

Experiences of Women in Statistics

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Abstract

Boys are better at math and girls are better at language arts. This is a myth that has permeated modern society for far too long. Women and non-binary individuals are systematically underrepresented in science, technology, engineering, and math (STEM) fields, including statistics which seemingly perpetuates this fabled lore. Moreover, little research has been conducted regarding women in statistics, specifically through the lens of their encounters, viewpoint, and understanding. Through this ethnographic study the author worked to discover the experiences and perceptions of women pursuing a graduate degree in statistics. Through twenty hours of participant observations, three in-depth interviews, and material data valuable insight was gained through the uncovering of three emergent themes. Participants shared a love of mathematics and statistics, recognized disparate respective gender experiences, and possessed a deep-seated desire to give back to community and country. The results of this research valuably aid in the development and implementation of bolstered services to support women working toward a tertiary degree in statistics, dispelling the long-standing fallacy that women are ill equipped to strive and thrive in the field of statistics.

KEYWORDS: Gender bias, Mathematics, Mini-ethnography, Non-binary, Qualitative research, Statistics, STEM, Women

INTRODUCTION

“Sugar and spice and everything nice, that’s what little girls are made of. Snips and snails and puppy dog tails, that’s what little boys are made of.” This paraphrased poem by Robert Southey exemplifies the binary perceptions of gender roles that seem as old as time. Society has traditionally gendered social roles as well as professional occupations. Men have been thought to be better suited for scientific, mathematical, and engineering roles among others while caretaking, teaching, and nursing are often thought to be better suited for women (Ji et al., 2004). With that in mind, it is not hard to see why women have been and currently are underrepresented in the field of statistics. While gains have been made, women still only account for 27% of STEM workers in the United States as of 2019 (Martinez & Christnacht, 2021). Strikingly, few of these women STEM workers are women of color (National Science Board, 2018). Lack of support, representation, and opportunities has also led women in STEM fields to terminate their employment and leave the field altogether (Jefferson, 2019). Exploring the perceptions and experiences of women endeavoring to enter STEM fields, specifically statistics vocations, could illuminate on the drivers and inhibitions that propel women toward or hinder them from forward mobility in pursuing the educational credentials necessary to procure employment in statistical domains.

2. LITERATURE REVIEW

Existing literature specifically regarding women in statistics is sparse. While research material on women in STEM is present (e.g., Beede et al., 2011; McGee & Bentley, 2017; Xu, 2015) it is not exclusive to statistics. Some information pertaining to female figures in a historical context of statistics subsists (e.g., Britannica, 2022; Shetterly, 2017; Stinnett, 1990; Wargon, 2005) but few studies specifically focus on women in this field (Golbeck et al., 2021; Brooks, 1987; Buck, 1985). Notably, no research studies could be found explicitly regarding

marginalized women in statistics. Existing literature was discovered concerning the perceptions and experiences of women pursuing higher level STEM degrees (e.g., Alexander & Hermann, 2016; Charleston et al., 2014; Falkner et al., 2015); however, none specific to a graduate degree in statistics. With this in mind, the aim of this literature review will be to concentrate on the history of women in statistics and the few studies that have researched women in the field. Additionally, research concerning women's experiences in higher education STEM degrees will be addressed.

2.1 History of Women in Statistics

White women were predominate in existing research of female historical figures who forged a path in the field of statistics as opposed to their minority counterparts. As literature regarding minority women in statistics is more challenging to find, the minority women included in this section are more closely connected with data analysis which is related to the field of statistics. The first three women discussed in this section are identified as white while the remaining women represented here are acknowledged as Black Americans. Notably, the historical information unearthed in the literature principally highlights the careers and achievements of these trailblazers and not their personal accounts and experiences.

Florence Nightingale, thought to be the mother of statistics, asserts that statistics is, "the most important science in the whole world, for upon it depends the practical application of every other (science) and of every art; the one science essential to all political and social administration, all education, for it only gives exact results of our experience (Cohen, 1984)... to understand God's thoughts, we must study statistics for these are the measure of his purpose" (Walker, 1929, as cited in Stinnett, 1990, pp. 79-80). Nightingale was born in 1820 to aristocratic English parents in Florence, Italy (Stinnett, 1990). Her excellent mathematical education served

her well as a nurse and nursing administrator of the English General Hospitals in Turkey during the Crimean War (Stinnett, 1990). Nightingale was a pioneer in data visualization, advocated for recording information regarding health and home in the 1861 census, helped develop and implement standardized data-collection forms for hospitals, and was a Fellow in the Royal Statistical Society (Stinnett, 1990).

