

## **Board 158: Creating a Pipeline of Future Engineers in Texas (Evaluation) (DEI)**

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## **Creating a Pipeline of Future Engineers in Texas (Evaluation) (DEI)**

### **ABSTRACT**

In Texas, the engineering program of study is one of multiple Career and Technology Education pathways a school district may offer. The curriculum for these pathways can be adopted from commercial providers or locally developed by school districts. Project Lead the Way (PLTW) Engineering is a curriculum that can be adopted by schools in Texas to fulfill the Engineering STEM pathway. This study followed cohorts of PLTW students to determine what impact, if any, does the PLTW curriculum have on the graduation rates of high school students. The likelihood to graduate with a STEM major or engineering major after high school was also examined. Program impact on traditionally disadvantaged groups was examined when compared to matched non-PLTW students. The sample for student included three cohorts of students who completed PLTW in high school and were tracked post-graduation. Outcomes for over 43,000 students enrolled in PLTW were examined. Results indicate Project Lead the Way has shown to improve student outcomes in terms of increased high school graduation rates, including improved graduation outcomes for underrepresented groups. PLTW was also shown to increase the share of college graduates with a STEM degree, and specifically also increasing the share of students graduating with an engineering degree. There is also an increased share of students from groups that are underrepresented in STEM and engineering fields.

*Keywords: STEM education, engineering education, Project Lead the Way, Student Outcomes, Graduation Rates, STEM Degrees (Poster, Work in Progress)*

## **Introduction**

There are several K-12 curriculum programs that are being implemented across the Texas to introduce and prepare students for engineering. These include programs such as Lego Engineering, the Infinity Project, and Project Lead the Way (Brophy and others, 2008). One of the most widely used curriculum interventions with potential to support positive higher education and employment outcomes is Project Lead the Way – a systematic educational approach that uses problem-based learning principles to support the development of skills and knowledge needed for college and career readiness.

Project Lead the Way is a national initiative providing precollege educational curricula (i.e., Launch, Gateway, Computer Science, Biomedical Science, and Engineering) designed to support STEM knowledge development, engagement, interest, and motivation using project- and problem-based learning (PBL) techniques (Tai, 2012). PBL is an instructional approach derived from the constructivist tradition that emphasizes the importance of active knowledge construction in the development of transferable skills and knowledge (Hmelo-Silver, 2004). Within problem-based learning frameworks, educators support learners' efforts to construct their own understanding of course content through the presentation of real-world problems that require 21<sup>st</sup> century skills – such as problem-solving, critical and creative thinking, effective peer collaboration and communication – to solve effectively (Hmelo-Silver, 2004). This is shown to result in deeper learning. Further, classroom experiences are augmented with interactions with industry experts that allow students to better understand the importance of class content to the successful functioning of the larger STEM industry and generate excitement regarding the possibility of pursuing employment within STEM focused areas by connecting students with potential role models and mentors (Reid & Feldhaus, 2007).

Beyond the pedagogical techniques described above, PLTW also includes a comprehensive professional development component to ensure educators can implement innovative instructional practices with fidelity (Project Lead the Way, 2020). More specifically, educators have access to intensive training modules and supportive materials (e.g., curriculum guides) designed to challenge misconceptions regarding effective teaching and provide the skills needed to effectively implement student-centered teaching practices that reduce passivity and allow learners to become an active participant in the learning process. One meta-analysis of STEM instructional improvement efforts has pointed out the importance that teachers' professional development such as summer workshop and implementation meetings play in improving the effectiveness of these STEM program (Lynch, et al, (2019)). The unique alignment among innovative instruction, STEM community involvement, and professional development emphasized by PLTW help cultivate a “STEM ecosystem” in which learners are exposed to a variety of high-impact learning experiences that provide the academic preparation needed to overcome common barriers to STEM pipeline persistence (Reid & Feldhaus, 2007).

Prior investigations of the overall efficacy of PLTW have repeatedly demonstrated the impact of the educational program on proximal academic outcomes. For instance, students involved in PLTW report higher levels of STEM interest (Hess et al., 2016) and increased standardized test score performance compared to their non-PLTW peers (Van Overschelde, 2013; Tran & Nathan, 2010). Perhaps most notably, involvement in PLTW has been shown to impact “downstream” outcomes that are critical in supporting STEM pipeline persistence. Specifically, students

involved in PLTW are exposed to a more rigorous and engaging academic activities, complete a higher number of college-preparatory courses, are more likely to pursue a STEM-focused degree after completing high-school, and are more likely to persist until degree completion than students who complete a more traditional K-12 experience (Bottoms & Uhn, 2007; Gottfried & Plasman, 2018; Van Overschelde, 2013).

