Lack of Women in STEM Based on Non-Assertive Behavior

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Science, technology, engineering, and mathematics lay the foundation for a constantly changing environment in present day society. A prediction made by the U.S. President's Council of Advisors on Science and Technology stated that over the next decade approximately one million more STEM graduates above and beyond the current graduation level will be needed in order to meet the demands of the U.S. workplace (Ellis, Fosdick, & Rasmussen, 2016). These career paths, otherwise known as STEM, are lacking one factor: women. Women in STEM, particularly in the area of engineering, are underrepresented. In 2009, women earned only 16.5% of the undergraduate degrees awarded in engineering and 19.3% of the undergraduate degrees in physics (Heilbronner, 2012). It is proposed (Xu, 2008) that the underrepresentation within these fields are due to the academic culture that provides women with less opportunities, inadequate support, and imbalance in leadership rather than gender-based dissimilarities such as roles in family responsibilities. According to the Precluded Interest Theory (Cheryan & Plaut, 2010) stereotypes often occur when people associate themselves and or generalize a person or group's characteristics within that field (e.g. tall, Caucasian male, mechanical engineer, attended Cal Poly Pomona, etc.).

Women that tend to stray away from STEM related occupations are often due to family related goals and the preference to help others in the area they choose to study (Barth, Guadagno, Rice, Eno, Minney, & The Alabama STEM Education Research Team, 2015). Based on this information, a question is raised: does this seem like an excuse or should women be more assertive when going into STEM related areas? Assertiveness is sometimes labeled as dominance (Twenge, 2001) and is considered to be a sub trait of extraversion and grouped with other traits such as independence, leadership, and control. Assertiveness, in hindsight, is generally founded

on freely expressing opinions and feelings, being sure of whom an individual is, and being a leader. According to Twenge (2001), "assertiveness is linked to status." Social status is more essential (Bosson & Michniewicz, 2013) to the male than female gender role. Women are viewed as being at a lower status than men. This generally means the stereotypical role of a man is seen as the provider and protector, thus being more assertive, while a woman is stereotypically the nurturer and caregiver that possesses reserved and hesitant traits.

From a social learning theory perspective (VanLeuvan, 2004) this illustrates that students with less positive attitudes who do not expect success or do not value math and or science will lack the enthusiasm to continue in these fields. Based on previous research, it seems apparent that women are not pursuing careers in engineering based on a fixed mindset and stereotype that women are not qualified as men (Ma, 2011) lack of skill set or interest needed in preparation for this field, and a decline in assertive capabilities when it comes to pursuing this career path. By measuring women's assertiveness at a young age into adulthood, there needs to be more initiative in breaking the gender gap in STEM.

This study will take a comprehensive look at what a fixed mindset and stereotype is at an early age; along with establish the leadership style and assertiveness of professionals that are in STEM (specifically engineering) career pathways. This will give insight as to how women's assertiveness and leadership style changes over time, along with create new ways to enhance a women's interest and skill set in the field.

A Fixed Mindset and Stereotype

At an early age, most children are eager to know and learn about the world around them. Children's intelligence mindsets, which are beliefs about whether intelligence is fixed or malleable, (Haimovitz & Dweck, 2016) strongly influence their motivation and learning. The

differences in sex have been observed over time with verbal and spatial specialization. Females have shown to be fairly better in verbal skills and males marginally better in spatial skills (Yeo, Ryman, Thompson, van den Heuvel, de Reus, Pommy, Seaman, & Jung, 2016). Spatial skills are used in problem solving and are an important part of the cognition process.

Women have been told at a young age that "men are better than women at math" or "women should not be in a certain area of work." This has often hindered women from jobs related to STEM. One study found that parents' perception of kindergarten through third grade children's math competence did not differ by gender (Gunderson, Ramirez, Levine, & Beilock, 2012), yet the same parents believed that math was more important for boys than girls, thus proving a strong math-gender stereotype at an early age. Women's math performance is often obstructed by their concerns about approving the negative stereotype about their group's math ability, according to the stereotype threat theory (Marx, Monroe, & Cole, 2013). Math self-concept is considered an important predictor in the pursuit of STEM fields (Sax, Kanny, Riggers-Piehl, Whang, & Paulson, 2015). Numerous studies have surveyed the role of self-efficacy, self-confidence, and self-assessments in predicting career related outcomes among women in STEM. One study showed (Szelényi, Denson, & Inkelas, 2013) that self-assessment of math skills were not related to women's aspirations to engineering careers.