Enid Charles daughter of the Reverend James Charles was born in 1894 in North Wales (Wargon, 2005). Charles received her Bachelor of Arts, Master of Arts in from the University of Cambridge and her Ph.D. from the University of Cape Town in 1929 (Wargon, 2005). Charles was interested in demography and human population which led her to joining the staff of the University of London School of Economics and Political Science where she authored books focusing on the study of human population (Wargon, 2005). Due to World War II, Charles moved to Canada with her two youngest children and was highly influential in adding demographic and health information to the Canadian census in her work with the Dominion Bureau of Statistics (Wargon, 2005). In 1947, Charles moved back to England joining the Birmingham City Council's Statistical office and became the Chief Statistical Officer of two Birmingham hospitals (Wargon, 2005). Additionally, Charles made notable contributions to the World Health Organization in documenting health statistics of various nations around the world (Wargon, 2005).

Gertrude Cox was born in Dayton, Iowa in 1900; she attended Iowa State College earning a degree in mathematics in 1929 (Stinnett, 1990). Cox had a long and fruitful career beginning in 1931 as a graduate assistant at the University of California, Berkeley and ending as the first head of the Research Triangle Institute's Statistics Research Division in 1965 (Stinnett, 1990). Notably, the Department of Experimental Statistics in the School of Agriculture at North

Carolina State College in Raleigh appointed Cox to organize and head the department in 1940 where she did an exceptional job recruiting top talent, raising funds, and establishing statistical programs within the college (Stinnett, 1990). Her many contributions include operating as the first female full professor and department head at North Carolina State College, functioning as director of the Institute of Statistics at North Carolina State College, and helping to establish the Department of Biostatistics in the School of Public Health at the University of North Carolina at Chapel Hill (Stinnett, 1990).

Dorothy Vaughan was a pioneer in the National Advisory Committee for Aeronautics' ((NACA) (Precursor to NASA) segregated West Area Computing Unit (Shetterly, 2017). Born in 1910 in Kansas City, Missouri, Vaughan went on to earn her bachelor's degree in mathematics from Wilberforce University in 1929 (Shetterly, 2017). After working for a time as a math teacher in Virginia she took a job as a mathematician at the segregated West Area computing unit of Langley Memorial Aeronautical Laboratory where she and a group of all Black female mathematicians worked to help process an abundance of aeronautical research data (Shetterly, 2017). Vaughan was the first Black woman to be promoted to the position of supervisor at NACA (Shetterly, 2017). After the transition of NACA to NASA Vaughan joined the Analysis and Computation Division (ACD) where she learned electronic computing (Shetterly, 2017). Vaughan worked to become an expert in FORTRAN programming and contributed to the Scout Launch Vehicle Program (Shetterly, 2017).

Mary Jackson was born in 1921 and graduated from Hampton Institute in Hampton, Virginia in 1921 with a degree in Math and Physical Sciences (Shetterly, 2016). Mary taught math at a Black school in Maryland before obtaining a position at Langley Memorial Aeronautical Laboratory in the segregated West Area Computing Section under the supervision

of Dorothy Vaughan (Shetterly, 2016). Within two years, Jackson was offered a position working for an engineer at the laboratory conducting experiments where it was suggested that she enroll in a training program managed by the University of Virginia that would give her the opportunity to be promoted from a mathematician to an engineer (Shetterly, 2016). Obtaining the promotion elevated Jackson's career as she became one of the nation's only Black female aeronautical engineer of the time (Shetterly, 2016).

Katherine Johnson was a child prodigy beginning high school at age ten (Britannica, 2022). Johnson was born in 1918 in West Virginia. She graduated from West Virginia State College at 18 with honors with two degrees, one in mathematics and one in French (Britannica, 2022). After beginning her career as a teacher in Virginia, Johnson took a position at the segregated West Area Computing unit at the National Advisory Committee for Aeronautics (NACA) where she analyzed data as well as provided mathematical computations for the U.S. space program (Britannica, 2022). As a member of the Space Task Group, Johnson authored or coauthored research reports and was instrumental in calculating the path for *Freedom 7*, which put Alan B. Shepard, Jr., the first U.S. astronaut into space (Britannica, 2022). Notably, Johnson worked on the team that helped launch the rocket that sent the first three men to the moon as well as greatly contributing to the space shuttle program (Britannica, 2022).