The engineering pathway in Texas is aligned to critical workforce needs in the state. As a result, precollege engineering qualifies for Career and Technical Education (CTE) funding, Nationally, there is a gap between the supply and demand for engineers, with BLS estimating 140,000 new engineering jobs from 2016 – 2026. Another goal of precollege engineering programs is to increase the pipeline of potential future engineers. Programs like PLTW are designed to appeal to underrepresented groups and expose/immerse students in engineering to foster interest and build efficacy to facilitate students seeking STEM majors in postsecondary education. There are persistent disparities in STEM majors and workforce when it comes to female and minority participation in engineering and the physical sciences. Despite more women enrolling in college than men, women only make up 22% of the share of engineering degrees awarded. White students make up 64% of the share of engineering degrees awarded, while Black and Hispanic students make up 4% and 12% respectively (NCES, 2021)

### **Research Questions**

This research focuses on the following three research questions:

1. What impact, if any, does a project-based STEM curriculum have on the graduation rate of high school students?
2. Compared to matched non-PLTW students, how does participation in PLTW courses affect students' likelihood to graduate with an engineering major compared to matched non-PLTW students?
3. Are there differential impact of the PLTW program on traditionally disadvantaged groups such as female and/or minority students?

### **Data**

Multiple data sets were used to investigate the research questions. Two primary repositories of data were accessed including the national PLTW dataset provided by PLTW and the Texas Education Research Center (ERC) data housed at UT Austin. The ERC houses education and workforce data for the state of Texas. Data sets included the following:

- National PLTW panel dataset covering 2008 to present that indicated whether a school offered a PLTW program and the type of program adopted.
- Demographic, Course Information, and Outcome files
- STAAR Test Scores files (Texas State Assessment for grades 3-12)
- Texas Higher Education Coordinating Board College Graduation files

### **Sample**

We examined three cohorts of students who started 9th grade in 2013, 2014, and 2015 The overall sample included 918,243 total students and 43814 PLTW students.

## Methodology

The research methodology utilized propensity score matching to create a set of matched control students. This included matching on student socioeconomic as well as education related variables. The matching variables included ethnicity, sex, economic status, gifted status, Limited English Proficiency (LEP) Status, special education status, and their 8th grade STAAR math scores. The last step was to estimate the program treatment effect.

## Results

**Table 1: High School Graduation by Sex**

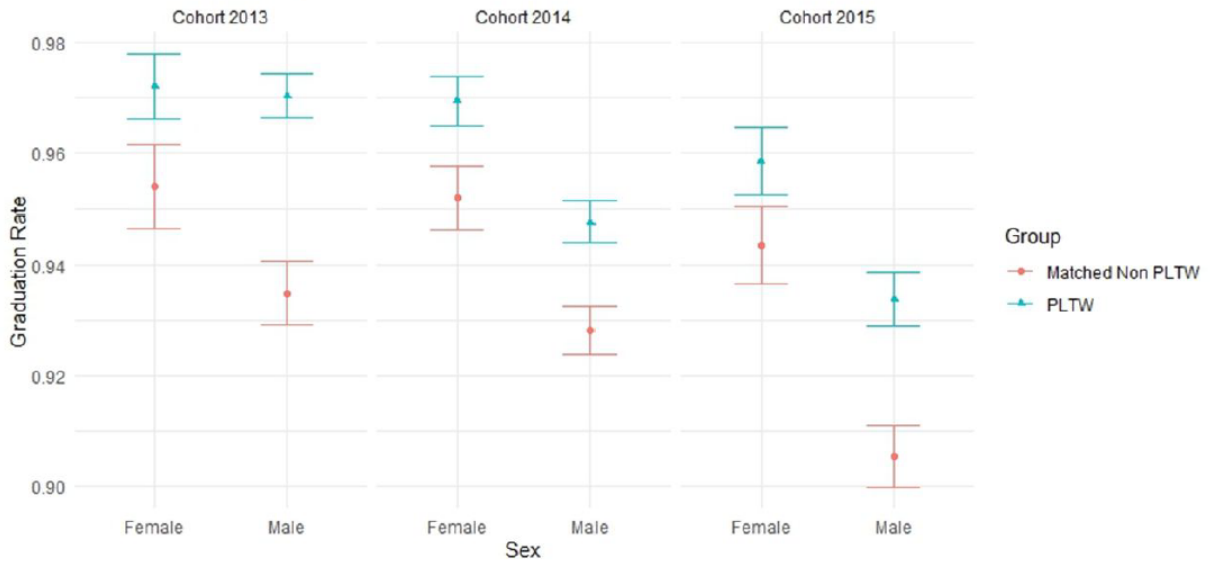


Table 1 shows that PLTW students graduate at higher rates when compared to matched non-PLTW high school students. This was true for all three cohorts examined. Females also graduated at higher rates than males within the PLTW group.

