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Title IX and Project Lead the Way: Achieving Equity through All-female Cohorts in Public School Settings

Ms. Shawna Fletcher, Texas A&M University

SHAWNA L. FLETCHER is Director for the Women in Engineering (WE) Program at Texas A&M University. Her primary responsibilities include outreach, recruitment and retention programs for women students and faculty in the Dwight Look College of Engineering. She has been President of the Arizona Promoters of Applied Science in Education (APASE) since 2006. She holds an M.S degree in Bioengineering and B.S. degrees in Physiological Psychology and Microbiology from Arizona State University. Since 1997, she has been dedicated to engineering recruitment/retention programs and K-12 STEM educational efforts in Arizona, Ohio and Texas.

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Abstract

Nationally recognized programs, such as Project Lead the Way (PLTW), have provided interventions to increase the number of students exposed to engineering principles at the K-12 level. Although numbers of participants are increasing, in many high schools PLTW is offered as an elective and attracts few female students. In an effort to understand classroom dynamics, many PLTW programs show that interest of underrepresented populations mirrors national metrics for women in engineering. Recently, specialized efforts to recruit and retain women have emerged. Partnerships between universities and K-12 educational systems have been created to provide opportunities to increase student engagement.

All-female PLTW Intro to Engineering Design (IED) courses have been developed in several schools to attract more underrepresented students. Over a few short years, specific all-female cohorts have served to increase the number of women at high rates. Though programs with cohorts continue to show success, questions regarding Title IX compliance or violation emerge with single-gender courses offered within public educational settings. This paper will provide an overview of known all-female cohort efforts in Project Lead the Way, an overview of Title IX, and a discussion of whether these cohorts are compliant with gender equity legislation when offered in a public school setting.

Background and Introduction

Project Lead the Way (PLTW) is a nationally recognized organization in over 8,000 schools across the US. With professional development and training for teachers, Project Lead the Way program curriculum encompasses Kindergarten – 5th grade (PLTW Launch), Middle School (PLTW Gateway), and High School (PLTW Engineering, Biomedical Science, and Computer Science). For Launch and Gateway programs, curriculum may be embedded into public school settings in an effort to expose all students to activity, project or problem-based learning strategies[1]. For high school students, many PLTW initiatives are not embedded, but offered as an elective course, outside of their normal Science, Technology, Engineering and Math (STEM) trajectories. Students in public school settings where PLTW is offered as an elective may find that these courses conflict and compete with other courses that may hold a personal interest. Though PLTW courses are engaging and expose students to principles in engineering and technology, in many educational settings, it is up to the individual student to decide on PLTW as a viable and worthwhile pathway.

To assess the impact of PLTW, several states have begun longitudinal tracking of students enrolled in PLTW courses. In Illinois, PLTW programs have shown a dramatic increase in the number of schools participating with almost 8,000 students enrolled in 2012[2]. From their pathway to engineering courses, females were shown to go on to Introduction to Engineering

Design Courses (48%), Principles of Engineering (21%), and Digital Electronics (8.5%) at substantially higher rates than in 2004. Though these students represented 16% of the total PLTW pathway courses, their enrollment in high school courses were evidenced by their previous exposure to STEM content and Gateway to Technology unit modules[2]. In Milwaukee, PLTW programs boast 37 schools with an enrollment of 9425 students. Females represented 49% of the total population in these programs, much higher than national average[3]. Positive impacts included better student outcomes and engagement in STEM subjects as well as higher attendance rates for seniors[4].

Longitudinal research on Iowa PLTW graduates report overall graduation rates were 3% higher than in control groups. Males and females both showed slight increases in their probability of graduating from high school after participating in PLTW programs[5]. This study also found that approximately 70% of PLTW students transitioned to higher education, while non-PLTW students were more likely to transition to 2-year institutions[5]. Further examination revealed that although the majority of Iowa's PLTW participants are white males, 20% of PLTW female participants suggested their numbers mirrored national trends for mechanical and electrical engineering[6]. Indiana programs reported that PLTW increased the proportion of students majoring in STEM disciplines. If students took three or more courses, they were six-times more likely to major in these disciplines than non-participants[7]. However, this study discussed that less than 17% of PLTW participants took more than two courses[7]. Overall results indicate that PLTW participation increases the number of students entering university STEM majors. Many states are able to show impact with PLTW however, they are relying on students that self-select PLTW as an elective course.