The field of statistics has significantly benefited from the numerous contributions of women statisticians and data analysts across a considerable number of decades. While the valuable histories of these female pioneers have been recorded, the extent is merely chronicled achievements. Information regarding these women's perceptions and experiences of their pursuit and attainment of a career in statistics are scant at best. Further research is needed to explore the insight of women who have traversed this less traveled vocational endeavor.

2.2 Past Research on Women in Statistics

Of the minimal literature discovered, Amanda Golbeck and colleagues supported and promoted women in statistics in a few publications. Highlighting the Caucus for Women in Statistics (CWS), whose mission is, “to advance the careers of women statisticians through advocacy, providing resources and learning opportunities, increasing their professional participation and visibility, and promoting and assessing research that impacts women statisticians,” Golbeck (2020) offers that this valuable platform has been a supportive and inclusive community for fifty years (Caucus for Women in Statistics, 2023). She contends that the CWS challenged accepted practices of the 1960s and 1970s of women in academia, made valuable and lasting contributions to the profession of statistics, and revived its mission during the #MeToo epoch (Golbeck, 2020). Moreover, in their book, *Leadership and Women in Statistics*, Golbek and fellow editors, (2015, 2021), relayed information with respect to this topic including material underscoring characteristics of leadership for women in the field, the underrepresentation of women statisticians heading large-scale projects, and gender disparities present in this male-dominant vocation.

Brooks and Buck also contributed research distinct to women in statistics. Notably, the investigative study of Brooks (1987) was in direct response to that of Buck (1985). As a psychology professor who had taught numerous elementary and advanced undergraduate statistics courses, Buck believed that females displayed a higher level of math anxiety than males and therefore ran a statistical analysis to determine if there was a difference in grades between the two genders. The researcher found that there was no statistically significant difference between males and females in the distribution of letter grades in her thirteen semesters of data (Buck, 1985). Buck (1985) contends that the results may be due to the extra attention she pays to

female students, her influence as a female role model, and the expectation she conveys that women should perform equally as well as their male counterparts. In response to Buck's assertions, Brooks (1987), conducted his own experiment comparing the grades of male and female students that took his introductory statistics course over a 10 year time frame. The instructor (1987) reported that his female student's grades were statistically significantly higher than his male student's grades. He maintains that the results suggested in his findings could not be related to his gender as an instructor nor to any specific expectation conveyed to his students relaying that females should perform equally as well as males (Brooks, 1987). Additionally, Brooks (1987) contends that it is possible, though not probable, that he gives more attention to his female students as compared to his male students.

These few studies pointing to gender-disparity, female underrepresentation, and equal to superior academic performance in statistics, make it clear that more research is needed in respect to women in statistics. While information is available concerning women engineers and women in STEM, a paucity of information specific to women in statistics persists. Moreover, the meager literature discovered highlighting women in statistics does not provide insight into the experiences and perceptions of women in this niche mathematical field.

2.3 Women's Experiences Pursuing STEM Degrees

Limited information regarding women's experiences pursuing statistics degrees exists. As female representation is low in computer science degrees, Falkner and colleagues (2015) explored the perceptions of female students working toward a degree in this discipline. The findings of their investigation revealed that perceptions of identity conflict as well as a feeling of a lack of belonging to the discipline were persistent struggles for the research participants (Falkner et al., 2015). Turning attention to minority women pursuing STEM degrees, Charleston

and fellow researchers (2014), discovered that Black women working toward a degree in computing sciences were met with an unwelcoming environment in their academic journey. Moreover, these female students experienced isolation and subservience as well as social sacrifice, (i.e., not spending time with friends or socializing in general) in their quest for degree attainment (Charleston et al., 2014). Mirroring Charleston and colleagues' findings, Alexander and Herman (2016) report that eight African American women enrolled in STEM graduate programs at a predominantly White university experienced racial microaggressions, low levels of self-efficacy, and lack of institutional support in their journey toward obtaining a STEM degree at the graduate level.

These unfortunate experiences are the reality for many women working toward a degree and subsequent employment in the highly male-dominated STEM fields. It is important to note that while the aforementioned studies examined the experiences and perceptions of women in STEM, they were not expressly related to statistics. Therefore, examining the attitudes, views, and experiences of women actively laboring toward a tertiary degree in statistics would definitively add to the body of knowledge regarding women in this mathematical concentration.

3. MATERIALS AND METHODS

3.1 Methodology

Ethnography has been extensively employed in anthropologic studies for decades yielding rich information from remote cultures across the globe (Creswell & Poth, 2018). This valuable methodology has been adopted by social scientists to conduct in-depth and profound research on a vast variety of groups (Douglas, 1963; Malinowski, 1922; Mead, 1952).

