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Departmental Culture Shapes Female Trinity Students' Understanding of Their Experience in STEM Majors

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Abstract

The under-representation of women in STEM fields is still an existing problem. It is important to study the factors that influence female students' experiences in STEM fields to help understand the potential structural obstacles that might exist and lead to the under-representation of women in these subjects. This study conducted semi-structured interviews with seven female students who majored in male-denominated, non-male-dominated, and/or non-STEM fields at Trinity College to investigate their experiences with their professors, other students, and the department. Institutional factors (role model of female teachers and course design) and personal factors (support from the professors/advisors and connection with other students) were found to contribute to female Trinity students' experiences at STEM majors. Because of the disconnected departmental culture, however, female students perceived their experiences as personal, which leads to the conflict between their perception of gender impact on their experiences and their expression of actual experiences in the major. The findings of this research suggest the significance of increasing department-initiated connections between the department and female students to improve their experiences in STEM majors.

Keywords: gender, women in STEM, higher education, departmental culture

Introduction

From the twentieth to twenty-first century, interest in science, technology, engineering, and math (STEM) education has exploded in the United States, leading to an increasing amount of literature investigating people studying or working in these subjects. Specifically, the focus on women's underrepresentation in STEM education, from pre-school to higher education, has led to a proliferation of studies that examine the ways to motivate and retain female students in the major and in their STEM careers. Among tons of literature investigating women's experiences in STEM major, gender inequality is certainly a term that has been frequently brought up by scholars. Gender inequality refers to the social process in which men and women are treated differently because of their gender. It can be extremely invisible in academic fields. For women in male-dominated professions such as STEM, pointing out gender differences during interactions may evoke negative responses towards femininity from both men and women – people will think it is unnecessary and unprofessional (Ridgeway, 2011). After interviewing one hundred and two women academics from thirteen universities, Britton (2017) found that female faculty would deny gender's influence or view gender inequality as aberrant when describing a seemingly neutral working environment. Nonetheless, they would notice this inequality when trying to recall specific scenarios in daily interactions, organizational structures, and workplace culture. In short, they only realized gender's impact when it becomes salient – "now you see it, now you don't" (Ridgeway, 2011). This elusiveness of gender influences makes females lose sight of its significance in their experiences in the academy. Therefore, if gender inequality is embedded in the learning experiences of female college students, it certainly cannot be directly observed through a balanced gender composition of the major.

Comprehending gender in an educational context such as Trinity will facilitate scholars' understandings of gender inequality at schools, consequently helping promote gender equality on campuses. Given the previous literature about gender inequality and female students' experiences in STEM fields, this research conducted interviews about several personal or institutional factors to answer the important question: What is female Trinity students' experiences in male-dominated STEM fields, and how do they compare to experiences in other non-male-dominated STEM majors or non-STEM majors?

Literature Review

The underrepresentation of women in STEM fields

The under-representation of women in STEM fields is still an existing problem. In the United States, women account for less than ¼ of jobs in STEM fields (Ong, Smith, & Ko, 2018). The percentage of women of color is even lower. Hispanic, Asian, and African American women received less than 5% of STEM bachelor's degrees (Kricorian et al., 2020). In 2013, the National Centre for Education Statistics (NCES) compared its data from 1997 and reported that the gender gap remains in STEM majors at universities. After nearly two decades, women are still under-represented in STEM fields from their education to career (NCES, 1997, 2013; Christie et al., 2017). They are also getting lower pay and are more likely to leave the field at some point in their education or career (Michelmore & Sassler, 2016; Ellis et al., 2016). Moreover, a recent report from the U.S. Department of Commerce states that women with a STEM degree are more likely to work in an education or healthcare industry, whereas their male counterparts are more likely to pursue STEM careers (Beede et al., 2011), leading to more imbalanced gender composition in STEM fields. Thus, gender imbalance in STEM fields continues to exert a