When tracked to college, a 2006-2007 report found that 40% of former PLTW students select engineering and technology. Overall, students selected engineering at 5-10 times the rate of typical students[8]. Though this report concluded women were not well-represented, they expected the implementation of Biomedical Engineering PLTW courses would attract females at higher numbers, thereby increasing the participation of women in engineering university programs. This study also found that 80% of PLTW students planned to go to college, compared to 63% of their peers. Further, 90% indicated they knew what they wanted to major in because of their PLTW experience and 80% indicated their PLTW experience would significantly assist their success in their postsecondary education[8]. This comprehensive report suggests further evidence PLTW increases the quantity, quality and diversity of engineering students.

In Texas, students were measured over a six-year period. From 2006 – 2010, enrollment quadrupled and participants increased 18,686 individuals (4498 in 2006 to 23184 in 2010)[9]. Female participation increased 586% and Hispanic students increased 507%. This study also showed a high impact on students enrolling in higher education (62.1%) compared to their non-PLTW counterparts (58.4%)[9]. In addition, post-secondary enrollment was slightly greater for females (63.5%) compared to their non-PLTW peers (63.1%).

Several studies have examined self-efficacy of females for math and science subjects when participating in PLTW[10,11,12]. Exposure to engineering through PLTW has shown to have significant impact on self-efficacy and underrepresented students[10]. The more exposure students experienced, the higher their self-efficacy in engineering. In addition, formal exposure to engineering is necessary. For females, many all-female cohort efforts exist in informal settings (camps, one-day programs, science museum activities) and show little long-term results. Exposure to engineering through PLTW assists students with interest as well as achievement in other core subject areas, such as math[11]. Time and time again, females were shown to outperform males in subject areas as well as increase their confidence and self-efficacy in answering questions in math courses if they participated in PLTW. Classroom observations indicated that PLTW females volunteered to answer questions in math classes four times (68%) more often than their non-PLTW female counterparts (17%)[11]. Overall, studies have shown that exposure to PLTW has a positive influence on student math and science achievement, career interest, motivation, and future career choice[12].

Though these studies show impact, females are not enrolling in PLTW programs at high rates. Therefore, efforts are needed to remove environmental factors that inhibit women's participation in PLTW and traditionally male-dominated areas.

All-Female Cohorts

Recently, several all-female cohorts have popped up in Ohio, Georgia, Florida, Alaska and Texas[13,14,15]. Though not widely known, these efforts have been enlisted to significantly increase the number of women entering IED and Electronics courses through PLTW. In 2011, a partnership between Hilliard Davidson High School in Worthington, OH and the Women in Engineering (WiE) Program at The Ohio State University (OSU) was initiated. Originally, a male math and PLTW teacher was concerned about participation of only two female students in his entire PLTW four-year program. With research-based practices, the Women in Engineering Program suggested that an all-female cohort be piloted for freshman through senior women to get them engaged. With support from the administration, an all-female IED course called "WiE IED" was offered in Fall 2011. Support from the university was minimal as female engineering students visited the classroom about five times per year.

One of the first events included recruitment from the feeder middle school to bring interested students to the high school campus for a ½ day program. Five OSU engineering student volunteers and the Interim WiE Director assisted the school to create an interactive, hands-on experience with PLTW high school students. The results were positive and 18 students enrolled in the course. The next year, the program had 30 students enrolled in their PLTW all-female cohort[13,15]. By the third semester, the all-female IED course had a wait-list and students were continuing on with other PLTW courses. A video was produced and launched on the PLTW national website, with the teacher, current students, former PLTW participants and program administrators from Ohio State.

Due to hearing about the success of the Hilliard Davidson group, Alaska's Dimond High School PLTW initiated a similar program. "Smart Girls Rock" increased their PLTW participation from 13% to nearly 35% with a 50-50 split in their Digital Electronics course[7]. Gulliver Academy Middle School in Coral Cable, FL also showed a significant increase in the number of females in their PLTW courses after opening an all-girls section of IED. Jefferson High School in Cedar Rapids, Iowa also formed the Society of Women Exploring Engineering and Technology (SWEET) to keep girls already studying engineering engaged[8,15]. Across the PLTW community, with support from their administration, schools have been offering all-female PLTW cohort classes with great success. However, one question remains, if IED and PLTW courses aren't appealing to females, why do they have as much success when offered as all-female cohorts?