Ethnography provides the researcher a unique insight into the target group of interest through observing individuals in the context of their environment (Roberts, 2009). Working to

understand group values, beliefs, and behaviors the researcher endeavors to immerse themselves into the group's day-to-day lives through purposeful observation (Creswell & Poth, 2018). From these observations, the researcher concentrates on developing a thorough overarching characterization of the group complete with social and ideational patterns and systems (i.e., ideas, concepts, regulating mechanisms) (Creswell & Poth, 2018). The value of ethnography cannot be overstated. However, in cases where budgetary and time restrictions are of concern, a mini-ethnography is a beneficial methodology that can be employed to yield similar outcomes (Dobbins et al., 2021). Utilizing the same focused inquiry and observation in a smaller window of time still affords the researcher the opportunity to collect rich, detailed, and comprehensive data that aids in illuminating standards, beliefs, and functions of participants within a target setting (Dobbins et al., 2021). The current study employed mini-ethnographic methodology to uncover the beliefs, cognitive understandings, and social patterns of women pursuing a graduate degree in statistics.

3.2 Theoretical Framework

Social constructivism stems from Lev Vygotsky's view that cognition is influenced by social interactions (Kim, 2014). Vygotsky posited that cognitive processes initially occur on an interpersonal level and then on an intrapersonal level (Kim, 2014). Subsequent subjective meanings are then ascribed to objects and things (Creswell & Poth, 2018). This theoretical framework affords the opportunity to attain an understanding of the world by developing respective meaning derived from personal experiences acquired through social interactions as well as historical and cultural constructs (Creswell & Poth, 2018). As social and cultural norms wield such influence, participant perceptions must be heavily relied upon to gain an understanding of lived experience (Creswell & Poth, 2018). Within this framework, it was

important for me as a researcher to attend to participant interviews and observations with social context at the forefront of my mind.

3.3 Participants

Participants for this current study were drawn from a sample of graduate student volunteers taking part in a larger mini-ethnographic study. The participants were all working toward a graduate degree in statistics and attended the same public university. Four participants from the larger study are represented in this current research. Three of the four participants took part in individual semi-structured interviews and two of the four consented to observations of classroom teaching and/or data consulting meetings. The participants ranged in age from 22 to 35 and all identified as female. One participant identified as Caucasian while the other three participants identified as Asian. Three participants were international students with the remaining student being a domestic scholar.

Table 1

Participant Information

Participant	Pseudonym	Ethnicity	Age	Country/Continent of Origin
Amy	Yes	Asian	20s	Asia
Naomi	Yes	Asian	20s	Asia
Samantha	No	White	30s	United States
Daria	Yes	Asian	20s	Asia

3.4 Procedure

Recruitment

Graduate students pursuing a degree in statistics who identified as women or non-binary from a public university were recruited to participate in the current study via e-mail.

Interviews

Participants agreeing to take part in the study responded to the recruitment email and completed a participant consent form and demographic survey. Participants were then asked to take part in a 60-minute semi-structured interview and queried as to whether they would be willing to allow the researchers to conduct observations of teaching and/or consulting activities.

Observations

Observations included viewing classroom instruction and statistical consultations. Moreover, participants were asked to share a piece of material data that was representative of them of being a woman in statistics. Twenty hours of observation was conducted at the University research consulting lab, classroom, and Zoom consultation meetings/presentation. The majority of observations were conducted at a university research consulting lab. Some of the observations included the three participants interviewed in this study and some included other research consultants who consented to taking part in the observational aspect of the study.

Study Aim

The overarching aim of this study was to learn more about the perceptions and experiences of women and non-binary individuals who are graduate students working toward a degree in statistics. As women and non-binary individuals are often underrepresented in STEM disciplines, it was important to give voice to these individuals by learning their storied

experiences. A mini-ethnographic approach allowed rich data of this unique group of scholars to be collected through interviews, non-participatory observations, and material data collection.

Analysis

Thematic analysis was utilized in processing interviews, observations, and material data. Thematic analysis is an approach that allows the researcher the opportunity to identify and analyze themes (i.e., patterns of meaning) in respective data (Braun and Clarke, 2006). Braun and Clarke's (2019) six step process of analysis was employed as the researcher read and reread the data (familiarization), generated codes, merged codes into themes, reviewed themes, confirmed the significance of themes, and reported the findings. This process was inductive and iterative with patterns of meaning being derived from the raw data and then examined and reexamined to definitively determine themes. These themes were then woven together to tell the story of the data through authentic and detailed representation of written and observed materials.