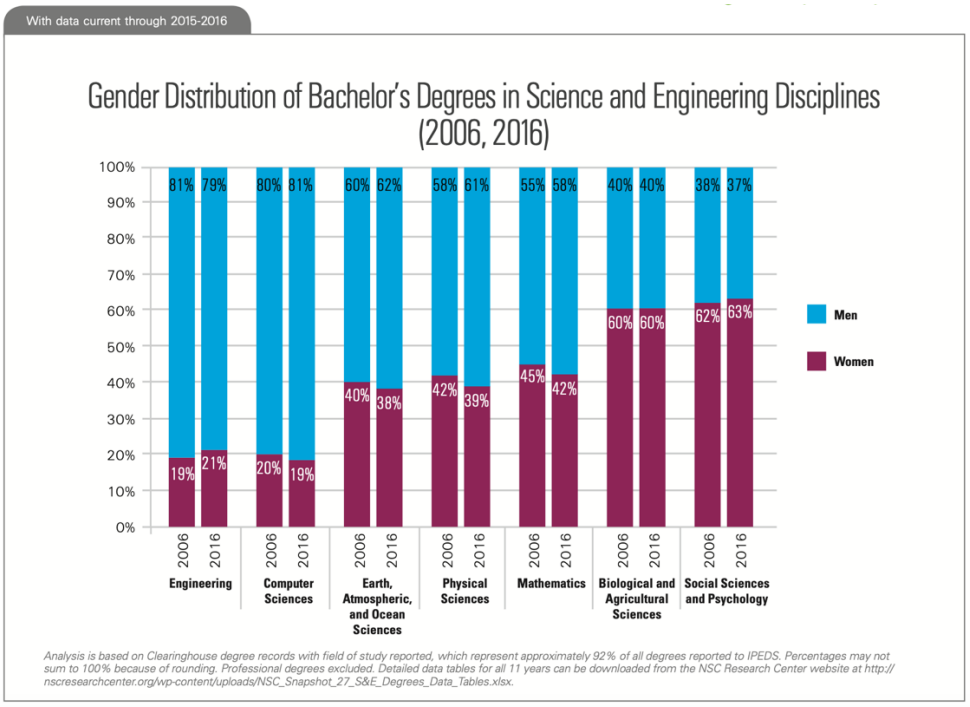
negative impact on women. Improving this gender imbalance could help increase the diversity of STEM fields and bring more creativity into the design and application of STEM research. It is important to study the factors that influence female students' experiences in STEM fields to help understand the potential structural obstacles that might exist and lead to the under-representation of women in these subjects.

Female students' experience in STEM fields

The influence of gender on women's academic experiences has been broadly demonstrated by research across fields. In 1982, Hall and Sandler coined the term "chilly climate" to describe the inequality that women faculty face in school environments, including unfriendly climates within departments or classrooms, inhospitable attitudes holding by students and colleagues, and biased school policies that derogate women's responsibilities on campus (Britton, 2017). According to Griffith (2010), "female students are less likely to enter college intending to major in a STEM field major, but if they do so, are more likely to switch away from a STEM major." Past research has identified many institutional and personal factors that influence female students' experiences in STEM fields. Institutional factors refer to the factors that are present in the structure and are accessible to all students, despite their gender. For example, school resources allocation and gender of the faculty member/role models are defined as institutional factors. By contrast, personal factors are unique to individuals and can impact different students differently, such as SES, academic performance, and professor-student relationship. Institutional and personal factors influence female students' motivations, retention, and sense of belongingness in STEM (Blackburn, 2017; Bottia et. al., 2015; Chen, 2013; Griffith, 2010; Wang, 2013), consequently shaping their experiences in STEM fields.

It is important to note, though, female students' experience in different STEM majors may vary and do not always align with the statistics. When discussing STEM majors, we always assume "hardcore" STEM fields that are male dominated, such as engineering and computer science. Nevertheless, different STEM fields have different gender compositions (Table 1) that lead to female students' distinct experiences in specific majors. Moreover, for foundational subjects like mathematics and statistics, students from other STEM majors may attend the course without declaring a major. Thus, although quantitative data suggest some STEM majors such as math and statistics as female-dominated, female students' learning experience in the classroom may not necessarily align with the percentage. Therefore, qualitative research that investigates the dynamic between students, professors, and the department needs to be conducted to reveal female students' experience in STEM fields.