Case for Single-Sex Interventions

There are many reasons why women do not automatically enroll in engineering and technology courses. The absence of role-models, coupled with feelings of isolation, social bias, classroom and environment, and male-dominated teaching methodology are a few[16]. PLTW-specific studies have found that female students in PLTW IED courses lack parental support as well as support from peers and school administrators[17]. Qualitative studies indicate that inequitable classroom interactions, coupled with gender-biased instructional methodologies, deter female students from pursuing engineering career paths. When women are enrolled in single-sex programs or all-girl schools, the results are dramatically different. In Australia, 40% of the University of Technology, Sydney (UTS) female engineering students previously attended single-sex secondary schools[18]. The study found that female students were primarily motivated to pursue engineering due to their self-efficacy in math and females consistently outscored their male counterparts in measures of self-perception of skill and ability in mathematics. They also found that female students benefited from verbal encouragement, single-sex problem-solving groups, engineering problems that were embedded in context and single-sex classroom dynamics[18].

Identity as an engineer for females pursing engineering is important[16,19,20]. In multiple studies, support from single-sex programs enhanced female engineering students' sense of belonging in their major and the university in their first year[20]. Single-sex efforts are also found to increase and impact retention of women in STEM. Findings suggest a direct correlation between single-sex programs and identity compatibility for college women in STEM majors[16,20]. When stereotype-threat conditions were introduced to male and female students taking math tests, female students from single-sex educational institutions consistently performed higher than their male counterparts. In addition, females from single-sex educational systems outperformed their male and female co-educational counterparts on standardized math tests[21]. It was found that girls from single-sex schools had higher intrinsic motivation and self-esteem. The evidence is

clear, these factors are important to girls' self-efficacy and self-concept of their math ability, which in turn, affects their educational and career choices[21].

It is important to note the abundance of research that exists on women in engineering majors and self-efficacy[20,22,23,24]. However, the abundance of research is usually performed by studying mixed-sex teams, where female and underrepresented students exist in small numbers. The effect of being overpowered has significant effects on university-level students' confidence, identity, self-efficacy, and persistence. Several studies used the Longitudinal Assessment of Engineering Self-Efficacy (LAESE) instrument[22,23]. Overall, women and underrepresented students were found to perceive a "lack of inclusion" in engineering environments[23]. This result was thought to be attributed to negative social cues by fellow students and faculty.

Studies on mixed-gendered teams in freshman engineering courses also show that females experience isolation and take on stereotypical roles during projects and team presentations[25,26,27]. In one study, males were found to take on more active, technical roles and had better outcomes than their female counterparts[26,27]. On equal and male-dominated teams, male students were more likely to answer technical questions and appear more knowledgeable. Females were found to perform better when on all-female groups or when paired with other females than when they participated in mixed-gendered or male-dominated teams[26]. While literature suggests creating a team gender balance can improve student performance, the evidence supports that gender balance is not enough to overcome stereotypical team-role adoption[27].

Title IX

Title IX was added to the Education Amendments of 1972 to prohibit sex discrimination in educational programs that receive federal funds. Simply stated, Title IX ensures that "no person in the United States shall on the basis of sex, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any educational program or activity receiving Federal financial assistance"[28]. Under the law, Title IX requires that schools provide male and female students with equal opportunities and equal services, including facilities and teaching.

Title IX was originally intended to prohibit sex discrimination in educational programs and activities[29], applied to all aspects of education. However, Title IX is probably best known for its application to sexual harassment issues and equity in sports programs. The application of Title IX to sports has overwhelmingly shown that providing opportunities for girls can increase their participation[31]. Further, participation in athletics has shown to be beneficial for girls' self-esteem and confidence. In a comprehensive study, girls that participated in Title IX-sanctioned sports programs were found to have higher academic achievement, positive health benefits, and were more successful than non-participating groups[30].