**Table 2: High School Graduation Rate by Race**

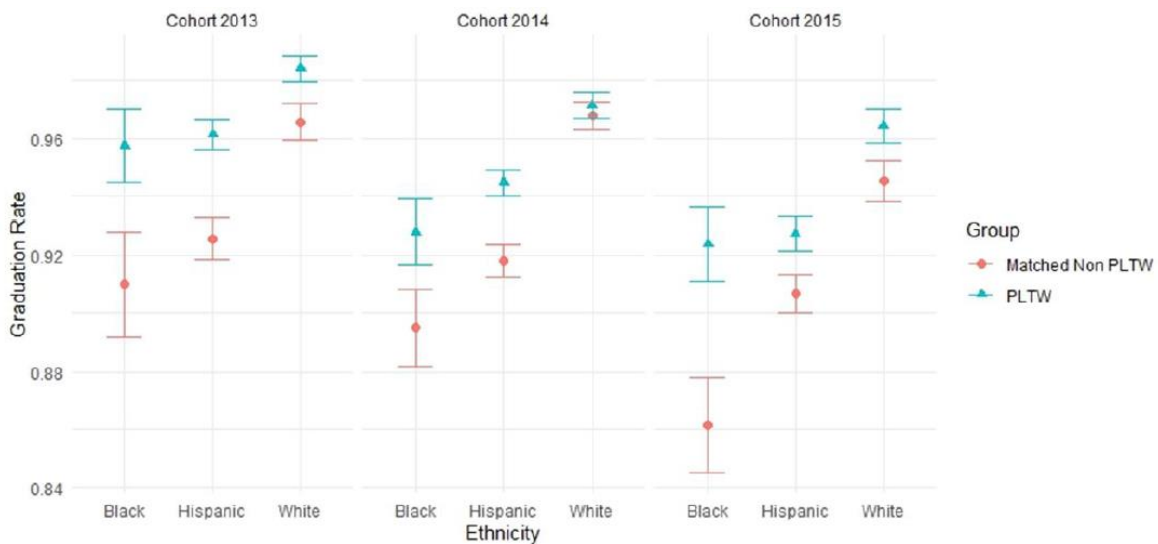


Table 2 shows that white, black and Hispanic PLTW students had higher rates of graduation than their non-PLTW matched peers. Overall students benefit from participation in PLTW concerning graduation outcomes. What about postsecondary outcomes?

