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Impacts and Factors of Women in STEM Education at UW-Stout

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Abstract

The purpose of this research was to gain an understanding of the factors that contribute to women choosing science, technology, engineering, or math (STEM) career paths. This research gathered information from other findings on the gender gap, the decline of interest of women pursuing STEM fields, and on ways to engage young women in STEM-related courses. Interviews from three female students seeking a STEM degree at the University of Wisconsin – Stout collected suggestions on how to increase young women joining STEM-related courses throughout their educational ladder, how those women persisted within their degree, and the hurdles they faced to get a STEM degree. Strategies suggested when conducting the interviews included implementing STEM curriculum such as simple coding programs in pre-kindergarten, providing mentorships with another female student or woman from a STEM profession and evaluating the STEM courses to adapt to the needs of everyone, not just males. Showcasing the story of women in a male-dominated occupation will present a better understanding of developing said occupation as an equal ground for all. The role of a female teacher holding a STEM education degree may have a significant impact on young female students' future.

Keywords: Women in STEM, technology education, women educator

Introduction

Classrooms of science, technology, engineering, or mathematics are prone to have more seats filled with male students' bodies rather than females. This research will help fill classrooms with female students. Spreading awareness of the gender gap, identifying a decline of interest in women pursuing a degree in a STEM field, and

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exploring ways of engaging young women in STEM-related courses have shown there are changes that can be made in attracting women into STEM careers.

Literature Review

Gender in STEM fields

Based upon the outcome of standardized testing, women make up approximately half of the United States of America's workforce, but are underrepresented in STEM. Based upon the American College Testing's (ACT) fifth and latest test results, more than 2 million students participated in the college readiness test. Within the ACT, there is a portion that contains a STEM score to predict the students' ability to succeed in college courses such as calculus and biology which are typically required for a STEM-related university degree. Just 18 percent of females—compared to 24 percent of males—met the STEM benchmark. Moreover, among students who have an interest in STEM-related university degrees, the gap is even more significant, with 22 percent of female students meeting the STEM benchmark, compared to 31 percent of males. Overall, females interested in STEM were less likely than males to match or surpass the benchmark (ACT, 2018).

Before entering a university, there is already a gender gap between females and males interested in STEM-related education. According to Yonghog Xu (2015), individuals make education-related investments with the intention of future earnings, professional experiences, interventions to reduce gender-based pay inequality, and family-friendly workplaces that are open to and supportive of women's dual role as the primary family caregiver and successful professional. Furthermore, incentives are needed to support women's continuation of graduate education to increase their human capital and equalize their pay level (Xu, 2015). Statistics on those who have earned bachelor's degrees in 2012 show that females have: been awarded 59 percent of degrees in the biological/biomedical sciences; made up only 43 percent of degrees in mathematics and statistics; earned 18 percent of degrees in computer and information sciences; been awarded 19 percent of degrees in engineering, and received 38 percent of degrees in the physical and technological sciences (Wang & Degol, 2016). After receiving a STEM-related degree, women with STEM jobs earned 35 percent more than comparable women in non-STEM jobs — even higher than the 30 percent STEM premium for men. Women with STEM jobs also received 40 percent more than men with non-STEM jobs (Beede et al., 2011). As a result, the gender wage gap is smaller in STEM jobs than in non-STEM jobs.

Addressing the gender segregation rather than the gender gap in occupational expectations for STEM fields is seen across countries. Gender bias refers to the prejudicial differences in the treatment of women and men. Segregation is keeping one group of people apart from the other and treating them differently. The different

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treatment of people is based on gender, race, ethnicity, religion, and education. As Younghong Jade Xu (2008) mentions "faculty members of the opposite sex have no reason to feel threatened by the elimination of gender inequality given that the goal is not to force an equal number of women and men at all costs, but to provide equal access to career opportunities and similar resources and support for success to all talented scientists, be they men or women (p.14)." The gender gap is the difference in representation or expectations between women and men, in social, political, intellectual, cultural, or economic achievements or attitudes. For example, Seong Won Han (2017) indicated that computing and professional engineering expectations are higher for males than for females, although the magnitude of this gender gap varies across countries.

