# COMPARING TRANSFER AND NON-TRANSFER COLLEGE STUDENTS' MATHEMATICS PROFESSIONAL VISION

Sarah A. Roberts
University of California, Santa Barbara
sroberts@education.ucsb.edu

Hannali Pajela
University of California, Santa Barbara
pajela@ucsb.edu

*This research focuses on the importance of attending to transfer students in mathematics departments at research universities. This study explores the development of professional vision among mathematics transfer students, through examining community, "student" skills, and students' future career aspirations. A bundle of three transitional mathematics course for transfer students offered concurrently at a four-year research university provided the setting, and we compared transfer students enrolled in bundle, non-bundle transfer students, and non-transfer students. Overall, students identified differences in their mathematical communities, their development as mathematics students, and their resources for career pathways.*

Keywords: University mathematics; Affect, emotion, beliefs, and attitudes

The recent increase of transfer student enrollment mandated by many universities drives a need to understand how we can better prepare faculty to support this growing population of students. There is currently little research about how to support mathematics majors as they make the transition from two-year institutions to four-year institutions of higher education, even though there is general scholarship about transfer students (e.g., Melguizo et al., 2011). Understanding mathematics transfer students is important for three key reasons. First, the mathematics transfer population includes large numbers of underrepresented minorities, low-income, and first- generation college students (>50%), who start their college education at a community college—students who are often left out of the STEM pipeline (Carnevale et al., 2011). Second, we have seen a high level of attrition of transfer students from the mathematics major at our university, with just over half completing the major. It is important to understand whether retaining students in the major with the proposed intervention, a bundle of course to support transfer students helps. Third, transferring and adjusting to a four-year institution can be a complex process for students, requiring adjustments on many different levels (Laanan, 2001). In addition to a drop in GPA, transfer students often report feelings of alienation and isolation at their new institution (Laanan, 2001), with women and minorities majoring in STEM more likely to face this particular struggle (Espinosa, 2011). For these reasons, we studied how transfer mathematics students compared to non-transfer mathematics students enrolled in the aforementioned bundle of courses designed to support transfer students.

## Framing

We use Lave and Wenger's (1991) *legitimate peripheral participation* and Goodwin's (1994) *professional vision* as a conceptual framework to consider mathematics transfer students' development along a novice to expert continuum of professional vision. In particular, our research question was: How do community college transfer students differ from non-transfer students enrolled in a bundle of support courses for transfer students in a mathematics department in terms of: (a) feeling that they are part of a community; (b) learning to be a college mathematics student; and (c) preparing for a future mathematics career?

### Legitimate Peripheral Participation

We drew on Lave and Wenger's (1991) ideas of legitimate peripheral participation, as related to apprenticeships, and active participation in a community of knowledge. In particular, we were interested in how individuals engaged with one another to feel like they were part of a community.

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Students learned content not simply by receiving factual knowledge, but within and engaged as part of a community of learners, developing facility with content and community (Lave & Wenger, 1991). As students learned to be college students and prepared for their future careers, they engaged in peripheral participation, which was full participation in the community of practice (Lave & Wenger, 1991). This allowed four-year mathematics students to engage in novice-expert relationships, being apprenticed into new skills and knowledge of expertise, such as becoming four-year university college students or mathematics professionals.

### Professional Vision

Such novice-expert interactions as those previously described were organized for the development of professional vision (Goodwin, 1994). We drew on Goodwin's professional vision to understand the development of the professional vision needed for being a four-year student and a future mathematics professional, which he defined using three characteristics: 1) being perspectival; 2) being situated; and 3) being learned, because it was situated.

## Research Methodology

This research took place in the context of a research university mathematics department and involved students engaged with at least one "bundle" course. Three mathematics courses made up the bundle: (1) special topics in mathematics (a course to develop problem solving and the expectations for upper level mathematics courses)—Course A, (2) group studies in mathematics (an academic and career advising course)—Course B, and (3) transition to higher mathematics—Course C. This third course served as a comparison course across all three groups of participants in the study, as it was a prerequisite for many mathematics courses that followed. Course C was an introduction to the elements of propositional logic, techniques of mathematical proof, and fundamental mathematical structures, including sets, functions, relations, and other topics. This was the second year of this study. In the first year of our study (Roberts et al., 2019), the mathematics department selected students into the bundle and placed all students into the same section of Course C. During the second year, reported here, students voluntarily selected into the bundle, and the mathematics department placed students into two separate sections of Course C.

Three groups of students participated in this study: transfer students who voluntarily chose to take the "bundle" courses (concurrently); transfer students who took only Course C; and non-transfer students who took only Course C. This allowed for comparative groups to understand how groups of students engaged with the content in the bundle courses.

We conducted and audio-recorded semi-structured focus groups (Yin, 2016; 40-60 minutes) and individual interviews (25-35 minutes) to understand how participants developed professional vision around being a mathematics major and mathematics professional. The interview covered the following: background information, three-course bundle, being a mathematics student, ways of thinking and doing mathematics, and preparation for a career in mathematics.