Trustworthiness

Trustworthiness is fundamental in the research process as Lincoln and Guba (1985) foundationally conveyed in their model for implementing credibility, transferability, dependability, and confirmability to determine reliability and validity in qualitative research. While much has been written and debated on the topic, trustworthiness can be summarized as transparency (Adler, 2022). This current study validated the evidence of the data through transparency and triangulation strategies (Creswell & Poth, 2018). A audit trail was maintained from inception to completion of the research study. Records including, a research log, field notes, reflexivity writing, interviews, observation notes, and recording of material data were meticulously kept throughout the research process. Member checking was conducted and feedback from participants was processed accordingly. Prolonged participant observations in

tandem with in-depth interviews afforded the opportunity to gain clear insight from the participant's lens through participant collaboration. Moreover, rich, thick description of the research process together with the analyses and conclusive results drawn from the raw data further bolstered the trustworthiness of this study.

4. RESULTS

In this section I present major findings in the areas of passivity, a love of statistics, gendered experiences, and the desire of participants to give back to community and country.

4.1 Researcher Reflection from Field Notes

Passivity was a notable topic that was frequently present in research consulting lab observations. Consultants that identified as female were more likely to defer to a male counterpart in consultations. Female consultants did not speak as much during consultations when a male was present and some, "remained silent throughout the consultation." When presented with opportunities to function as the lead consultant in a role play exercise a female consultant, "quickly deferred" to the male consultant and relayed to myself and another student how "nervous" she had been functioning as the consultee. On another occasion when a client presented a question to a female consultant that she did not have the answer for, she quickly inquired of the male consultants before querying a female consultant. However, when female consultants worked alone or with other female consultants, more confident interactions were observed. For instance, when Daria and Amy conducted consultations with clients, their confidence, competence, and professionalism stood out. Both consultants asked questions and provided sound and valuable feedback for the client. Notably, Amy was interactive and participatory in these consultations where both consultants identified as female but was silent and deferent in the consultation where a male was her contemporary. Correspondingly, Samantha

exemplified self-assurance, expertise, and effective communication skills in teaching statistics to college level students. This was made evident in the way the “students were respectfully quiet,” focused on the lecture, and taking careful notes. The observations of the study participants in various statistical settings provided a window into the world of statistics from a female perspective and revealed some behavioral disparities in interactions between genders.

4.2 Love of Mathematics and Statistics

“I love stats.” ~ Samantha

Rationale for entering the statistics discipline at a graduate level differed between participants while carrying the common thread of appreciation for, and enjoyment of, the field. All interviewed participants indicated an affinity for mathematics and statistics. Naomi conveyed that she always possessed a natural propensity toward mathematics and excelled in these areas throughout her academic career. She shared she did really well in school that a secondary instructor encouraged her to pursue a mathematical degree in higher education:

Actually, I did really well but also my instructor or my teacher helped me a lot. Also, encouraged me saying, “Naomi, you have to complete your bachelor, which is, you are more intelligent in that field. You have to complete this in statistics.” Also, he told me to complete a Ph.D. in mathematics but my work told me to complete a master's in statistics. Subsequent to attaining her tertiary degree in mathematics, Naomi's colleague and mentor emboldened her to work toward a graduate degree in statistics:

Also, he has a Ph.D. in applied statistics. And also, he encouraged me to complete the degree. Yeah, because he's one of my role models in my career. That's why I would like to learn from him.

Amy's fondness for mathematics was evident in her excitement talking about her undergraduate degree in business. In subsequently exploring her options after graduation, Amy's uncle pointed her in the direction of statistics:

My uncle is also a statistician. He is doing a Ph.D. So, from him I came to know about applied stats. It was from him I came to know about this University. I then realized the importance of statistics in life in general. So yeah, eventually from then I shifted towards applied statistics.

Amy's interest in becoming a statistician also lies in her desire to be an "independent woman:"

First thing is that I want to be independent woman. I don't want to depend on any other person, whether it's financially or emotionally, or any kind of dependence. So, to ensure my independence, I know that I have to work hard, and I have to achieve whatever I'm thinking about, whatever I'm planning about.

Mathematics was and is one of Samantha's passions. She wanted to pursue an undergraduate degree in statistics however, the university she was attending did not offer this as an undergraduate major, so she attained a degree in education. She was fortunate enough to secure full funding for her master's degree in education. Although her undergraduate and master's degrees were in education, she never lost sight of her goal to earn a degree in statistics. She is making that dream a reality through her enrollment in an applied statistics and research methods Ph.D. program:

So, it's really just been like the thing that I wanted to do since high school, and I just pushed it off. And so, when I got into the program like I had been working professionally for a few years before I was admitted to the program.

