Board 299: Funds of Knowledge and Intersectional Experiences of Identity: Graduate Students' Views of Their Undergraduate Experiences

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Funds of knowledge and intersectional experiences of identity: Graduate students' views of their undergraduate experiences

Abstract

Our S-STEM program Humanitarian Engineering and Science Ambassadors (HESA) supports the retention and graduation of high-achieving, low-income students with demonstrated need at the Colorado School of Mines. Our program is grounded in a funds of knowledge (FOK) approach to teaching and learning, mentorship, and student professional development. Funds of knowledge are "historically-accumulated and culturally-developed bodies of knowledge and skills essential for household or individual functioning and wellbeing" (Gonzalez et al. 2005). Our previous research found that low-income engineering students who could make connections between their FOK and engineering learning had stronger self-efficacy beliefs, interest in engineering, and a sense of graduation certainty. Whereas the students in our previous study had self-developed this "connecting" skill, our program provides a formal platform for low-income students to learn and practice those connecting skills at the graduate level. This will allow us to investigate through pre- and post-surveys whether "connecting" skills can be developed through mentorship and whether developed connecting skills enhance their self-efficacy, STEM identities, and persistence beliefs.

This poster shares the results from student surveys completed at the beginning of our first academic year of the S-STEM program, reflecting on their undergraduate experiences. Specifically, we highlight the particular FOK held by our students as they entered graduate school from engineering and science undergraduate programs and we identify differences in student undergraduate experiences based on their intersectional identities. For example, we found that women were more likely than men to connect individual FOK with their graduate coursework and had strong STEM identities (including feelings of being recognized as being an engineer or scientist), even though they reported lower levels of belongingness in STEM. Students who identified as Latinx reported stronger FOK related to tinkering, strong internal and external recognition of being a scientist or engineer, and higher levels of grit; however, they simultaneously reported lower levels of belonging in their undergraduate science and engineering courses, graduation certainty, and university support. Students with the greatest financial need reported lower levels of belongingness, self-efficacy, recognition, and university support, but stronger tinkering funds of knowledge. This research underlines the demographic differences present among low-income STEM students and points to fruitful areas of mentorship and professional development that take into consideration the intersectionality of students' identities.

Introduction

The HESA program contributes to the national need for convergently trained STEM professionals by supporting the retention and graduation of high-achieving, low-income

students with demonstrated financial need at the Colorado School of Mines. The HESA program awards scholarships for diverse students to complete the university's new Humanitarian Engineering and Science master's degree, in which students integrate knowledge from engineering, geoscience, and social science to solve contemporary challenges alongside the communities they seek to serve. Our program is grounded in a funds of knowledge (FOK) approach to teaching and learning, mentorship, and student professional development. Funds of knowledge are "historically-accumulated and culturally- developed bodies of knowledge and skills essential for household or individual functioning and wellbeing" [1]. Our faculty integrate a FOK approach in their own teaching, and students who receive the scholarship are invited to participate in co-curricular activities to support their professional development.

Grounding the HESA program in the FOK framework allows us to generate new knowledge about the relationships between FOK and positive student outcomes. For example, our prior research found that low-income engineering students who could make connections between their FOK and engineering learning had stronger self-efficacy beliefs, interest in engineering, and a sense of graduation certainty [2]. Whereas the students in our previous study had self-developed this "connecting" skill, our program provides a formal platform for low-income students to learn and practice those connecting skills at the graduate level. This will allow us to investigate whether "connecting" skills can be developed and refined through mentorship and whether connecting skills enhance their self-efficacy, STEM identities, and persistence beliefs.

This paper provides a snapshot of our first cohort of students as they began their graduate program. Differences among these groups underscore the importance of taking an intersectional approach to identity, as "race, class, gender, sexuality, ethnicity, nation, ability, and age operate not as unitary, mutually exclusive entities, but as reciprocally constructing phenomena that in turn shape complex social inequalities" [3].

