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Abstract

This study investigated self-efficacy in men and women studying STEM (science, technology, engineering, and mathematics) majors at a small private university in order to determine whether women had lower self-efficacy scores than men, as has been suggested by previous research. The study also investigated the possibility of a negative correlation between femininity and self-efficacy. The participants (N=67) were evaluated using the College Academic Self-Efficacy Survey created by Owen and Froman (1988) to find self-efficacy scores, and the women (N=37) were also given the Bem Sex Role Inventory (Bem,1974) to determine femininity scores. The results found no relationship between gender and self-efficacy, as well as no correlation between femininity and self-efficacy. Possibilities suggested for why the results were different from past research include the small sample size and the college environment at this university. Possible further research could be done at larger universities to determine whether there is a factor at this school that makes the STEM majors more attractive and comfortable to women than at some other universities.

Among high school students, interest in STEM (science, technology, engineering, and mathematics) majors is largely equal among boys and girls. However, once these students reach college, female students are far less likely than men to actually pursue a STEM major, and men largely outnumber woman graduates in nearly every STEM field (Hill, Corbett, and Rose, 2010). There have been many studies done on possible reasons for this disproportion, but there are many different possibilities to be tested. This study will look at the correlation between gender and the academic self-efficacy of students in STEM majors as a possible reason for the low percentage of women in STEM careers. Self-efficacy can be looked at as the confidence people have in their ability to do something, so academic self-efficacy is a student's confidence in their ability to succeed academically (Sander and Sanders, 2015). According to Bandura's Social Cognitive Theory, efficacy has a large effect on both motivation and persistence: those who believe they can accomplish something are far more likely to attempt that task, and also less likely to be dissuaded by failure (Bandura, 1989).

Research has been done that relates this theory to college students, and has shown that academic self-efficacy has a significant effect on academic achievement, and in particular is strongly linked to persistence within the STEM majors (Litzler, Samuelson, and Lorah, 2013). In a study published in 2014, Litzler, Samuelson, and Lorah collected data from 10,366 undergraduate engineering students using the PACE (Personal Assessment of College Environment) test. Using results from this survey, the researchers found that white women do show lower academic confidence scores than white men and that this self-efficacy can have a large effect on factors that contribute to persistence and satisfaction within engineering majors. So if women have less academic confidence than men within these majors, this could be partially responsible for the low numbers of women in these fields. The first hypothesis that this study will test is that women in STEM

majors will have lower academic self-efficacy scores than men.

Although some studies have shown that women consistently show lower confidence scores than men in STEM fields such as engineering (Litzler et al., 2013), it is unclear if there is a correlation with gender roles, or if it solely based on biological gender. Gender roles refer to a person's adherence to traditionally masculine or traditionally feminine traits (Muehlenhard & Peterson, 2011). It can also be reflective of stereotypes of men and women; the higher a person's conformation to the traditional characteristics of their gender, the more chance they will internalize and be affected by this stereotype (Bandura, 1989). Because there is such a large stereotype that STEM subjects are for males (Hill et al., 2010), females can be less likely to pursue these majors, and be more easily derailed by hardships in their classes; that is to say, women that adhere to these gender roles and are affected by these stereotypes can have a lower sense of academic self-efficacy in STEM subjects. In 2001, Correll published a study looking at the correlation between students' reported self-assessment in math and persistence in a STEM major, using the National Educational Longitudinal Study of 1988 (NELS-88), a data set of over 16,000 high school students (Hill et al., 2010). This study showed that even when actual mathematic ability was equal, high school boys were more likely to report that they were good at mathematics. However, female students rated themselves as much more competent in verbal subjects. This suggests that the reason for low self-assessment by females in the subject of mathematics is due to the stereotype that mathematics is a masculine subject. The study also found that higher self-assessment in math predicted the student being much more likely to enroll in higher-level STEM courses and pursue a STEM degree (Hill, Corbett, and Rose, 2010). Because higher femininity scores can lead women to identify more with gender stereotypes, the second hypothesis that this study will test is that femininity scores will be negatively correlated with self-efficacy scores, and therefore females with high femininity scores will have low self-efficacy scores.

Method

Participants

This study used convenience sampling to obtain a sample of 67 students in STEM majors at a small, private college in the Southeast United States. Students were selected from general and upper division biology, chemistry, and physics courses. Thirty-seven of the participants were women, and 30 of the participants were men. The mean age of participants was 19.5 years, S.D. = 1.43. All of the students were pursuing a bachelor's degree in a STEM field: Biology, Physics, Chemistry, or Mathematics.