Table 1. Major field of study with a focus on STEM fields by Gender



(Source: Science & Engineering Degree Attainment—2017. *National Student Clearinghouse Research Center*)

Methods and Data

As aforementioned, it is important to qualify female students' experiences in STEM majors. Thus, data of this study is collected through semi-structured interviews. The data collection process received the IRB approval at the institution. Invitation emails were sent to selected course instructors to advertise the research. Female students who have declared a STEM and/or non-STEM major and are interested in this study were eligible to participate. Students were also encouraged to refer their friends to participate. Before the interview, participants need to sign their informed consent.

The interview consists of three open-ended questions:

1) Tell me a story about your interaction between you and your professor/department. It can be something about your learning experience, or something that influences your understanding of the major, or something that may impact your major choice or career choice.
2) What is your experience with your classmates in and out of the classroom?
3) At the end of the day, why do you choose your major?
    a. Do you have any plans to change?
    b. Do you have any regret for your choice or that change?

During the interview, the interviewees were encouraged to elaborate on these three questions and some of the questions may not be asked based on specific interview content. The interviews were conducted remotely through Zoom and recorded. Pseudonyms were used to protect the participants' identities. While interviewing the first participant, I randomly asked her "Do you think gender impacted your learning experience in the major?" as a wrap-up question.

To my surprise, she answered no to this question although she expressed how gender influenced her experiences in STEM fields throughout the interview. Thus for afterward participants, I explicitly asked whether they think gender influences their experiences in the major at an appropriate time to investigate this unexpected conflict that emerges during interviews.

In total seven female students, two sophomores and five seniors, participated in this research. Their major information is presented in Table 2. Students who double majored in two fields were interviewed about their experiences in two majors separately. Therefore, although there was only one student who only declared a non-STEM major, there were additional two students who double majored in a non-STEM field. Furthermore, according to data from National Center for Education Statistics, CS and chemistry is a male-dominated STEM field, whereas biology, neuroscience, and math are relatively female-dominated. However, as aforementioned, the women-to-men ratio in STEM classrooms may not align with the statistics. Therefore, I directly asked the interviewees whether they think their major is male or female-dominated, and the results are also presented in Table 2.

Table 2. Participants' declared majors

Majors	# of Participants declared this Major (*N* = 7)	Male or female dominated according to the participants
Computer Science (CS)	2	Male-dominated STEM
Chemistry and Math	1	Half-half and Half-half STEM
Neuroscience and Hispanic studies	1	Female-dominated STEM and Female-dominated non-STEM
Sociology	1	Female-dominated non-STEM
Biology	1	Female-dominated STEM
Biology and Hispanic studies	1	Female-dominated STEM and Female-dominated non-STEM

Results

Both institutional and personal factors were identified during the interview and influenced female Trinity students' experiences at male-dominated and non-male-dominated STEM majors at Trinity. However, the disconnected departmental culture of STEM majors deemphasizes female students' perception of the impact of institutional factors on their experiences. As a result, they understand their experiences as only personal instead of under the influence of social forces (e.g., the department), which obscures their perception of the influence of gender on their STEM experiences.

Finding 1: Institutional Factors Influence Female Students' Motivation and Persistence in STEM Majors

Institutional factors such as topics/course design and the number of female professors in the department impact female students' motivation and persistence in STEM majors. Female Trinity students in both male-dominated and non-male-dominated STEM majors suggested that they think course design, which includes the topic and teaching styles, influences their motivations and retainment in the major. Ella from the biology department stated that "I like lectures unless they are not boring, so the lecturing style of biology course works for me." Zoey, whose intended major changed from chemistry to biology and finally declared a biology major stated that "I took intro to chemistry as a freshman. The topic is so interesting, but the lab is very strict with no flexibility, so I stayed away from chemistry… [But] I love how my intro to bio professor set up his labs, the topic was also interesting." Therefore, interesting topics and attractive teaching styles of the courses increase female students' likelihood of staying in the STEM fields, whereas boring topics or unattractive teaching styles could push them away.

Chloe, who is currently a sophomore majoring in CS, stated that "The CS courses are more theory-based rather than practical, but I felt I'm not good at theories, so I am thinking about changing majors in graduate school."