Student profile

The HESA program has supported 13 unique students to date. Of these, three have received the maximum possible award (up to $10,000 per award, for each of two years). Three students funded by the program have graduated and have transitioned to STEM employment in engineering consulting firms. Of the 13 students, ten identified as female (77%) and three as male (23%). Nine students identified as white (70%), one as Black or African American, two as Asian, and one as American Indian or Alaska Native, with some students identifying with more than one racial category. Six students (46%) identified as Hispanic or Latino. Five students indicated they have a disability related to a physical, mental, or emotional condition. On average, students reported working

approximately fourteen hours per week, including funded research or teaching assistant duties. The average GPA achieved by participants by the Fall 2022 semester was 3.74 on a 4.0-point scale.

Thirteen students enrolled at the beginning of the Fall 2022 semester responded to the survey. This did not include all prior scholarship recipients, as some had graduated during the previous semester. We asked all students enrolled in our graduate program, not just the scholarship recipients, to take the FOK survey and offered a $25 Amazon gift card as an incentive. We wanted to maintain student confidentiality (i.e., not revealing who was invited to take a scholarship-only survey) and be able to compare responses from students not meeting the income and need requirements of the scholarship. Of the 13 students who responded to the survey, seven had received the scholarship. Six identified as male, six as female, and one as non-binary. Five identified as Hispanic or Latino and three as speaking a primary language other than English at home. Two identified as being the first in their families to attend college and five had parents where at least one held a master's degree or higher. Two reported having received a Pell grant as an undergraduate, and one had transferred to their undergraduate institution from community college.

Methods

To assess program impact, all students enrolled in our graduate program take the survey at the beginning and end of their first year of graduate studies, and once every subsequent year if their program extends beyond one year. The survey was originally developed and validated by Dina Verdín, Jessica Smith, and Juan Lucena in a prior NSF award and is available in [2]. For their first survey, students were instructed to reflect on their *undergraduate* engineering and science experiences. The survey was administered by our external evaluator, who also removed identifying information and sorted the data for the faculty team to examine. In this paper, we analyze student responses by multiple demographic categories: gender, race and ethnicity, and scholarship status (a proxy for socioeconomic status, given that recipients must meet particular income and financial need requirements). We did not conduct a statistical analysis due to the small sample size (n=13). In future work, we plan to combine descriptive statistics with qualitative analysis of student interviews.

Results

Belongingness

The most significant difference in student reporting of undergraduate belongingness were by socioeconomic status, as students who received the scholarship were less likely to

report strong feelings of belongingness in their major, in STEM, in social relationships, and in their classes (Table 1). We draw particular attention to the stark differences in classroom belongingness.

Table 1: Average student responses to belongingness questions (7-point Likert scale where, e.g., 0 = not at all, 3 = neutral, 6 = very much so)

	Female	Male	Latinx	Not Latinx	Scholarship recipient	No scholarship
In major	3.1	2.9	3.2	2.9	2.6	3.8
In STEM	3.2	3.4	3.2	3.2	2.9	3.6
In social relationships	3.8	4.0	3.7	4.0	3.4	4.9
In classes	4.2	3.6	3.6	4.3	3.1	5.1

Overall, we were struck that none of our student groups expressed strong senses of belonging in their undergraduate majors or a strong sense of certainty that they would find a job in their field. Their responses hovered around 3.0, which represents “neutral” on our survey scale. These results are likely due to the unique nature of our graduate program. Its emphasis on integrating engineering and science with social science, combined with its focus on sustainability, social justice, and working with communities, draws students looking beyond traditional undergraduate engineering and science major programs.

STEM identity

We understand STEM identity as comprising recognition as a scientist or engineer (both internal – “I see myself as a scientist/engineering” – and external – “Others see me as a scientist/engineer”), interest in science or engineering, and competence beliefs [4]. As summarized in Table 2, we again see strong distinctions between scholarship students and their peers, as scholarship students were less likely to express a strong interest in STEM (3.7 versus 5.1) and less likely to express strong internal recognition (2.9 versus 3.5). Latinx students reported stronger internal and external recognition, but lower expressions of interest (3.9 versus 4.4) and competence beliefs (3.4 versus 4.3). We also note that women expressed stronger STEM identities than men in all dimensions.