In contrast to computing and engineering occupational expectations, health service professional expectations are higher among females than males in almost all the countries. But just as for computing and engineering expectations, the magnitude of the gender gap varies across countries. This pattern of gender differences in STEM occupational expectations remains even when a student, school, or national characteristics are considered. After controlling for all individual, school, and country-level factors, females are 54 percent less likely than males to expect computing and engineering occupations (Han, 2016). A work environment free of gender bias is the best recruitment and retention policy for women.

Factors in the Decrease of Women's Interest in STEM Fields

Females' lack of participation has been attributed to curriculum content that is biased toward males' interests (Weber & Custer, 2005). Others attribute females' lack of interest in STEM to academic approaches rather than to the inherent nature of the subject (Weber & Custer, 2005). Even when interested in STEM fields, young women often lose confidence when they take courses with small numbers of female students. Women in introductory computer-science courses are often intimidated by male students who have significant programming experience (Coger, Cuny, Klawe, McGann, & Purcell, 2012). Computer-science programs at some universities and colleges, including Harvey Mudd, Carnegie Mellon, MIT, and the University of British Columbia have succeeded in recruiting and retaining more female students by creating a more encouraging and supportive learning environment (Coger et al., 2012).

Closing the gender gap in specific male-dominated science, technology, engineering, and mathematics occupation is essential for educators to establish a stable and inviting environment. The number of women in male-dominated professions has increased over the years, but that is only for specific fields such as biology, chemistry, and math. The gap has grown in computer science, engineering, and physics occupations. It has demonstrated that male-dominated fields such as

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computer science may deter females due to females' lack of perceived similarity and belonging. Wang and Degol (2016) have found that removing stereotypically masculine objects, such as male characters, from computer science classrooms can increase female interest in these courses.

In the United States, women hold fewer than 25 percent of jobs in STEM fields, despite accounting for 47 percent of the workforce (DeNisco, 2019). A female student's environment will determine whether she is academically prepared to enter a specific field in college (Davis, 2016). The atmosphere has a significant impact on females' student lives and their overall motivation to succeed in an area.

Engaging Young Women in STEM Careers

The role of an educator in the classroom and practice is to foster learning and serve as a role model. Ashley Janis (2012) states that role modeling has often been referred to as the "hidden curriculum" of professional education as we often lack understanding regarding the influence role modeling has on learners. One of the founding theorists of critical pedagogy in the United States, Henry Giroux is best known for his work in pedagogy, cultural studies, youth studies, higher education, and critical theory. Fulya Kentli (2009) states that Giroux identifies hidden curriculum as what is being taught and how one learns in the school. Giroux also indicates that schools not only provide instruction but also more such as norms and principles experienced by students throughout their education life. A student's environment influences their plans to enter a STEM field. Motivation is a large part of entering a STEM field and making a career out of it. When a female is motivated, there will be nothing hindering her from making her goals (Davis, 2016). DeNisco (2019) offers advice for administrators who want to support female STEM students:

- Start as early as pre-K.
- Expand teaching methods. For example, students can learn about physics by building a structure with real materials, instead of just reading about it in a textbook.
- Challenge media portrayals of STEM professions. Men are depicted as STEM professionals over women 5 to 1 in family films. Men are portrayed as computer scientists 14 to 1 in family films, according to a February White House fact sheet. Make students aware of this stereotype.
- Build mentor programs with female STEM professionals. Female students need to see women who are in STEM jobs and understand their struggles to connect on a personal and professional level and set an example.
- Reach out to local STEM companies, organizations, and nonprofits and ask if female professionals can speak about their work and expose students to what a STEM career entails.
- Examine your STEM programs to see if the enrollment in classes, clubs and after-school activities mirror the recruitment of females in your school. Ask female students why they are (or aren't) interested in STEM. Administrators should use this information to actively encourage women to pursue STEM and to make the programs more appealing.

Female students must know that entering these fields will not be easy. They must be prepared academically, mentally and emotionally for what will occur while navigating through the curriculum which will lead to their future career.

Methodological Approach

The purpose of this research was to gain an understanding of the factors that contribute to women choosing a STEM education career path, primarily in Technology Education, at the University of Wisconsin-Stout. The research question was, "What is the experience of women choosing a STEM education career path?" Six probes guided the study:

1. What are the types of STEM courses you have taken in high school?
2. What influenced you to take STEM-related courses during high school?
3. How did the instructors of the STEM courses create a classroom environment ensuring the female student return rate?
4. What are the hurdles you have faced while achieving a STEM education degree?
5. Why did you persist to achieve the STEM education degree?
6. What are your suggestions to increase the female population in STEM fields?