Besides topics and teaching styles, some female students from non-male-dominated STEM majors reported seeing female professors in the department as strong support for their persistence in STEM majors. For example, Emma, a senior who majors in neuroscience stated that "A lot of professors in the neuroscience department are women. That's really helpful and inspiring." Therefore, female Trinity students from STEM departments with more female professors may view the professors as their role models, which increases their confidence of success in the field, thus making them more likely to stay in the major.

Finding 2. Personal Factors Impacts Female Students' Career Path and Social Connection in STEM Majors

Personal factors, including support from the professors/advisors and connection with their peers, impacts female Trinity students' career path and social connection in STEM majors. Female students from both male-dominated and non-male-dominated STEM majors reported tighter connections with their professors/advisors rather than the department. Ella from the biology major stated that "My advisor is nice and supportive but a little bit nerdy. I meet him frequently because of my research… [whereas] the department only contacted me during major declaration and ask whether I plan to go to med schools." Moreover, male professors and female professors could provide different types of support to the students. Ava, a senior who majors in CS stated that "Professors here were very nice in career support. Female professors helped me figure out what I want to do while male professors helped me revise research

projects." This distinction suggests the impact of professors' gender on the interaction between professors and female students in STEM fields.

Similarly, the gender of their peers also influences female students' connection and socialization to other students in the department, consequently shaping their sense of belongingness to the major. Ava (CS): "I have better in-class relationships with the girls because there are fewer female students in the department. But I do not have gender preference and generally only attend activities of acquaintances out of the classroom." Chloe, a newly declared CS student also stated that "I'm afraid to talk to people, but I want to connect to female students socially. I normally ask male students about academic questions." Therefore, female students from male-dominated STEM majors expressed the need to socialize with other female students in the department, while they want to connect with male students academically. This requirement of connection with their peers, especially other female students, helped female students in STEM fields build a sense of belongingness to the department, thus increasing their likelihood to stay in the major. This finding aligns with Tinto's Institutional Departure Model, which proposes that students' persistence in the major is determined by their ability to interact socially and academically in the institution (Aljohani, 2016; Tinto, 1993).

Finding 3. Disconnected Departmental Culture Leads to Conflicting Understanding of Structural Gender Impact among Female Students in STEM Majors

Despite the significant impact of gender on their learning experience in STEM fields, female students in male-dominated or non-male-dominated STEM majors explicitly express that they think gender does not matter to their experience. For example, Chloe (CS) stated that "I don't pay particular attention to gender in the department", even though she also expressed

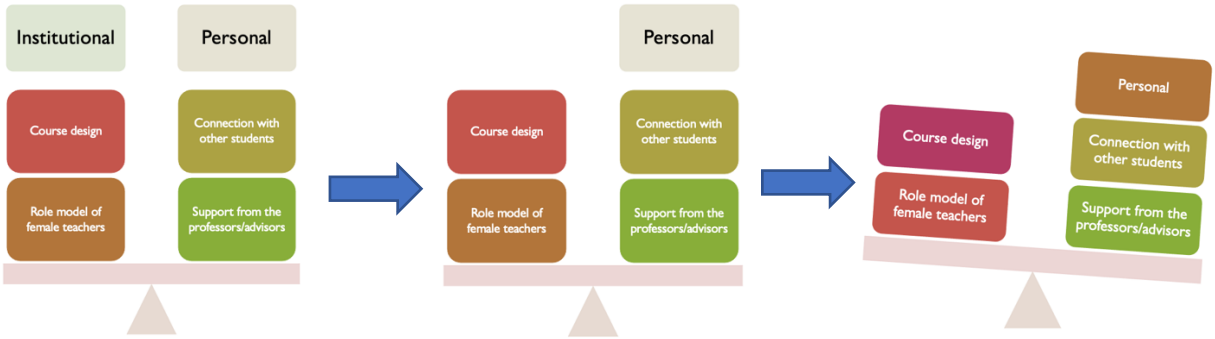
how she thinks "More female students [I would be] more relaxed during the classes and the female teachers are more friendly." Thus, there is a conflict between female students' perception of gender impact on their experiences and their actual reported experiences in the major. Theories about women's experiences in STEM fields suggested that women in STEM fields may sometimes deny the existence of gender inequality as a defense mechanism to avoid being an "activist" who brought up the problem. However, these theories also suggest that these women were able to recall specific instances about how they had been treated differently because of their gender (Britton, 2017), and this phenomenon did not appear among my interviewees. Therefore, instead of being a defense mechanism, this discrepancy between the participants' perception and expression might be a "side-effect" of the disconnected departmental culture in both male-dominated and female-dominated STEM departments. Departmental culture as an institutional factor plays a significant role in shaping female students' experiences in the major. Female Trinity students in STEM fields generally reported a feeling of disconnection to the department:

