STUDENT ENGAGEMENT AND GENDER IDENTITY IN UNDERGRADUATE INTRODUCTION TO PROOF

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I examined how gender identity shapes engagement experiences in undergraduate mathematics classrooms through a mixed methods study. Data collected from 12 classroom observations, stimulated recall interviews, and student-reported data on engagement were used to answer the question, "How does gender identity shape students' engagement experiences in undergraduate mathematics classroom?" The findings indicate that students' in-the-moment engagement is characterized by classroom environments that foster collective mathematical discussions and group work.

Keywords: Equity and Diversity, Gender and Sexuality, Inclusive education

Introductions

Student engagement is a strong predictor of achievement and behavior in school irrespective of students' socioeconomic situation (Klem & Connell, 2004), making it a powerful factor in education. Additionally, in the social sciences, women earned a majority of bachelor's degrees (55%) and master's degrees (57%) from 1993 to 2015 (NSF, NCSES 2019). On the other hand, of all STEM degrees awarded in 2016, women earned about half of bachelor's degrees, 44% of master's degrees, and 41% of doctorate degrees, about the same as in 2006 (NSF, NCSES 2019). Based on these data, it is possible that gender identity plays a role in the field(s) one chooses to pursue. At the classroom level, gender identity and participation in mathematics are related in that students' gender identity can influence their decision to continue studying mathematics (Boaler, 2002a; Boaler & Greeno, 2000). To better understand how students learn mathematics, there is potential in better studying connections between students' engagement and gender identity in mathematics learning environments.

Student Engagement in Mathematics Education

Engagement manifests itself in activity, including observable behavior and mental activity involving attention, effort, cognition, and emotion (Middleton et al., 2017). Engagement is thus a complex meta-construct consisting of cognitive, affective, and behavioral dimensions (Fredricks et al., 2004). For students to learn mathematics, they must be engaged. For instance, Bodovski & Farkas, (2007) found that student engagement is a significant contributor to students' mathematical growth in early elementary school. At the middle and high school level, researchers found that higher cognitive, behavioral, and emotional engagement predicted students' academic achievement (Wang et al., 2016). However, the literature lacks studies of student engagement in mathematics classrooms at the undergraduate level (cf. Williams, 2017).

Gender Identity

In the early 1900s, researchers used sex hormones to explain masculinity and femininity (Bell, 1916; Lillie, 1939), replacing religious justifications with scientific ones for restricting women's roles (Risman et al., 2017). In the latter part of the century, social scientists began to push back against using scientific justification to explain gender and viewed masculinity and femininity through the lens of roles that were assigned to men and women by society. In the 21st century, sociologists including gender research expert Risman (2017), argue that gender identity is a socially constructed

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component of one's identity built as a result of internal and societal interactions. For the purpose of this study, gender identity is comprised of personal identity made up of psychological characteristics and a social identity encompassing salient group classifications which differs across cultures and can change.

Gender Identity and Student Engagement

At the college level, most studies regarding student engagement and gender identity strive to either explain the growing disparity between degrees awarded to men and women or differences in undergraduate enrollment at baccalaureate-granting institutions between women and men. Thus, at the college level, most studies on student engagement and gender focus solely on how many males and females either graduate or drop out from degree programs. However, such conceptualization of student engagement is different from student engagement as defined in this study nor are the labels "male" and "female" sufficiently capturing what is meant by gender identity (Risman, 2017). Engagement goes beyond enrolling or graduating from a degree program. Additionally, of the literature reviewed, most work on gender differences in student engagement tend to generalize across content areas that is not math focused. This study is unique in its focus on student engagement (as defined by Fredricks et al., 2004) and gender identity(as a social structure) in the mathematics classroom at the college level.

Theory

Flow theory offers an effective lens for interpreting student engagement in that both flow and engagement describe states of total involvement in a task and involve internal motivation (Steel & Fullagar, 2009). From flow theory, student engagement is made up of interest, enjoyment (emotional & behavioral), and concentration (cognitive) (Shernoff, et al., 2003). Thus, the extent of students' engagement is based on these factors.

To understand gender identity as a social structure (Risman, 2017), this study adopts the stance that gender identity is a person's own sense of self by virtue of being part of a society. Gender is socially constructed in that societies have a set of gender categories that usually serve as a basis for the formation of gender identity. This perspective emanates from Tajfel and Turner's social identity theory (1986), which assumes individuals define their own identities as a result of societal norms. Gender as a social structure has psychological and social characteristics.

Methods

I addressed the research questions: (a) What characterizes student's engagement in an undergraduate introduction to proof course? (b) What are the different ways in which gender identity shape students' engagement experiences in this setting? To address these questions, I observed an introduction to proof class for five consecutive weeks. The participants in this study are students enrolled in the course. Fifteen undergraduate students: three of those who identify as women and twelve of those who identify as men volunteered for the study. The sessions I observed focused on the teaching of combinatorics. All students are assigned pseudonyms.

Sessions were video recorded. A demographic survey was administered to students, which asked questions such as "Please describe your gender identity?", "Do you believe that how you identify (gender) affects your experiences during classroom interactions? If so, please explain?". In-the-moment student engagement was captured through the experience sampling method (ESM) (e.g., Shernoff, et al., 2003). ESM data took student-reports of interest, enjoyment, concentrate (i.e. engagement), perceived skill and challenge.