A phenomenological methodology used interviews with three women pursuing an undergraduate degree in a STEM Education at the University of Wisconsin – Stout. Upon being interviewed, the participants were presented a consent form to sign before the guided questions were recorded. The interviewed women were in a closed room with no distractions, and the session took less than 10 minutes of their time. Participants' identity was concealed; although the published responses from the interview questions are made public, the participant's identity is altered to protect participants.

Procedure

The following steps were used in the phenomenological approach to the research question. Creswell (1998) stated that phenomenological data analysis

proceeds through the methodology of reduction, the analysis of specific statements and themes, and a search for all possible meanings. The researcher needs to set aside all prejudgments, bracketing their experiences. Bracketing is when researchers put aside their own experiences, biases, and preconceived notions to understand how the phenomenon appears to participants instead of how it is recognized by the researcher (Flipp, 2014). The first step in storing away unconscious bias and personal experience is becoming aware of what it is and how it can affect others. By storing away beliefs and values received from family, culture, and experiences that strongly influence how we view and evaluate others. It allows the researcher to explore the views, perspectives, understandings, and feelings of participants who have experienced being a woman in STEM education.

Phenomenological research is naturally conducted with detailed interviews of small samples of participants. Recruited participants were women seeking out a STEM education degree at the institution and have experienced the phenomenon of interest. The researcher personally contacted the participants to solicit their participation. Once the participants agreed to answer the interview questions, they were sent an email asking when they would be available to be interviewed. Information collected from the interviews was recorded, while written notes were taken during the interview. Participants' identifying information was anonymized. These interviews gave a better understanding of the factors that contribute to women choosing a STEM education career path and provided a broad perspective of gender equality in a male-dominated occupation. Insights were also gained on how to improve on the growth of women seeking to pursue those professions.

Data Analysis

The phenomenological data analysis structure follows that procedures are divided into statements or horizonalization, the units are transformed into clusters of meaning, then tie the transformation together to make a general description of the experience, including textural description, what is experienced and structural description, i.e., how it is experienced (Creswell, 1998). The horizonalization approach used for this qualitative analysis, which aid in significant supported statements taken from interviewed transcripts provides a framework for text analysis (Flipp, 2014). Significant statements are quotes directly taken from the transcript that describe how the participants experienced the guided probes and placed into clusters of meaning. The cluster of meaning is putting the supported statements from the participants into themes of how the guided questions were answered. Presenting long text passages of the interviewed participants' experiences by using essence to give an understanding of what it would be to in the same shoes as the participants. The essence is the central core meaning of the experience shared within the different lived experiences.

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The participants of the study shared what year and major they declared at the University of Wisconsin – Stout, along with college courses they had previously taken. The first participant was Ellie, a junior at the University of Wisconsin – Stout in Technology Education (TechEd), who indicated she never took any courses related to her choice of major due to the school she attended being unable to fund a TechEd program. The second participant was Mo, a sophomore at the UW – Stout in TechEd, who began her experience during the first year of high school taking computer-aided design and manufacturing. Mo continued to take related courses throughout her high school education. The final participant was Ayla, a junior at UW-Stout in Science Education, who started her education exploring science and began to advance into upper-level science-related courses such as biology, chemistry, AP Physics 1, AP Physics 2 and AP environmental science.

Results

This author conducted interviews with three females at the University of Wisconsin – Stout who were pursuing a Bachelor of Science in a STEM education fields. They were seeking to inspire the younger female generation to find a career in a STEM-related field. The long passages that follow were guided by females' experiences and responses to the six guided questions. The guided questions refer to the experience participants received in high school and college that resulted in their pursuing a degree to teach a STEM subject. The themes that emerged included how the instructor of their high school created a classroom environment ensuring female student return rates, the hurdles faced while achieving a degree, why they persist, and suggestions of ways to increase the female population in STEM fields.