Instruments

This study used two different surveys, as well as a demographics questionnaire. The survey used to measure academic self-efficacy was the College Academic Self-Efficacy Scale (CASES). This 33-question survey was created by Owen and Froman (1988). Participants indicated their confidence using a 5-point Likert scale on items such as "answering a question in a large class," and "taking an essay test." The rating scale on this survey was 1=Very little confidence, 2=A little confidence, 3=Neutral, 4=A lot of confidence, and 5=Quite a lot of confidence. The survey was scored by finding a mean value of all items rated in the survey. Reliability was determined by administering the test to 88 psychology students twice over an 8 week period (Owen and Froman, 1988). The internal consistency was found to be .90 and .92 for the two testing occasions, and the

test-retest reliability estimate was .85 (Owen and Froman, 1988). Concurrent validity estimates were performed with the variables of frequency of performing the task, and enjoyment of the task, both of which were suggested by self-efficacy theory (Owen and Froman, 1988).

The second survey used was the Bem Sex Role Inventory (BSRI). This survey was developed by Sandra Bem (1974) as a measure of masculine and feminine traits, as well as androgyny. Participants rated themselves according to how often a number of traits described them, including 20 masculine traits, 20 feminine traits, and 20 undifferentiated traits. These surveys were scored by finding the mean of the traits in the different categories. Participants rated themselves using a 7-point Likert scale where 1 = Never or almost never true, 2 = Usually not true, 3 = Sometimes but infrequently true, 4 = Occasionally true, 5 = Often true, 6 = Usually true, and 7 = Always or almost always true. This survey has been used over the years for many studies and is one of the most often used when determining sex roles. It has been found to have high test-retest reliability (Masculinity: r = .90, Femininity: r = .90, Androgyny: r = .93) (Bem, 1974). It was also found to have discriminant validity by testing it against the California Psychological Inventory and the Guilford-Zimmerman Temperament Survey and finding little to no correlation between the scores (Bem, 1974).

The study also included a small demographics survey that included items such as "What is your major?" "How old are you?" and "What is your gender?" These were used to determine whether the participants were STEM majors and what their gender was.

Procedure

The participants were first given an informed consent form and allowed to ask the researcher any questions they had pertaining to the study. As the forms were picked up, participants were given a packet with the surveys and the demographics page. Men were given a packet with just CASES and the demographics portion, while women were given a packet that included CASES, the BSRI, and the demographics section. The researcher picked up the surveys when the participants indicated that they were finished.

Results

Hypothesis 1

It was hypothesized that women in STEM majors would have lower academic self-efficacy scores than men. It was found that women (MEAN = 3.55, SD = 0.71) did not have significantly lower self-efficacy scores than men (MEAN = 3.75, SD = 0.45) in STEM majors, t (65) = 1.30, p = .10$_{\text{one-tailed}}$. Therefore, the first hypothesis was not supported.

Hypothesis 2

It was hypothesized that femininity scores would be negatively correlated with self-efficacy scores. It was found that femininity and self-efficacy were not correlated, r = .217, p = .102. Therefore, the second hypothesis was not supported.

Discussion

Research has shown repeatedly that women in STEM majors tend to be less confident in their academic abilities than men. Hill et al. (2010) collected and summarized multiple studies performed in recent years to explain why there are less women in STEM fields than men, citing several factors linked to self-efficacy, including beliefs about intelligence, stereotypes, and self-assessment. In Correll's study (2001), it was found that in high school students, women always scored themselves lower on academic ability in STEM fields

than men, regardless of actual ability or grade in the subject. Litzler et al. (2013) found that in a study of over 10,000 undergraduate students, women in engineering had significantly lower confidence scores than men, regardless of race, largely due to relationships with faculty and peers, as well as perceptions about the field.

The current study hypothesized that women in STEM majors would have lower self-efficacy scores than men, and that there would be negative correlation between femininity and self-efficacy. The study found that in a small, private university, there was no relationship between gender and self-efficacy, or between femininity and self-efficacy. The sample was 67 students from general and upper division science courses who were majoring in a STEM field such as biology, physics, or chemistry.