4.3 Gendered Experiences

“Statistics is a STEM field, and traditionally women have been underserved in STEM fields and specifically in higher education STEM as it gets more and more complicated, you tend to see less women in the field.” -Samantha

While all participants acknowledged that they had noticed some gender differences operating in the field of statistics, participants from countries outside of the United States did not perceive the stark disparities that the native participant identified. Naomi, a participant from a country in Asia felt that she had not experienced gender divergency here in the U.S. She did convey that she felt that women functioning in the field of statistics in her country actually were confident and capable in their statistical proficiencies:

Because when I was in my master’s degree in my home country the women have a lot of knowledge about their fields. And also, that is reflected in their scores on exams. When asked if she felt if she was treated equally with men in both statistics and mathematics she said, “No, actually it is totally different from men to women.” However, she did not elaborate on this topic outside of her aforementioned statement.

Similarly, Amy did not feel that she had experienced or noticed contrasting gender experiences in the U.S. She asserted that she felt a sense of equality in her statistics journey at the University:

In my personal experience I haven't raised any kind of discrimination in case of gender. I'm given as much importance as the male people. I'm treated, I do believe that I'm treated equally as males are. Yeah, I haven't faced any kind of discrimination.

In speaking about gender roles in Asia, her country of origin, Amy expressed an alternate perception of the functions of men and women:

So, in my country because it's a patriarchal society. Still, it's a patriarchal society.

Because no matter how much we say that there is modernization or anything, it is still

patriarchal society here. And sometimes it's tough to survive in such kind of situation. I know my family is much more progressed in that sense. They have never stopped me in case of my academics situation, or academic interest. They have always pushed me to achieve whatever I want to. In fact, I'm here because of their support, of course. So yeah, as a woman, I have always got support from my family members, my parents. But to be in my society sometimes there are few restrictions for the women back in my country. Let's say, come at certain age where they want me to marry, they want me to settle down, which I see as some kind of limitations being a woman. And there are certain other factors also, where previously they didn't want women to get as much involved in a job or academics. So, but now it's changing, but it hasn't changed entirely. But there are certain hindrances for a woman in the academic section part also. And in work the field also, there are certain kind of obstacles that as a woman we do feel.

Juxtaposing the other two participants, Samantha, a domestic student, strongly sensed the gender disparity present in statistics and mathematics. She felt that male classmates have expected her to take notes for them, complete the homework and let them know what her answers were, or talk to the professor on their behalf. She shared, "There's definitely been moments that make me pause, and that have made me think it's because of my gender identification and has been very frustrating for me." Moreover, Samantha shared an experience that occurred with a professor that she identified as gender discrimination:

I finished my masters, and then I applied for my Ph.D. and I reached back out to some of my masters professors and ask for some letters of recommendation to apply to this program, and I had a professor who was male, who replied back to me, and they said, "Oh, well, you did such a great job in our program. And are you really sure that you want

to move from an education-based program to a math-based program? That sounds kind of difficult. I want to make sure you're successful. You could probably just follow your passion but do it in an Ed Doc degree rather than in your degree.” And I was like, “No.”

4.4 Desire to Give Back

“I’m hoping to get a job in the U.S. to get the experience on the biostats side so that I can use that knowledge to help my country, I believe.” ~ Amy

There was a strong sense of wishing to give back by all three participants. Each had a unique contribution that they desired to provide to others. It was heartening to hear how Amy not only wanted to make her family proud but also sought to beneficially contribute to the people of her country through the knowledge she attained through her studies in the U.S.:

My long-term plan is to work for the ministry of health in [my country]. Yeah, so that I can provide some information of use to them to cope with the different kind of health situations in Nepal. For that I know. I also know that I need to have a lot of experience. So, what I want to do is I want to gain as much experience in different fields, whether it's pharmaceuticals or any kind of public health or anything. So, my major concern is related to disease.

Likewise, Naomi wished to work within her country’s government to help oversee finances. She shared, “I would like to return to my country to work as instructor in the financial department.”

As a student and educator, Samantha has a strong interest in utilizing her skills to serve underrepresented groups, specifically women, by encouraging them to pursue STEM degrees at a tertiary level:

One of the areas of interest in my masters was about studying specifically how we help encourage underserved populations to pursue higher education degrees in certain fields.

So, I have focused on getting women into STEM.