**Table 3: College Graduates with STEM Degrees**

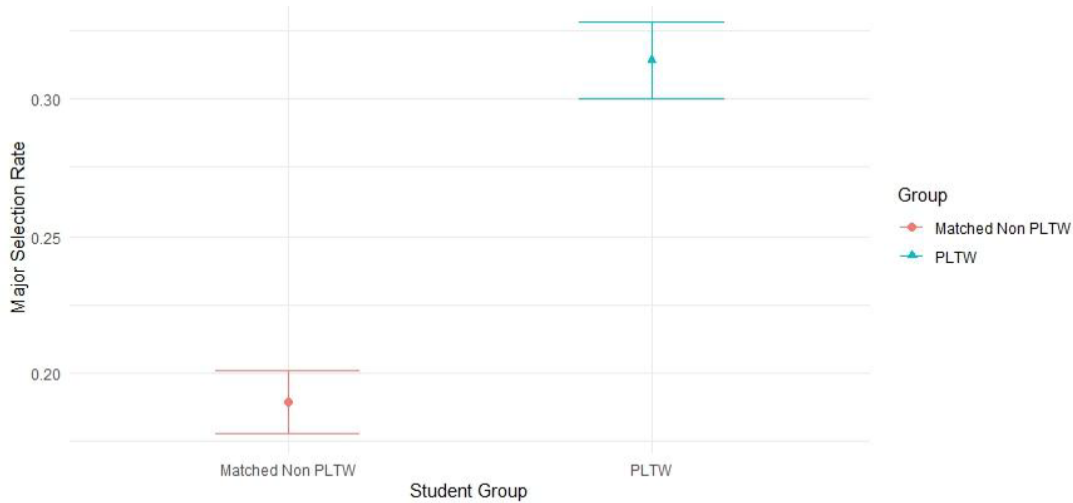
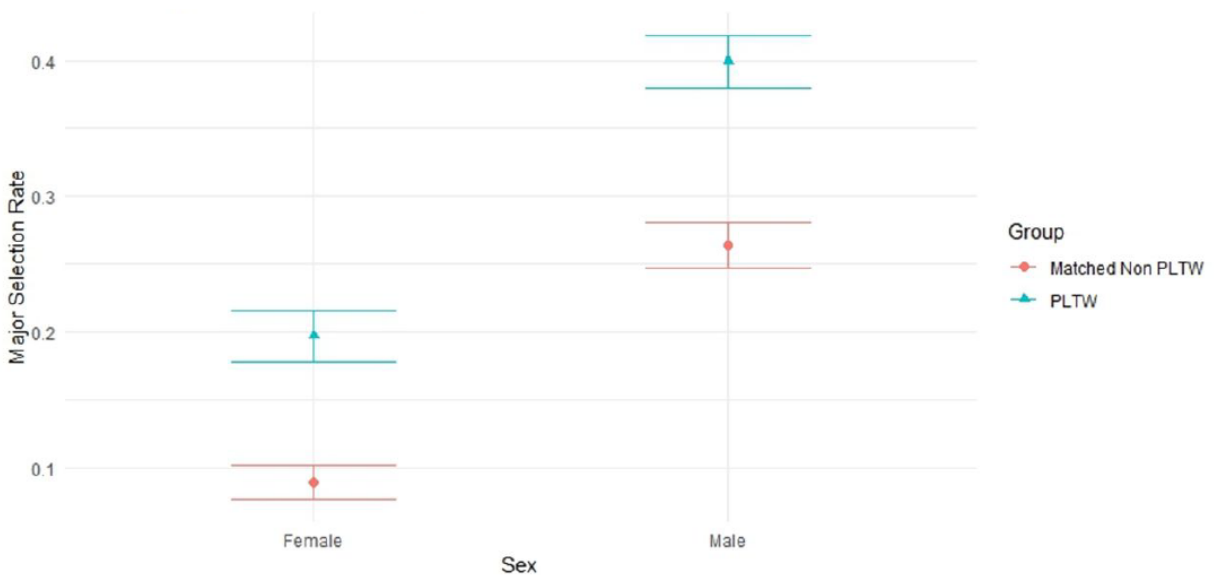
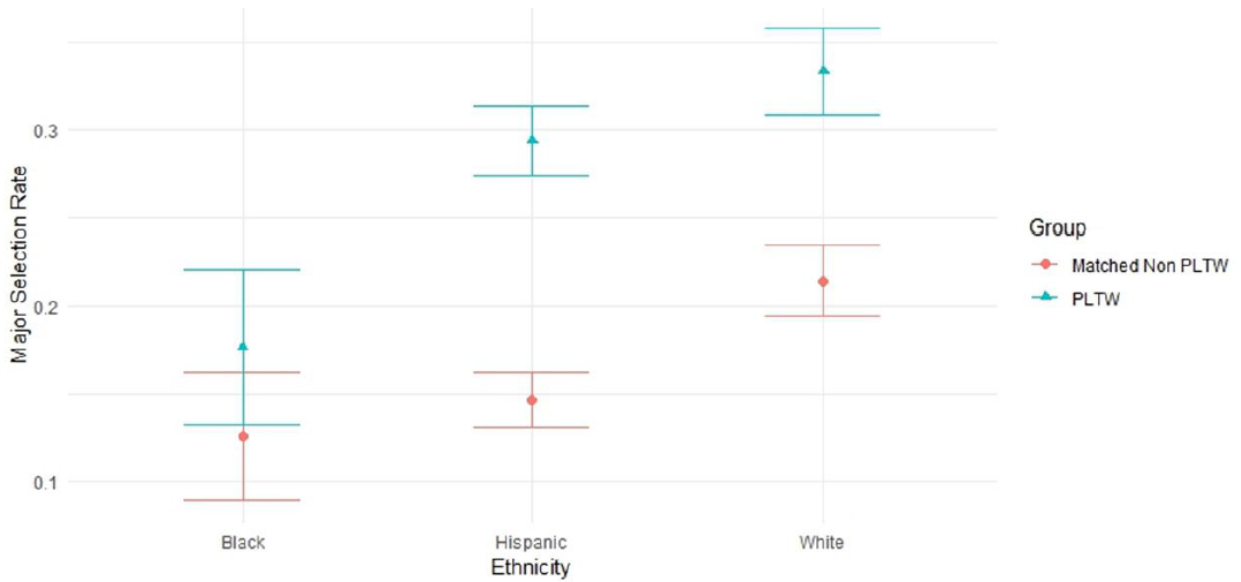