Instructors' Return Rate Strategies

Ellie mentions how she was introduced into a related TechEd subject, robotics, by a family friend. He noticed that Ellie and her brother weren't doing a whole lot in the early evenings and invited them to start going to the robotics meetings at the school. Ellie got involved in TechEd, but an educator didn't do it. Mo stated that there were only two TechEd teachers at her high school. One of the TechEd teachers was her basketball coach, and she took the TechEd course because he taught the class. It was a secure "A" grade because the coach liked her, but she didn't learn a thing. She stated that "it was so silly being in that class, so I didn't take him anymore." Mo mentions that this first TechEd teacher took more of a counselor role than an educator role, which resulted in a more personal relationship. Mo indicated the TechEd teacher was a role model. The second teacher was terrible because he was more of a football coach than a TechEd teacher. Lastly, Ayla states that her educator had "a lot of interactive groups, group learning where we worked together, solved real-world problems and talked about the world instead of just like something

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confined to four walls of a classroom." Women are sharing their experience, which can give insights into different ways educators continue to have a seat in the classroom filled by a young woman.

Hurdles

Ellie mentions that there were only nine students in her graduating class throughout high school. There were only two girls and seven boys. Ellie is comfortable around male students. She is part of the Marines, where one percent of Marines are females. Ellie stated, "it does not make any difference, I have always been a tomboy." She was referring to the surrounding of male figures throughout her life and being the one percent of females in marines, resulting in no alterations of her comfort with being the only female in the classroom. Ellie mentions that it was harder for her to join a sorority then hanging out in the TechEd classroom.

Mo experienced many hurdles being in TechEd. She began by stating that "one of the TechEd professors will make remarks comparing men and women." She gives an example of a quiz in the middle school TechEd course, asking how to get females in TechEd. Mo answered that "women are more conformable with a female teacher than a male teacher. Especially at that age, they don't want to be hanging out with a bunch of boys in a shop class with a male teacher. You want to be hanging out with your friends, and a female teacher will be more welcoming at that age". She states that it is close to what she put down as an answer to that question. She thought that it was going to be easy for her because she knows how to communicate with girls because she is one. However, the teacher of the class marked it wrong and said that Mo is a different kind of girl because she is pursuing TechEd. Mo stated her response to the teacher's remarks was "No, I am still a girl. Still a girl."

Ayla expressed that it was the male students giving her hurdles to face rather than the male professors. She began by stating that there is a minimal science education program at Stout. She is in many classes with male students majoring in engineering or construction and so forth. Moreover, those are majors where she finds herself being one of the two girls in the class. Ayla states that the males in her class won't always listen to her or do not think she knows information on the subject matter in class. She expresses that the professor are not the problem, and she has no issues with them. It is the other classmates who are mostly male students causing her hurdles. The obstacles these women have faced ultimately drive them to persist in achieving the career they are seeking. It is important to understand the interviewees' experience of hurdles faced when completing a STEM degree. Their persistence can be related to many other females who are experiencing the same impacts.

Persistence

Ellie indicated, "she persists in becoming a technology education teacher even

though she has faced or will be facing many hurdles." She states "It is what I want to do, and I like the major. It is what I want to do at the end of the day." Mo mentions that she came to UW - Stout for manufacturing engineering and then decided that she couldn't sit at a desk all day and needed to be working with people rather than with a computer. Then the one TechEd teacher she previously had was one of the most remarkable people she ever met. He helped her through switching majors and now is pursuing a degree in TechEd. Ayla stated she persists because she wants to teach chemistry or physics, the math-heavy subjects, because she likes the concepts and shows students that a female can excel in that field as well.

Suggestions

Ellie was introduced to robotics at a young age, which she stated that "when introduced at a young age it makes a big impact on the student's interest." Young children do their own thing, and it wouldn't be as weird for a first-grade female doing what a boy would be doing at that age. Mo had a different suggestion, and that is to be open. She states that she knows some will disagree with her statement or go along with her statement, but it just the way it is females are more interested in somethings than men are. Even though she is in TechEd people tend to think she wants to be out welding for hours on end or building stuff. There are female aspects that can be brought into TechEd. For example, one of the projects Mo worked on an Arduino in high school. She made a platform for her Arduino to light up two figures dancing. Since both males and females may like dancing, this was a gender-neutral activity appropriate for the classroom. It was still TechEd, but it was not gendered biased. Mo goes forward talking about her plans for teaching elementary STEM. She would like to get every student engaged in the subject and to build some passion whether it be in science, technology, engineering or math.

