal struggles that every college student deals with, but we deal with financial stress, which is a large burden during college years."

Avery described how the cohort provided a sense of comfort while navigating the first semester:

> "I have both [Scholar] and [Scholar] in my [Course Subject] class, so I see them often. […] I also see [Scholar] regularly, as we are both in the same dorm hall, and being able to see a friend randomly also brightens my day when I feel down. Most importantly, the [Scholarship] program has made me feel more like I belong than anything else at a time where I feel like I could not be further away from my surroundings."

For some, the continuity of their support was experienced by the FYE Seminar following the SBP. Daniel believed the continuity between the Summer Bridge Program and FYE Seminar was foundational to this sense of community: "My [FYE Seminar] experience was amazing for many reasons. Many of those have to do with being with the people who[m] I have become great

friends with. Having the [Scholars] in the same room after the summer program felt like we never left." Similarly, Leo shared, "Most of the friends and connections I have made are from the summer bridge program this summer; I feel like without these relationships, I would've felt overwhelmed, and after all, they are one of my major sources of support in university." Sofia saw the FYE Seminar as an integral support from the Scholarship program as she transitioned to her first semester: "I think without this class, it would have felt like I was thrown into things without guidance from [Scholarship Program]."

Finally, Scholars discussed how the scholarship program mitigated financial barriers to pursuing an undergraduate degree and afforded beneficial mentorship. In Amara's words:

> "The [Scholarship Program] has been a life-changing experience for me, as it has given me endless support, mentors in all fields, as well as friends who are studious and focused on their studies. As a first-generation college student, it had been a struggle to find financial and mentorship resources."

Discussion

In the spirit of continuous improvement, the discussion section describes three opportunities for improving the FYE Seminar, drawing from the preliminary results we present above and our experience analyzing the Scholars' reflections.

Opportunity Area 1: Integrate Continued Opportunities for Academic and Professional Development and Community Building. Our analysis revealed that Scholars perceived the academic and professional development course topics and community building with their fellow Scholars as highly beneficial. Notably, many Scholars emphasized their appreciation for taking the FYE Seminar as a cohort, as they saw the cohort as part of their support system. This finding suggests that offering more avenues for academic and professional development and community building (e.g., workshops and cohort-based events) may be desirable to Scholars.

Opportunity Area 2: Identify Additional Avenues to Connect Students with Major Departments. The Scholarship Program aims to connect students to their major department by introducing students to alumni and faculty guests during the SBP and through structured faculty advising. In addition, the FYE seminar asked students to create a course plan, explore alumni career paths, and engage in engineering student organizations. Students completed these activities independently or in a small group of students in their major. While some Scholars cited these efforts as a beneficial part of their scholarship experience, we noticed that, overall, the Scholars' reflections lacked major-specific language. Instead, Scholars more commonly connected the FYE Seminar experience to their journey as engineering students, more broadly. While we believe the connection to engineering is positive, the lack of major-specific language urges us to identify additional ways to connect Scholars with their major departments in the FYE seminar, as building connections in major departments can support underrepresented students' belonging [12].

Opportunity Area 3: Encourage Open Communication Between Scholars and Program Coordinators. Our analysis revealed two additional important insights tangential to the Scholars' FYE Seminar experience. Because Scholars did not explicitly connect these topics to their FYE Seminar or overall Scholarship experience, we did not situate them as findings of the research question; however, the prevalence of these topics urged us to include them as a point of discussion. First, Scholars discussed concerns with and reconciling expectations of starting university (e.g., building community and career opportunities). Second, Scholars discussed academic and personal stress they experienced during the first eight weeks of the semester. It is well understood that cultivating supportive communities for underrepresented engineering students can support their sense of belonging and, consequently, their persistence [12]Thus, we plan to continue encouraging faculty advisors to be attentive to the challenges Scholars may be facing inside and outside of the university context. We also hope to implement additional opportunities for individualized support during future iterations of the FYE Seminar (e.g., 1:1 mentoring meetings with the instructor).

Limitations & Future Work

While we present these themes associated with this group of low-income, academically talented students' experience in a multidisciplinary, cohort-based FYE Seminar, these findings represent a small sample size and a single context. Thus, we present our findings as preliminary and urge readers to consider these results in context of the limitations. We plan to use these preliminary findings to supplement our larger ongoing research avenues (including engineering identity development, persistence, and impacts of participating in the Scholarship program) as we iterate on the FYE Seminar experience for future Scholars.

Conclusion

This WIP study examined students' experience in a cohort-based, multidisciplinary FYE Seminar. We presented three main themes from Scholars' end-of-course reflections: 1) Scholars expressed appreciation for the FYE Seminar topics and believed they were beneficial as they navigated their first semester in engineering; 2) Scholars valued taking the class as a cohort, as it offered a built-in community; and 3) Scholars recognized their support system extended beyond the FYE Seminar. From these findings, we plan to iterate on Scholarship programming to build upon the topics that Scholars found most beneficial, addressing areas of opportunity.

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