The quest to attain a degree in statistics has benefits that extend far beyond mere personal satisfaction or achievement. These participants conveyed their wish to effect positive change both at an individual and national level. Involvement, influence, and impact are what these women hope to accomplish as a result of their graduate journey in statistics.

4.5 Observational Perspectives on Women Consulting and Teaching Statistics

Twenty hours of observation unearthed much information regarding the behaviors and experiences of women working toward a graduate degree in statistics. Two of the standout observations were female consultants conducting statistical consultations and my time viewing a female statistics instructor lecturing her undergraduate class.

The statistical consultations were conducted via Zoom and were carried out in a professional and highly competent manner. Daria was the lead consultant and Amy was the assisting consultant in the first consultation. Daria confidently took the lead in the first consultation with Amy following in step asking clarifying questions and offering helpful suggestions such as “sharing the nonparametric test used for this type of study.” Throughout the meeting both female consultants worked as a collaborative team to ensure the client’s needs were met. No acquiescent behavior was noted. The second Zoom consultation took place with Daria being the lead and only consultant. This consultation was slightly different as it was clear that Daria had an ongoing working relationship with the client who was sight impaired. Daria’s confidence, patience, and broad knowledge of the statistical topic, “navigating the coding

process,” created a productive and helpful space for the client to ask questions and learn while getting her statistical needs met.

The classroom was a small rectangle room with maroon desks strewn about making the space look disheveled. There was a projector at the front of the room with a white board residing behind it. What appeared to be prayer flags adorned the back wall and posters depicting world travel and maps lined the remaining walls. Samantha commanded the attention of her students with her confident and well-articulated lecture on probability. I was impressed to see the students paying careful attention to her words and actively taking notes as most undergraduate students I have observed in other settings have been inattentive to lectures regardless of the gender of the professor. Her presentation was detailed and valuably demonstrated the concepts. She provided sample problems and gave students the opportunity to work through them to grasp the lesson more thoroughly. Besides Samantha’s self-assured and competent demeanor, I noted, “how pleasant and jovial the instructor is in her interaction with the students. It seems that the students really appreciate her and are not at all intimidated to ask her questions.”

4.6 Material Data

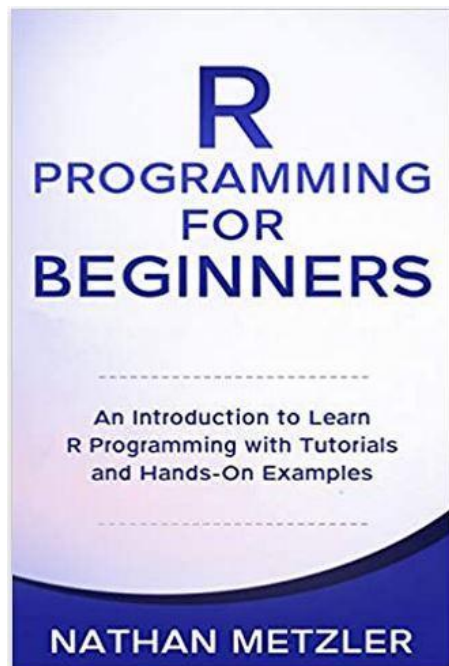
Material data is a valuable way to elicit a unique dimension of understanding of participant perceptions of statistics and their relationship to it. Three participants shared a piece of material data that they felt was representative of themselves as a woman in statistics. Naomi shared a book that meaningfully changed the trajectory of her career. She shares:

Actually, one of my friends in my home country told me about a program which is about how I can attend a conference. The Mathematical Society Association. After I completed the registration, they told me there is one requirement. I needed to have the knowledge about the statistics before, I think, since two thousand and nineteen. Yeah, but actually I

didn't have some knowledge about statistics or how can I deal with it. After that I tried to figure out what is statistics, how can I develop myself in this area? I read a book about the R program (See Figure 1). How can I analyze things by using the R program? It's a basic thing. But also, this book encouraged me to discover many other programs that can deal with data. So, after that I told my supervisor in my career that I would like to a complete a statistics program and learn to analyze data.

This book meaningfully empowered Naomi to realize that she could learn new skills and open herself up to new experiences as well as advanced career opportunities.

Figure 1



Naomi's Material Artifact

Amy presented me with an image of the Canvas course shell of the first statistics class she took as a graduate student (See Figure 2). She conveyed that this course was the inaugural step that will lead her to a life of independence and meaningful contribution.