Lastly, Ayla states that through the curriculum there are opportunities to bring females into STEM-related courses. For example, in physics, there have been different innovations that have come out in the field. The innovations presented are things that were developed by males. Ayla also mentions that having the same gender group activities in classrooms can interfere with increasing female enrollment for those who are interested in a STEM-related career. For example, if a female is going to go out into industry when she is only familiar with working in female-only groups, it may cause a struggle at work because the industry is full of males. Women will need to cooperate with the men to overcome their males and females' internal biases. Women needs background experiences working with other genders besides their own because otherwise, they are going to burn out right away, or leave the field because they are just not going to be comfortable in that working environment.

Discussion

Despite the gains, the gender divides are still apparent especially with participation in the STEM field. Given the historically disproportionate involvement of males in industrial arts and technology education, male perspectives and interests tend to saturate the technology education curriculum. The Standards for Technological Literacy represent a positive movement in addressing this concern since the structure of the standards provides for diverse ways of developing curriculum and representing the interests of both genders (Weber & Custer, 2005). Weber and Custer expressed that the curriculum developers in technology education need to be informed by research and theory designed to comprehend "women's ways of knowing" if they hope to effectively recruit and retain women and girls into the study of technology.

The first strategy is to change the classroom to fill the seats with young female students interested in STEM subjects. The suggestions shared by the participating interviewed females had a similar solution to increase the female population in STEM fields, which were the implementations of presenting STEM learning as early as pre-kindergarten. Ellie, an interviewee who is studying Technology Education, stated that with younger children, there is not a big issue with gender roles. Young females are expected to play tea party and play construction as the boys do. As Ellie mentioned during the interview, "everyone is doing their own thing, and it wouldn't be as weird for a first-grade female doing what a boy would be doing at that age." There is a lot of stereotyping but not by the young children themselves. The implication of STEM during early childhood can benefit young females who are interested in engaging in a STEM subject.

The second strategy is creating mentors, after-school clubs, and other types of programs with an emphasis on female participation. Bringing in programs that are geared towards young female students will get females into STEM courses. For example, a program can be as simple as how a product was created where the students will reconstruct the product after the demonstration occurs. Mentorship is another strategy mentioned; however, there are two pathways to the approach. First, there is having a female already in a STEM profession come into the classroom as a presenter to share information with young women in high school. The presenter shows these young female students not to be afraid of STEM occupations. The second path is a one-on-one mentoring or developing group relationship that helps a young female reach her full potential. For example, most people can recall a person who had a positive impact on them. Mentoring can be a powerful way for young females to develop a keen understanding of their skills and character. In the end, this plays a vital role in their life.

The third step is to examine the STEM programs to see if the enrollment in classes, clubs and after-school activities mirror the recruitment of females in a school.

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Ask female students why they are (or aren't) interested in STEM. Administrators could use this information to actively encourage women to pursue STEM and to make the programs more appealing (DeNisco, 2016). Teachers are encouraged to construct knowledge from students' experiences. While this is important for all students, it is particularly important that teachers and curriculum designers in the STEM disciplines attend to the experience base of female students. Students often feel that content lacks relevance to them. Connecting students to content through their life experiences is essential. Rather than continually using traditional tools, material, or examples to demonstrate technological concepts, teachers should use cases with which both genders can identify (Weber & Custer, 2005). As Ayla, the interviewee who is pursuing Science Education, states, that "through the curriculum, there are opportunities to bring females into STEM-related courses." Curriculum developers and STEM educators may find it difficult to change cultural and gender-related stereotypes, but it is possible that carefully designed and well-built activities could inspire female interest in STEM topics.

Conclusion

Gathered findings of the gender gap, a decline of interest in women pursuing a degree in a STEM field, and ways of engaging young women in STEM-related courses has shown there are changes that can be made in attracting women into STEM careers. Interviewing women who are currently seeking a STEM education degree, with their suggestions of how to increase the intake of young women joining STEM-related courses helps improve understanding of how to increase the interest and participation of young females in STEM learning throughout primary and secondary education. This stories of the interviewed women in STEM education creates a better understanding of how the role of a female teacher holding a STEM education degree can impact a young female's mind. Despite new efforts to increase the female population in STEM courses and occupations, more research is needed to develop to find a solid strategy to achieve that goal.

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