Stereotypes can be delicately triggered (Hoyt & Murphy, 2016) in a variety of ways including being the numerical minority or the lack of being a certain gender in a work setting. A stereotype threat is a concerned form of anxiety (Shapiro & Williams, 2009) that disrupts and undermines an individual's performance or actions can be seen through a negative stereotype. Researchers have revealed that contact to situational cue highlighting a gender imbalance at a STEM conference (Hoyt & Murphy, 2016) decreased female students' sense of belonging and

desire to contribute in the conference compared to those not exposed to this threat of identity. By using role models, the media, and environments in math-related fields, women will broaden what is deemed as a stereotype within these subject matters. Efforts are underway such as bringing engineers into high school classrooms and holding summer camps (Cheryan, 2012) that expose girls to a variety of math-related careers that are available to them in the industry.

Lack of Interest and Skill Set in STEM

In recent decades, women are becoming more attracted to fields such as medicine and architecture as opposed to computer science and engineering (Cheryan, 2012) because it is often seen as less likely to fulfill their communal goals. Some research specifies that girls' beliefs and attitudes contribute to a significant portion of their science and mathematics experiences and interests (VanLeuvan, 2004). In reference to Lippa, Preston, & Penner (2014) occupational sex segregation has declined in some occupations including law, veterinary medicine, biological science and medicine (Schreuders, Mannon, & Rutherford, 2009) whereas STEM occupations still maintain strong sex segregation is where women's participation is lower than men's. Research has been conducted to determine vertical and horizontal segregation. Vertical segregation focuses on job quality and in contrast, horizontal determines the level of work needed (Lippa, et al., 2014). An example of horizontal segregation would be manual versus non-manual labor. Based on job dimension (Lippa, et al., 2014) men are assigned to more manual labor and women are assigned to more non-manual labor.

Since women are underrepresented in mathematics and science-based professions, (VanLeuvan, 2004) girls may have less opportunities to meet female role models and acquire information about the career possibilities offered in these fields. To paraphrase VanLeuvan (2014) if girls observe that there are fewer women in engineering based occupations this can go

one of two ways. The first way is they determine that the field is more appropriate for men than women. The second being exposed to female engineers improves their future attitudes (in high school) towards science and women in science. In this study, the positive affect would be improving girls' views towards engineering and STEM related work.

A Conceptual Definition of Assertiveness

Hollandsworth & Wall (1977) depicted assertion (assertive responses) as including the expression of commendatory or affectionate responses as well as oppositional ones when collecting Assertion Inventory and rating the Rathus Assertiveness Scale. Women associated advanced (upper management) positions with conflict, which most likely affects their level of articulating dominance or authority. This explained the relationship between gender and the desirability (Gino, Wilmuth, & Brooks, 2015) for professional advancement. This lack of assertiveness is due to (Gino, et al., 2015) women being seen as less competent and lacking leadership capabilities. It is believed that women are more likely to encounter challenges, doubt, and repercussion when proposing new ideas. Overall, women are more interested in occupations or fields that deal with people, whereas man deal with things. A study in 2003 quantified that "young women value working with and for people" (Schreuders, Mannon, & Rutherford, 2009). Women do not perceive engineering as meeting that need of working with and for people. Assertiveness is strongly linked with status (Twenge, 2001) and stems from education and work. To breakdown this common gender role label, it has been said that men are seen as more aggressive and assertive because that is historically how they have been portrayed. This was more common in the past, whereas now there are stay at home dads and more women in the workforce (Twenge, 2001) in general, despite the lower number of engineering workers. With this thought in mind, the following directional hypotheses are addressed:

H1a: Women tend to have a more participative leadership style than men in the Engineering field.

H1b: Men are more assertive than women in the Engineering field.

Method

Participants

This correlational research study will be an overview of genders, male and female, at a professional level in the Engineering field. The procedures conducted will be a survey, self-assessment, data collection, and brief observation. The sample size will be 100 broken down to 50 men and 50 women. The demographic will range from Caucasian, African-American, Latino, and Asian. The Socio-economic status will be middle to upper class. The age range will be from mid 20's to mid 50's. The location will be based in Riverside and Orange County and possibly San Diego County as well. In addition, looking into schools that specialize in Engineering such as University of California, Riverside, Cal Poly Pomona, and University of California, San Diego that have a strong STEM base for alumni will be a quintessential opportunity to source for the sample size as well as Reddit, acquaintances, and social media.

The survey will be based on each of the individual's educational experience. Questions will range from: "What was your favorite level of math?" "What kind of STEM program was offered at your educational facility? "Do you feel like the courses prepared you for your field work?" "What was your least favorite level of math?" and "Have you ever considered dropping out of the STEM related field?" In addition to personal questions, questions based on preferred leadership style will be on there. The verbiage will consist of words such as: dominance, authoritarian, strict, and passive will be used in order to assess men and women's idea of what assertive behavior means to them. Lastly, there will be situational questions in regards to their

career (e.g. have you ever felt underrepresented or incompetent?). These types of questions will most likely differ, due to the previous research stating that over half of women in this particular field feeling out of place.