Table 2: Average student responses to identity questions (7-point Likert scale where, e.g., 0 = not at all, 3 = neutral, 6 = very much so)

	Female	Male	Latinx	Not Latinx	Scholarship recipient	No scholarship
Internal recognition	3.5	3.2	3.6	3.2	2.9	3.5
External recognition	4.6	3.8	4.4	3.7	3.9	3.9
Interest in STEM	4.6	3.6	3.9	4.4	3.7	5.1
Competence beliefs	4.1	3.6	3.4	4.3	3.7	4.2

Certainty

We surveyed feelings of certainty in graduating with a STEM degree and getting a job in their desired discipline. As summarized in Table 3, women and Latinx students expressed greater feelings of certainty in both dimensions than their peers. Scholarship students, however, reported much lower levels of certainty of graduating (3.8 versus 5.4) and getting a job in their desired discipline (2.5 versus 4.2). We note that the responses to certainty of getting a job were low overall, perhaps pointing to a mismatch between their undergraduate training and desired careers. For example, if students' *desired* discipline was not the one in which they majored (i.e., they wanted to do humanitarian engineering as an undergraduate but majored in chemical engineering because humanitarian engineering was not available). Their responses may also suggest that a lack of certainty in getting a job motivated them to enroll in graduate school.

Table 3: Average student responses to identity questions (7-point Likert scale where, e.g., 0 = not at all, 3 = neutral, 6 = very much so)

	Female	Male	Latinx	Not Latinx	Scholarship recipient	No scholarship
Graduation	4.8	4.2	4.8	4.3	3.8	5.4
Job in discipline	3.7	2.7	3.4	3.1	2.5	4.2

Support

We also surveyed students to gain a better sense of the support they received from their undergraduate institutions. As summarized by Table 4, there were clear differences among our student groups. Scholarship recipients and Latinx students were far less likely to report instructor support, but reported relatively similar levels of academic and institutional support (which included things such as advising, registering for classes, declaring, and changing academic programs). These responses emphasize the importance of instructors providing inclusive and supportive environments.

Table 4: Average student responses to support questions (7-point Likert scale where, e.g., 0 = not at all, 3 = neutral, 6 = very much so)

	Female	Male	Latinx	Not Latinx	Scholarship recipient	No scholarship
Instructor	4.2	4.1	3.7	4.5	3.8	4.8
Academic and institutional	3.5	3.2	3.2	3.6	3.4	3.4
Financial	3.3	2.6	2.5	3.4	3.0	3.5

Funds of knowledge

Here we focus on the following funds of knowledge: tinkering (at home and work), accessing networks to help with STEM coursework (work networks and neighborhood networks), interpersonal skills (perspective taking, reading people, and mediating), and connecting their FOK with STEM education. While FOK are extensive, these eight types of knowledge emerged as significant in our prior qualitative and quantitative research with low-income and first-generation engineering students [2]. As summarized in Table 5, our students overall did not report strong knowledge in connecting their home and work experiences (a proxy for FOK) with their STEM coursework. This underscores the importance of our program providing opportunities to develop this connecting ability. In contrast, our students reported very strong interpersonal skills (scoring between 4.3 and 5.4 out of 6.0) relative to other FOK and survey responses in general. This may suggest that students with this knowledge are drawn to community-centered STEM programs such as our own or that STEM students in general have deeper interpersonal skills than

STEM educators typically realize. We note that women, Latinx, and scholarship recipients were more likely to report stronger tinkering knowledge at both home and work, underlining that tinkering can be a key FOK for STEM educators to better support minoritized and under-represented students.