> Ava (CS): "Our department does not have strict requirements on us thus letting us have relatively high autonomy." "The activities in the regular seminar are not very attractive so we normally would not attend."
>
> Ella (biology): "There are a lot of students in the department, so we have high autonomy." "Students need to initiate connections to the department and other professors." "I sometimes receive departmental emails about presentations, but I seldom went to them."

Because of the disconnected departmental culture, Female Trinity students from male-dominated or non-male-dominated STEM majors view their choices and experiences as personal. They perceived themselves as the initiative of the connection to professors, other

students, and the department, and because they do not think they have gender biases, female Trinity students at STEM fields could not perceive the structural gender impact on their experiences in the major. In other words, the disconnection between the institution (i.e., department) and female students impairs female students' perception of structural gender effect on their choices. As a result, they could only interpret gender impact from their perspectives of thinking "whether I have gender preferences," whereas ignored the influence of gender in their social and academic environments that shape their experiences (Figure 1).

Figure 1. Disconnected departmental culture deemphasizes female students' perception of the impact of institutional factors on their experiences



Thus, female students' conflicts in understanding gender's impact on their experiences can be explained by the disconnected departmental culture that makes gender seem less salient when female students were trying to recall their experiences in the major. This culture deemphasized the structural impact of gender, leading to female students' unawareness of the structural impact of gender on their experiences at STEM majors. This unawareness may prevent them from perceiving any gender inequality in the departments, consequently reducing the legitimacy of promoting gender equality in STEM fields.

Discussion

Implications

Institutional and personal factors both contribute to female students' experiences at STEM majors. Because of the disconnected departmental culture, however, female students perceived their experiences as personal, which leads to the conflict between their perception of gender impact on their experiences and their expressed experiences in the major. The findings of this research suggest the significance of increasing department-initiated connections between the department and female students to improve their experiences in STEM majors. For example, STEM departments can implement administrative policies such as scheduling regular departmental meetings to foster the connection between students and to form a sense of community (Bancroft, 2014). The chemistry department as an exception to other STEM majors is reported to have a more connected departmental culture. According to Sophia, a senior double majored in chemistry and math, "Chemistry department has research seminars every Friday and is very supportive in helping people in career plans because most students go to graduate schools every year." Therefore, forming a more connected departmental culture is possible among STEM majors, and it is important for other STEM fields at Trinity to take action and foster this type of culture that supports female students' experiences in these subjects.

Besides forming connected departmental culture, STEM majors can offer more flexible assistant to students with different career paths. Ava (CS) mentioned how she thinks the department seminars are theoretically based whereas she wants to focus on the practical aspect of computer science, so she seldom went to the seminars. Ella from the biology department also stated about the effort she needed to reach out to professors to find

undergraduate research opportunities. "If the department can help me build connections, that will be much easier." Therefore, STEM majors at Trinity also need to be flexible in supporting students' learning experiences in the department, connecting to the students and providing assistant according to their individual needs.

Limitations and Future Steps

Limitations of the current research need to be recognized. Still, this study consists of a relatively small sample size, which decreases the generalizability of the findings. Also, under the restriction of COVID-19, only interviews were conducted to collect the data. The mono-method approach may not be able to comprehensively reflect female Trinity students' experiences in STEM majors. Future research can include multiple data collection methods, such as quantitative research and participant observation, to assess and understand female Trinity students' experiences from diverse perspectives. Moreover, female students from STEM majors mentioned a lot in their interviews about how they developed an interest in STEM before entering college. Thus, high school is also an important research environment when trying to understand female students' motivation in STEM fields. By studying female students' experiences from different stages of education, scholars can develop comprehensive theories about women's underrepresentation in STEM fields, consequently promoting better interventions to improve gender inequality in such subjects.

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