By instituting Title IX, athletics departments have discussed the positive benefits and oversights of the legal measure. One of the biggest criticism of Title IX is the lack of metrics that can be used to define Title IX violations. The athletics community has discussed criteria for disparities that determine whether Title IX violations exist. The metric found to exist is a general difference of 10 percentage points. If the average population percentage is 10 or more percentage points different, a red flag is raised that the school is not complying with Title IX[30]. In the case of science and engineering, the national population of women is over 50% (50.8%). If compared to participation in PLTW and elective STEM courses, 16 – 20% difference in participation raises concerns regarding equity and discrimination. For athletic programs, self-reported data show that high schools in every state are examining their athletic programs to ensure they are treating their female students fairly and providing opportunities for participation. For PLTW and STEM programs, some states have begun to keep statistics on their participants however, a comprehensive list of participation in all states for PLTW does not exist. It is widely believed that the application of Title IX to science, math, and engineering if applied, should have similar results as athletics programs to increase the number of female participants[31].

At the university level, the National Science Foundation and National Academy of Sciences have made strides to assess gender differences in science and engineering by examining the distribution of federal research funds[32]. PCAST (President's Council of Advisors on Science and Technology) called for more spending at every point of the Science and Engineering pipeline. Universities have been called to 1) increase retention rates among undergraduates who declare an interest in science and engineering degrees and 2) improve the climate for women. Without the implementation and enforcement of Title IX, institutions will continue to miss the mark for attracting and retaining women and underrepresented populations.

Sevo's 2009 *Literature Overview* provides much of the history and development of the application of Title IX to Science and Engineering[33]. At the end of the article, there were several recommendations and future areas for research. Among the recommendations included 1) the establishment of an inter-institutional monitoring organization to review Title IX compliance 2) the monitoring organization has the authority to set standards and provide climate survey instruments for self-assessments 3) federal agencies should establish clear guidelines for Title IX compliance 4) a proactive role should be taken to ensure compliance and 5) sanctions should be developed for non-compliance[33]. The overview clearly states that indicators (counting the number of students participating in programs) is insufficient evidence to conclude they are Title IX compliant.

PLTW and STEM-related education programs need to develop similar metrics to athletics programs, to assess and verify that their programs are compliant. Seven years have passed since Sevo's article and recommendations for gender equity in science and engineering have fallen on deaf ears. This is thought to be due mainly because Title IX complaints are expected to be on a

case-by-case basis[34]. It is up to individuals participating in engineering programs and PLTW programs to come forward with their issues and lodge formal complaints. Addressing issues of "culture" in public educational environments is imperative to ensure the long-term success of women who enter (or don't enter) PLTW programs and STEM-related disciplines.

The lack of female representation in PLTW programs across the country suggests there are underlying dynamics or obstacles added to female students' experience. Engineering programs are well aware that these environments undercut their confidence, motivation, and sense of belonging. As a program that provides an introduction to engineering, PLTW programs should be aware that increasing girls' interest in science and engineering is only half of the equation. The other half is eliminating sexism and gender-bias within public classrooms, which is essential to increasing the number of women that participate and pursue STEM fields in college. Without recognizing social complexities that exist within public educational settings, students are faced with surmounting the odds and overcoming more than expected educational requirements.

Conclusion

In conclusion, public educational institutions are responsible for educating students in a safe and effective environment. Across the US, the number of female students engaging in PLTW does not reflect the population as a whole. Therefore, women will continue to be underrepresented in these programs unless measures are taken. Offering all-female PLTW cohorts have proven their success to attract and retain more female students. Though the evidence is clear, all-female PLTW cohorts are slow to be adopted. There is a fear that single-sex education in a mixed setting gives preferential treatment and an unfair advantage to some students. However, without these interventions, the representation of women in PLTW and engineering programs will increase incrementally at best.

It is important that societal factors that underlie sex-role stereotypes are minimized and addressed in the classroom and PLTW programs. PLTW and STEM programs are provided in public educational settings. However, there is not evidence that mixed-gender programs, especially male-dominated programs, are providing an equitable and non-discriminatory STEM-educational experience[35]. In fact, studies referenced in this paper suggest the contrary. Therefore, Title IX compliance should be a factor that is considered when offering PLTW courses as electives. Again, to ensure PLTW programs are equitable, Title IX should be the basis for instituting all-female cohorts in PLTW and elective STEM courses in public educational settings.

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