Lastly, ESM responses and video data were used to develop protocols for stimulated recall interviews. Using thematic coding, data from this study were analyzed to understand the nature of student engagement and how gender identity shapes student engagement experiences.

Results and Discussions

I present themes associated with students' engagement that emerged from the stimulated recall interviews as students described both their personal high/low engagement moments. Finally, I focus on how gender identity influences these students' engagement.

Student Engagement

A theme associated with students' engagement from the stimulated recall interviews was the social norms of the classroom. The instructor presented the content with a very nontraditional approach. For instance, almost every single day, students presented their mathematical ideas on the board. Furthermore, students' ideas were valued in the classroom and were encouraged to initiate mathematical discussions. Students asserted that the nature of the classroom influenced their engagement. For instance, Bridget, who identifies as a woman, asserted that "seeing how they (students) thought to solve mathematical problems in different ways influenced my concentration positively." Being able to see the multiple ways to solve mathematical problems influenced her engagement. Nat, who identifies as a man, explained that "the fact that I was given an opportunity to describe the mathematics to my peers increased my interest." On the other hand, Ian, who identifies as a man, explained that since the nature of the class was not lecture based, his engagement was on the low side. As Bridget, explains seeing multiple ways of doing math influenced her concentration, her cognitive engagement is increasing. Nat's interest about verbalizing his mathematical reasoning positively influenced his emotional engagement. However, Ian's emotional engagement is on the low side as he does not enjoy the mathematical content being covered. Although Ian's emotional engagement was low, two of his peers explained how this student-centered environment fosters their emotional and cognitive engagement.

Group work was instrumental, in that all participants who volunteered for the stimulated recall interviews asserted that working with peers influenced their engagement positively. Bridget asserted that "I don't know, just working with my peers increased my interest and concentration." Nat explained that working with his classmates served as a competition for him to be cognitively engaged. During the stimulated recall interview, he explained,

> with the partners I have its kind of a motivation thing kind of use this as a competition type deal like to try match my partners' skills. if I was working individually, I don't think my concentration would be high for this mathematics class.

Ian explained that being a "privileged" male, he speaks less in group work when working with those women to enable them to express their ideas. He explained that working with his classmates positively influenced his cognitive and emotional engagement. He also explains that, "when working with classmates even though no one is an expert, they can still point that why did he (emphasis added) did that in this proof, so I think working with my classmates helps to concentrate."

Thus, from this study, there is a positive association between group work and their engagement. It is interesting to note how Ian did not wish to be the only speaker during a mixed gender group interaction to allow those he perceives as women to talk. Furthermore, it is more fascinating how he used a "male pronoun" for a hypothetical student, when describing his experiences working with classmates. This points out some connections between one's gender identity and engagement experiences.

The Role of Gender Identity in Student engagement

ESM data show that overall those identifying as women reported higher levels of engagement than those identifying as men. Aaron, who identifies as a man, reported being less engaged than his peers; whereas, Janet, who identifies as a cis woman, reported being most engaged. Aaron did not volunteer for the stimulated recall interview hence much cannot be inferred on the low engagement reported by him. Observations suggest his behavioral engagement aligned with his self-reported levels of engagement from the ESM survey. During the analysis of the initial demographic survey, Janet explained,

> I have a distinct memory of trying to take Calc 1 in summer and being the only woman in the room, and it being my first class not taught by a woman and feeling anxious about it. I don't think it was a very fair feeling, but I did feel it.

She did not volunteer for the stimulated recall interview, which might be explained by prior experience in her calculus 1 summer class and that possibly because I identify as a black man.

Five participants asserted that their gender identity influenced engagement. Ian, who identifies as a man, explains,

> If I am in a group interaction made up of different genders, the same actions done by a man and a woman will be definitely be viewed differently so I definitely think gender has an impact on how students engage with mathematics.

Edwin, who identifies as a man, explained how he thinks gender influences engagement in the mathematics classroom by indicating that being male has not "negatively affected" him as a learner of mathematics. Some students identifying as men said they did not think one's gender identity influenced experiences in mathematics courses; however, they would also say something to suggest otherwise. Although Nat explicitly acknowledged that gender did not influence one's engagement, his explanation indicated that gender actually influenced how he approaches group work, "when working with women I allowed them to express their mathematical ideas to get them involved in the discussion." Thus, we do see that those perceived to be women are on the disadvantage. For instance, Mike thinks men contribute more in the mathematics classroom. On the other hand, Bridget asserted one's gender did not influence their engagement while studying mathematics. In conclusion, some students indicated that their gender did influence how they engaged in the mathematics classroom.

Conclusion

This study investigated the nature of students' engagement in mathematics and how their gender identity shapes engagement experiences in the mathematics classroom at the college level. Some students indicated that their gender identity did influence how they engaged in the mathematics classroom, with those who identified as women more likely to be negatively affected. However, this perception was not borne out by the observation and ESM data. In the observation and ESM data, those who identified as women reported higher levels of engagement than those who identified as men. There is room for further exploration and research on gender as a social structure rather than biological, and much remains to be learned about the different ways in which gender identity shapes student engagement in mathematics.

End Notes

Students' gender identities were reported exactly as identified in the demographic survey.

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