Table 3 shows that students who participate in PLTW are more likely to graduate the university with a STEM degree. Tables 4 and 5 shows that the same is true for young women and minorities.

**Table 4: College Graduates with STEM Majors by Sex**



**Table 5: College Graduates with STEM Majors by Race**



The data supports that high school students go on to major with a STEM degree at higher rates than students who did not participate in PLTW. What about Engineering degrees specifically?

**Table 6: College Graduates with Engineering Majors**

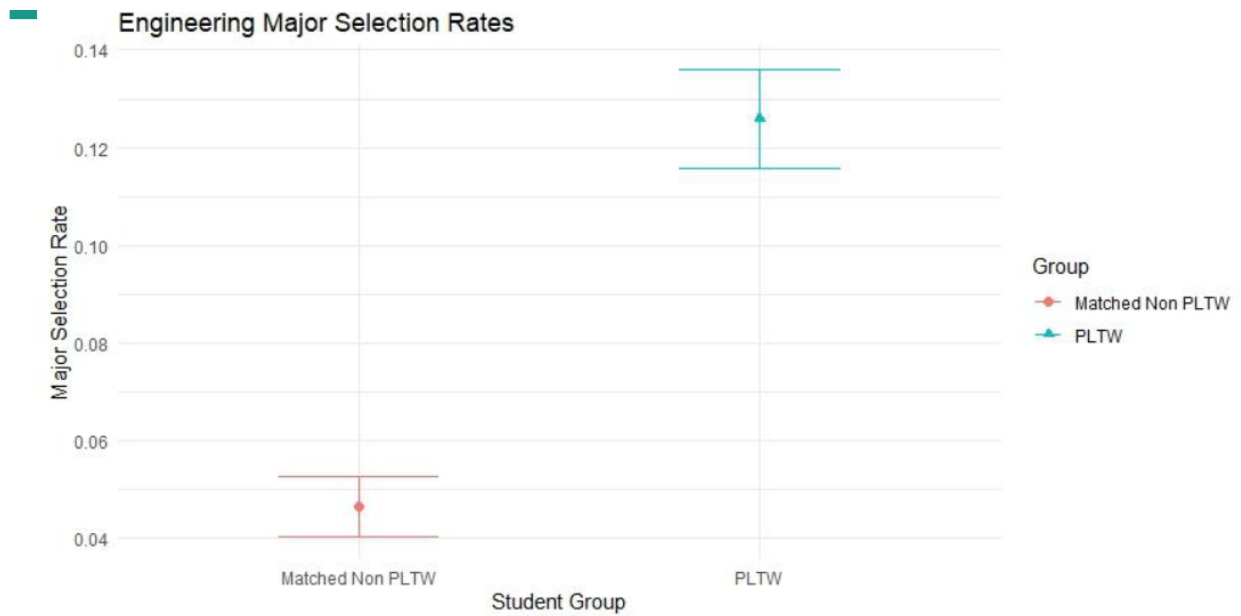


Table 6 shows that PLTW students are more likely to pursue and complete an Engineering degree than non-PLTW matched students.