As Bellou (2011) quoted Hersey and Blanchard (1982), leadership is seen as influencing individuals or groups in an effort towards a goal in a given situation. The professionals will fill out a Rathus Self Assessment that is based off the Likert scale. The questions will be primarily focused around assertiveness in comparison to the leadership style survey.

Measures

Leadership Style will be measured using Descriptive of Leadership Style, Employee Empowerment, and Organizational Measures Survey (Men, 2010) and Factor Analysis For Leadership (Bellou, 2011). The questionnaire consists of 10 questions regarding preference of leadership style and 5 questions based on educational experience. The 15 questions are based off of a 3-point Likert Scale and determine the following: people orientation, change orientation, and task orientation. Statements include, but are not limited to, work environments in the engineering being: consistent, trusting, considerate, appreciative, how subordinates are treated, conflict free atmosphere, and pushing for growth. The educational background questions are in direct relation to leadership style and STEM preference. These measurements contain a high predictive validity and generally strong reliability ($p < 0.01$ and $\alpha = .72$ in reference to Bellou, 2011).

According to McCormick, Hahn & Walkey (1984) assertive training has become progressively popular and is often evaluated by using self-report questionnaires as tools to improve a work environment. The Rathus Assertiveness Schedule Assessment (McCormick, et. al., 1984) is also is based off of a Likert scale. On this survey, there will be 10 statements related to level of assertiveness phrased such as “I am satisfied with my peers at work” “I like to be in

control over group projects" or "I prefer not to work in groups." These will be measured from 1 (strongly disagree) to 5 (strongly agree). This measure also has a high predictive validity and strong reliability ($\alpha > .77$). The pre-test consisted of $\alpha = .82$ and post-test $\alpha = .92$.

Results

An independent-samples and t-test were conducted to investigate the relationship between men and women's leadership style. The independent variable, sex, contained two levels: female (n = 16) and male (n = 1). The dependent variable was leadership style. The t-test obtained a significant result, $t(8) = .0.08$, $p = 0.020$. The results suggest that women's leadership style ($M = 2.75$, $SD = 1.33$) is statistically significantly different from men's ($M = 2.71$, $SD = 1.185$).

Hypothesis One: SPSS Independent Samples Test and T-Test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
eadership Style	Equal variances assumed	1.493	.257	2.887	8	.020	2.0000	.6928	.4024	3.5976
	Equal variances not assumed			2.887	6.817	.024	2.0000	.6928	.3528	3.6472

T-Test

Group Statistics

	What leadership style do you prefer?	N	Mean	Std. Deviation	Std. Error Mean
How satisfied are you with your work environment?	1 Women	17	2.75	.73030	2.61
	2 Men	17	2.71	1.185	.349

A sample of n = 17 subjects was obtained with scores on Leadership Style (M = 4.25, SD = 1.33) and Work Environment (M = 2.19, SD = 5.53). It was hypothesized that leadership style would negatively correlate with work environment. The correlation coefficient r = .24 (p < .001) indicates that leadership style is significantly negatively correlated. The results suggest that women have more of a participative leadership style than men in the engineering field. This is due to men being more assertive and dominant in their decision-making and verbal communication skills.

Hypothesis Two: SPSS Bivariate Correlations

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
Leadership_Style_Mean	4.25	1.3291	17
Work _Envir_Mean	2.19	5.5316	17

Correlations

		Leadership_ Style_Mean	Work_Envir_Mean
Leadership_ Style_Mean	Pearson Correlation	1	.249**
	Sig. (1-tailed)		.000
	N	17	17
Work _ Envir_Mean	Pearson Correlation	.249**	1
	Sig. (1-tailed)	.000	
	N	17	17

**. Correlation is significant at the 0.01 level (1-tailed).

Discussion

The independent t-test ran significant results. The study discovered that there were significant differences in women's leadership styles compared to men in the Engineering field.

This result is comparatively similar to previous studies that investigated the difference between men and women's preferred leadership style.

Implications of a Fixed Mindset

As previously stated in research by Gino, et al., (2015), women are seen as less competent and lack leadership capabilities. Women tend to doubt their capabilities and sometimes rely on other women (or men) for further clarification. The survey indicated that 13 out of the 17 (one being a man) surveyed preferred the participative leadership style as opposed to transactional, autocratic, Laissez-Faire and transformational. This also validates previous research from Gino, et al., (2015) on how women prefer to work in careers that involve working with people. Within the STEM field, the 16 women that participated in the survey agreed that they too also like to work with people in their designated area of engineering. Most women responded to what was hypothesized, demonstrating a greater ability to actively partake in a participative leadership approach than men. The one man that completed the survey chose transactional as his preferred method of leadership. Transactional leadership is most commonly known as the give then receive back kind of reciprocity (Bellou, 2011) where two people are often in exchange with each other.