We used focused coding (Maxwell, 2005), applying three themes: community, being a student, and future as a mathematician, to code the interviews and focus groups. We then looked within and across each set of coded data and research question, looking for consistencies and inconsistencies. We also drew on data from our Year 1 data from the 2018-2019 school year, which was coded similarly and used the same conceptual framework but only examined bundle transfer student (See Roberts et al., 2019, for more information), to make longitudinal comparisons, to triangulate, and to look for further consistencies and inconsistencies.

## Findings

We found that there were differences between bundle students, transfer students, and non-transfer students across the students we interviewed. We describe key differences in ways transfer and non-transfer students viewed community, office hours, and their future career opportunities.

### Role of Community

There was a difference in the way that transfer students discussed the role of community compared the non-transfer students, especially those students who were enrolled in the bundle courses. This resonated with our Year 1 findings, where we found that students were very connected with other students in the bundle course. In our Year 2 findings, students in the bundle noted the role of the community. For instance, Megan shared, "[So,] the community I feel, like, it kind of empowered me a bit" (p. 6), when she was asked about the benefits of taking the bundle courses. Similarly, Talia, also from the bundle, explained, "[T]o reiterate, the community…I feel like I can always text someone, even if they're not in the same class. I can always message and be like, 'Does anyone, you know, wanna help?' Or whatever" (p. 21). These students felt like there was a strong sense of community in the bundle, where they could go to other students for help and draw on the collective wisdom of other students—there was collective professional vision situated in their bundle (Goodwin, 1994). However, Caleb, a bundle student, also mentioned that he had community through another outlet, a club sport, and did not need to draw on the community from other transfer students and the bundle. Therefore, this was not consistent with all bundle students. Additionally, not all transfer students mentioned that they felt that they were part of this community. For example, a non-bundle transfer student, Madison, explained, "I agree that there was community, but I also felt very excluded from it, so I didn't feel like I was part of that community. I did see that there was a community" (p. 17). For this student, there was an issue with being excluded from the community.

The non-transfer students also mentioned community, but this community did not appear to emanate from the courses, like it did with the bundle courses. Instead this community was from friends made externally from the courses or friends made within the courses but not with the help of the courses. In the bundle courses, the community appeared to be built from within the course—with the instructors helped to develop that community, as described below. Non-transfer student, Esther, described a group of friends she with whom had taken earlier mathematics classes and with whom she had studied previously. However, those students were not in Course C, so there was not a feeling of community, because she did not have interactions with any of those same students any longer. Bundle courses, in contrast, forced students to work together, which likely allowed most students to develop community.

### Being a Student

Approaching faculty for support was the key component of being a student we explored in this study. Transfer students were the only students who mentioned visiting professors' office hours. Bundle students were the only ones who discussed their visits in detail. Others noted that these were resources for help in their mathematics course, but none of the other students we interviewed, besides the bundle students, discussed, in detail, attending office hours. Non-transfer students even went so far as to mention not going to office hours or not even interacting with faculty. This is notable, because office hours can be a useful tool for students to learn how to ask for help, especially for transfer students, who are more likely to change majors and leave universities. As we noted in our Year 1 paper, Course B required students to attend office hours. Talia, from the bundle, shared, "I think the first time I went to office hours last quarter, I was so terrified, but it kind of made me realize…how approachable people are" (p. 7). Even though going to visit professors was difficult at first, students found this valuable. As Talia explained, "And, so, now, I have no problem going to office hours if I need to" (p. 7). This was consistent with our Year 1 findings, where those students

who were "forced" to go to office hours in the bundle were thankful for developing familiarity with the process and with getting to know faculty and TAs.

### Future Career Opportunities

The Course B instructor, who was also a mathematics department advisor, was highlighted as key in sending out information to all student participants about future mathematics career opportunities. There was a key difference between transfer students and non-transfer students in their considerations about their future careers and what they had accomplished toward those careers by the time we had met for our interviews. Second year non-transfer students had already applied for internships, were participating in research on campus, had attended mathematics conferences off-campus, had secured funding, and had other such opportunities. Additionally, they seemed to feel like they had plenty of time to figure out their future plans. In contrast, transfer students were just beginning to learn about these opportunities, but they also felt the pressure to figure out their future more quickly as third-year students. Bundle students had, as part of their Course B coursework, weekly panels on graduate school, jobs in industry, and other opportunities, whereas, non-bundle transfer students were dependent upon weekly department emails, clubs, and reaching out for individual emails. Even so, bundle students asked for more, such as how to write in LaTeX, what K-12 careers might entail, and how to write cover letters for research internships (which those non-transfer students had already secured). We noted in our Year 1 findings that bundle students were similarly reaching out for more internship opportunities. The fact that non-transfer students had already applied for these placements supports this finding that more needs to be done to work with transfer students to level the playing field for future opportunities. Finally, because not all students had access to the bundle, we see that transfer students are missing out on Course B and this future career advising.

## Discussion and Conclusions

There were three key differences between transfer students and non-transfer students in the bundle and non-bundle courses. First, the bundle course provided a community for transfer students to develop a mathematics community. Second, those transfer students in the bundle were more likely to attend office hours, which meant they were more likely to reach out for support in their coursework. Third, transfer students were more likely to be behind non-transfer students in their future mathematics plans; however, bundle students were more likely to have had exposure to more future possibilities. This bundle of courses offered transfer students with connections that helped them adjust to life as a mathematics student, as well as professional vision for their future mathematics careers.

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