There are several factors in this study that could contribute to results that do not support the hypotheses. One of the biggest limitations of this study was the sample size. Because convenience sampling was used, all of the participants came from a small, private university. Due to the size of the university and the time frame for this study, the sample size was not as large as in many of the other studies done on this topic. With the sample being so much smaller, the data might not represent the attitudes of women and men in STEM majors as accurately as a study using a larger sample.

Another possible limitation of the sample was where the sample was collected. Private universities tend to attract a certain type of student due several factors: private universities are usually much more expensive than public universities, private universities usually uphold a stricter code of conduct, and many private universities are religiously affiliated. This leads to a student population that is widely uniform and not particularly diverse. This, along with the small sample size, could have led to lack of variation in the study.

Related to the variation of the sample is the background of the participants. One of the largest factors that research has shown contributes to a low sense of self-efficacy in women in STEM fields is stereotypes (Hill, et al., 2010). There is a large stereotype of science and technology belonging to men. According to Bandura, the first place children learn gender stereotypes is from their parents (1989). When parents only dress their children in certain colors or only give them certain toys according to their gender, the child learns gender roles. If the parents of the participants in this study did not enforce gender roles, and instead reaffirmed interest in STEM fields regardless of gender, this could affect their self-efficacy scores. A way to combat the negative effects of stereotypes is through role models (Bandura, 1989). Many students with STEM majors have parents in STEM fields, so if the participants grew up with a female guardian or authority figure that was in a STEM field, they would also feel less of an effect from the stereotype and may have higher self-efficacy scores.

Another factor that could contribute to the divergence from the research is the environment in which the participants were selected. According to Litzler et al., lack of role models and insufficient encouragement can lead to low self-efficacy in women (2014). At the university that the participants attend, 4 of the 9 total STEM professors are women, almost an equal ratio with men. Also, many of the introductory classes are taught by female professors, showing students in their first year positive female role models in the field. The presence of strong women teaching in the STEM major could significantly contribute to higher self-efficacy scores in female students.

Support is also an important factor. The university where data was collected has one-on-one advising for STEM students with a professor in the field, as well as a small professor to student ratio. This provides personalized attention and guidance to the students pertaining not only to classes but also to future career goals. This advising also shows students that there are STEM professors that know them personally and are interested in their wellbeing. This support may be a major cause for higher self-efficacy scores than in other studies.

Along with small class sizes, the STEM classes that the surveys were administered in had almost equal numbers of male and female students. Peers contribute largely to a sense of self-efficacy and can determine how confident a person feels in their ability (Bandura, 1989). Because of the stereotype of men being better at math and science than women, male students tend to underestimate their female peers (Hill et al., 2010). A large number of female students in the class could lessen the impact this has on the self-efficacy of the female students.

An interesting way to continue this research would be to attempt the study with a larger sample, perhaps from a public university. Comparing this study with one performed at a large school would be a good way to test what factors are contributing to higher self-efficacy scores. These could then be implemented to help retain women in STEM majors and fields.

References

Bandura, A. (1989). Social cognitive theory. In R.Vasta (Ed.), *Annals of child development. Vol.6. Six theories of child development,* 1-60.

Bem, S. L. (1974). The measurement of psychological androgyny. *Journal Of Consulting And Clinical Psychology, 42(2), 155-162*

Correll, S. J. (2001). Gender and the career choice process: The role of biased self-assessments. *American Journal of Sociology, 106*(6), 1691-1730.

Hill, C., Corbett, C., & Rose, A. S. (2010). *Why so few?: Women in science, technology, engineering, and mathematics.* Washington, D.C.: AAUW.

Litzler, E., Samuelson, C. C., & Lorah, J. A. (2014, March 21). Breaking it down: engineering student STEM confidence at the intersection of race/ethnicity and gender. *Research in Higher Education*, 55(8), 810-832.

Muehlenhard, C. L., & Peterson, Z. D. (2011). Distinguishing between sex and gender: History, current conceptualizations, and implications. *Sex Roles, 64*(11-12), 791-803.

Sander, P., & Sanders, L. (2015, October 14). Measuring confidence in academic study: A summary report. *Electronic Journal of Research in Educational Psychology and Psychopedagogy, 1(1),* 1-17.

Owen, S. V. & Froman, R. D. (1988, September). Development of a college academic self- efficacy Scale.Paper presented at the 1988 annual meeting of the National Council on Measurement in Education, New Orleans: LA.