The correlations test provided insight on how women's leadership style ultimately affects how their work environment and how assertive they will be in that setting. The results indicated a positive correlation between the word confident and the word assertiveness, as well as enjoying working with others in their work place. The 16 women engineers worked primarily in the field of mechanical engineering.

Implications of Assertiveness

When measuring what the term "assertive" meant to an individual, 11 out of 17 thought that assertive meant being confident compared to the words: firm, insistent, assured, and overbearing. This proved that women viewed assertiveness as something that was positive rather than negative in the workplace. When asked "I enjoy working in groups" 9 out of 16 women chose that they agreed and that they enjoyed working in groups at work. The one man that participated in the survey disagreed and chose that he did not enjoy working in groups at work. In contrast to Twenge's (2011) research on mean being portrayed as more analytical and assertive, 8 out of the 16 women chose their preferred communication style as analytic, while 7 out of the 16 women favored the expressive communication style. This question on the survey showed how women in this particular field preferred a more common form of communication style, more closely related to how men in this field and in general tend to communicate.

Limitations of Study

During this research, there were a number of limitations to this study. The first limitation was the sample size acquired. Originally, there were supposed to be 50 men and 50 women participating in the survey. The sample size of the survey only equated to 16 women and 1 man. Due to time constraints, only women in the engineering field (that graduated from college) were surveyed. The reason for leaving men out of the survey was due to previous research conducted; more men are usually surveyed than women. By obtaining data of women ONLY, this gave the study a more in depth analysis on women in STEM. This indicated their preferences to see if the research was proven to be true. The distribution of survey was sent via link through social media outlets including a STEM group on Facebook, via email to CSUF alumnus in the engineering field, and through word of mouth via conversations in classroom and at work. The age range and demographics varied from the youngest age of 25 to the oldest 66. If there had been a limit of

age range from 25 to 45, this also would have changed the way the answered were chosen as well. Hypothesis 1a was proven to be true; women tend to have a more participative style of leadership than men do.

The second limitation of study was incomplete surveys and possible untruthful answers. When looking at the data provided, 28 people (25 women and 3 men) in total took the survey, but did not fully complete it. This could have offered a better sample size and in depth analysis of women in comparison to men in engineering. The data would have had a greater number in standard deviation, degrees of freedom, and mean. Essentially, all of the data would have been substantially different. Untruthful answers may have been another to rush through and complete the survey as well.

The third limitation was the number of questions and format. When observing the data, most were Likert Scale questions, open ended, and multiple choice. In this case for future studies, it would have been more efficient to stick to one type of formatted question and maximum 10 questions. Most individuals stopped taking the survey by question 8. Convenience and random sampling was mainly used in this research, which may have limited the sample size. Hypothesis 1b was proven to be true, BUT due to the lack of men participants, needs to be further studied in the future.

All in all, there were a number of things to do differently when acquiring data for this study. It would be most beneficial to continue studies like this from 3, 6, to yearly increments to see the growth or decline for women in STEM. Also, using more of the approach McCormick, et. al., (1984) took with the Rathus Scale Assessment and shaping it better just based on that. Advice for future research studies would be to attend actual engineering and STEM based events, look for STEM groups that have a strong representation specifically just for women, and

use a different method of sampling. By using focus groups, face-to-face interviews, and surveying both genders, this will give a more accurate interpretation of women and men in STEM.

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Appendix

eliability

ale: COMMANDLEADERSHIPSTYLE

Case Processing Summary

		N	%
ases	Valid	16	94.1
	Excluded[a]	1	5.9
	Total	17	100.0

a. Listwise deletion based on all variables in the procedure.

eliability Statistics

ronbach's Alpha	N of Items
.628	3

Item Statistics

	Mean	Std. Deviation	N
mmandLeadershipSty	2.7500	.73030	16
3 – Which mmunication Style st describes you?	2.3125	1.35247	16
11 – Which Leadership yle do you prefer?	3.1875	.65511	16

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
mmandLeadershipSty	5.5000	2.133	1.000	-.117[a]
3 – Which mmunication Style st describes you?	5.9375	1.329	.526	.552
11 – Which Leadership yle do you prefer?	5.0625	4.129	.091	.856

a. The value is negative due to a negative average covariance among items. This