Table 5: Average student responses to FOK questions (7-point Likert scale where, e.g., 0 = not at all, 3 = neutral, 6 = very much so)

	Female	Male	Latinx	Not Latinx	Scholarship recipient	No scholarship
Tinkering (home)	4.4	4.0	5.1	3.5	4.2	3.8
Tinkering (work)	3.6	3.3	4.0	2.9	3.5	2.3
Work networks	5.2	3.6	4.3	4.5	4.2	4.7
Friends	2.2	3.4	2.6	2.8	2.9	2.1
Perspective taking	5.5	4.8	5.2	5.2	5.1	5.4
Reading people	4.3	4.5	5.1	4.1	4.2	4.6
Mediating	5.0	4.6	4.6	5.1	5.0	5.0
Connecting	3.3	2.4	3.2	2.5	2.9	2.6

Doing good with STEM

Finally, we share student perceptions of their ability to make positive changes in the world through engineering or science. This set of questions included helping communities, improving quality of life, and advancing knowledge for human welfare. These scores were high overall, as summarized in Table 6, but slightly lower for scholarship students. These responses could signal that students enroll in a humanitarian graduate program because they already are convinced that STEM can be used to serve others. They may also suggest that students who have experienced economic hardship are

more clear-eyed about the limitations of using STEM to address structural problems of poverty and wellbeing.

Table 6: Average student responses to "doing good" questions (7-point Likert scale where, e.g., 0 = not at all, 3 = neutral, 6 = very much so)

	Female	Male	Latinx	Not Latinx	Scholarship recipient	No scholarship
"Doing good"	5.3	5.3	5.4	5.4	5.1	5.7

Discussion

The small number of survey respondents (*n=13*) guards against making large generalizations about our findings. Our preliminary results do raise serious concerns about the experiences of low-income science and engineering students. When asked to reflect on their undergraduate experiences, students who received the S-STEM scholarship reported lower scores on questions related to belongingness, graduation and job certainty, and institutional support. This suggests that undergraduate engineering and science education continues to be an unwelcoming environment for these students. It remains to be seen whether and how graduate programs like ours can provide students with more belongingness, support, STEM identity, and certainty in finding a job. Scholarship students reported slightly weaker beliefs that they could "do good" in the world through STEM, perhaps signaling an acknowledgement that the "wicked problem" of poverty is difficult to solve through STEM. This perspective is valuable in the growing field of humanitarian engineering. One bright spot is that scholarship students reported stronger tinkering funds of knowledge, consistent with other research [2, 5]. Integrating tinkering knowledge into teaching and mentorship could be a fruitful path for engaging and supporting students from low-income backgrounds.

While the study revealed some preliminary demographic differences, we caution against extrapolating from them given the small sample size. We found that students from the most marginalized backgrounds did not rely on networks from friends and families to help them with their STEM coursework. The Latinx students reported strong FOK related to tinkering and reading people but weaker senses of belongingness and institutional support, especially from instructors. In terms of STEM identity, they reported stronger feelings of being recognized as a scientist or engineer, but weaker feelings of interest and competence.

We found that none of our student groups expressed strong belonging in their undergraduate major or certainty that they would find a job in their field, consistent with other research on belongingness in engineering [6]. The planned follow-up surveys at the end of their first and second years in the program, coupled with an exit interview, will help us ascertain whether our program was a successful pathway for students to develop a sense of belongingness that was absent in their undergraduate experiences.

Of particular interest to our program, we found that all students reported neutral scores on "connecting experiences". This is concerning because in our prior research, we found that this connecting skill was essential for leveraging funds of knowledge into positive student outcomes, such as STEM identity, belongingness, and certainty. The survey responses affirm the need for formal training and opportunities to learn to make those connections, as we are developing and refining through the program.

Conclusion

The first survey taken by our students provided a snapshot of their perceptions of their undergraduate experiences. In particular, they point to the recalcitrant challenges faced by low-income students, who have much to offer STEM but experience lower feelings of belongingness, STEM identity, and certainty. Improving institutional support and building on students' FOK seem to be promising places to start interventions. While students in general did not report strong feelings of STEM belongingness or job certainty, their strong sense that they could "do good" with STEM may have buoyed them to continue into graduate school.

Much work remains to be done. In future work, we are particularly keen to analyze whether students' connecting knowledge improves, and in turn, if their belongingness, certainty, and identity scores improve, given our previous research suggesting the importance of this interconnection. We will also analyze if students will recognize more of their own FOK as a result of our curricular and co-curricular programming. Another fruitful avenue can be examining whether specialized training in the complex and often problematic history and politics of development and other humanitarian interventions tempers the relatively optimistic views held by students upon entering the graduate program.

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