Figure 2

Amy's Material Data

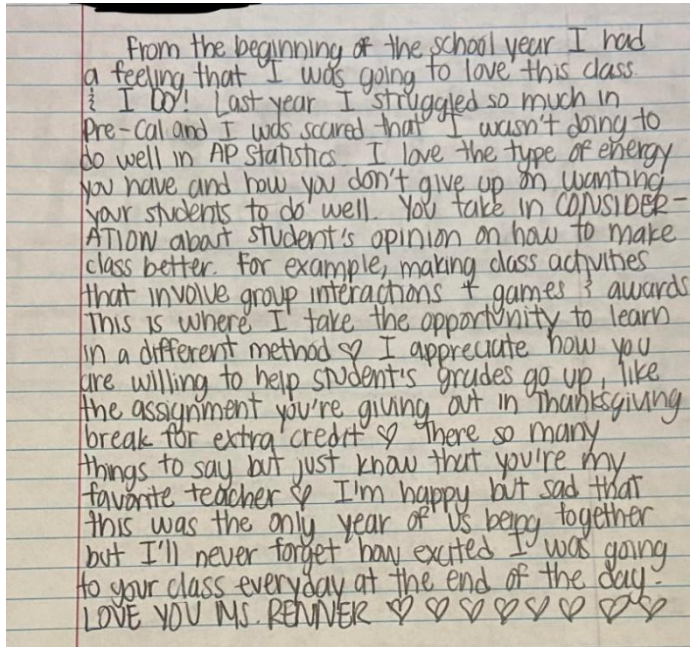


Samantha conveyed that through much thought and introspection, she chose a letter from a student as an artifact representative of who she is as a woman in statistics (See Figure 3). This individual was a student of Samantha's in her first year of teaching. She said:

During that year was kind of what set me on the track of wanting to do stuff with like helping specifically like minority students like be more passionate about stats. Because stats were always my passion, and I found that, like all of my AP stats kids, most of them really struggled with like loving the subject because they didn't feel confident. And I wanted to like really help people feel like they could do it. And so, I don't know, that was just a very meaningful moment to me, because even to this day she ended up going and doing stats minor in her undergrad, and she'll still email me, like Facebook message me

sometimes it's like, "Hey, Miss, I have this homework problem. Will you help me with it?"

Figure 3



From the beginning of the school year I had a feeling that I was going to love this class. I DO! Last year I struggled so much in Pre-Cal and I was scared that I wasn't doing to do well in AP Statistics. I love the type of energy you have and how you don't give up on wanting your students to do well. You take in CONSIDER-ATION about student's opinion on how to make class better. For example, making class activities that involve group interactions + games + awards. This is where I take the opportunity to learn in a different method. I appreciate how you are willing to help student's grades go up, like the assignment you're giving out in Thanksgiving break for extra credit. There so many things to say but just know that you're my favorite teacher. I'm happy but sad that this was the only year of us being together but I'll never forget how excited I was going to your class everyday at the end of the day. LOVE YOU MS. REMMER ♡ ♡ ♡ ♡ ♡ ♡ ♡ ♡

Samantha's Material Data

5. DISCUSSION

This study aimed to explore the perceptions and experiences of women working toward a degree and eventual employment in statistics. Through observations, interviews, and material artifacts it became clear that while every woman's academic journey in statistics is different, the love of mathematics and statistics, gendered experiences, and the desire to give back bound them together through common understandings, practices, and encounters. Each of these themes provided a nuanced understanding of participant experience as a woman in statistics. The women that took part in this study shared a love of mathematics and statistics that began in their primary academic career and carried with them into adulthood compelling them to pursue a graduate degree in the discipline much like their historical predecessors. Moreover, participants conveyed that gender differences do exist although with perceptive variance in meaning and magnitude.

Seemingly, these disparate perceptions were separated by geographic and sociocultural divides. Participants from outside of the United States viewed this country as primarily equitable between genders in statistics while the domestic participant saw vast disparities between gender equality in the field. However, the international students recognized inequality between genders within their respective country of origin. Profoundly, these women wanted to give back by making a difference in the lives of others through their knowledge and achievement in statistics. Each participant held a laudable goal to altruistically provide help at an individual, community, and national level. The findings from this study provide a brief but insightful snapshot into the experiences and perceptions of women pursuing a graduate degree in statistics. Future research could seek to employ a larger and more diverse set of participants in order to gain a broader perspective of women in statistics. Results from this research could likely benefit graduate students, universities, government, and industry in helping to understand ways to bolster support for this underserved population to strive and succeed in the field of statistics.

“After I did the seminar, I won a prize for being the first woman in my university in this department that did a right project with all the contents in the right side.” ~Naomi

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