**Table 7: College Graduates with Engineering Majors by Sex**

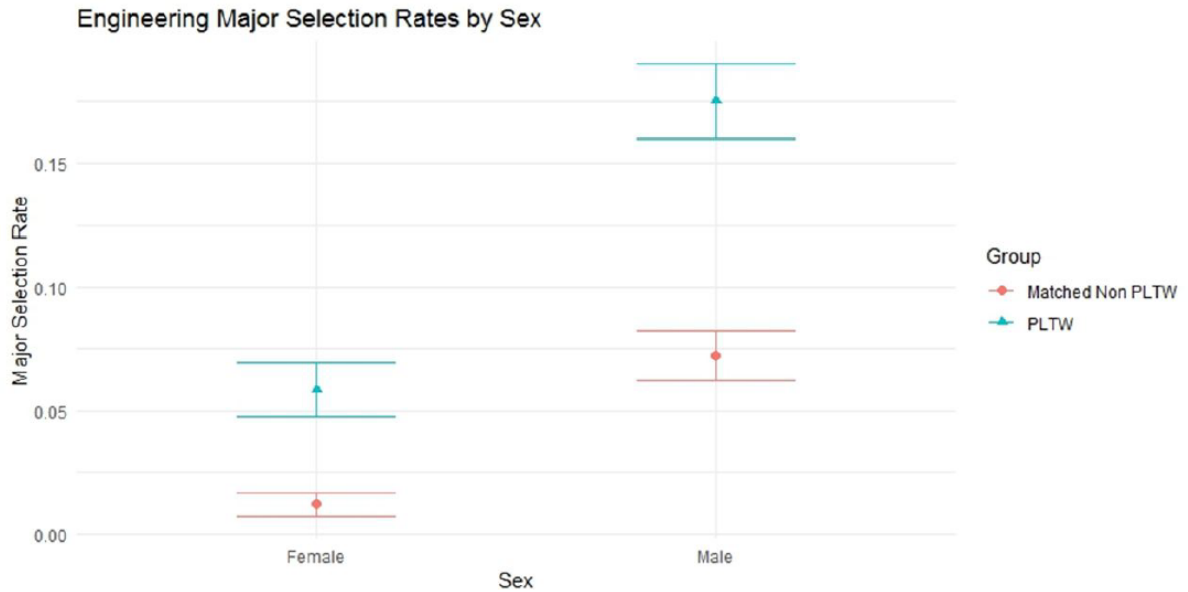


Table 7 shows that female PLTW students are more likely to pursue and complete an Engineering degree than non-PLTW matched students.

**Table 8: College Graduates with Engineering Majors by Race**

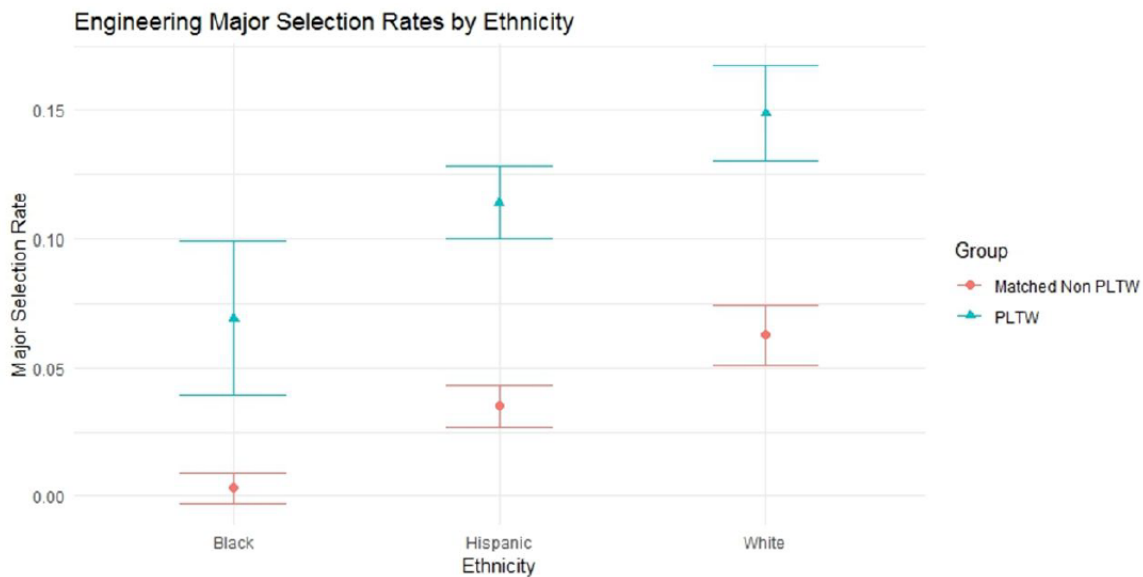


Table 8 shows that underrepresented PLTW students are more likely to pursue and complete an engineering degree than non-PLTW matched students.

**Results/Discussion**

Based on the research presented, Project Lead the Way has shown to improve student outcomes in terms of increased high school graduation rates when compare to non-PLTW students and non-PLTW Matched students. It was found that PLTW also improves graduation outcomes for



historically marginalized groups. Project Lead the Way has also shown to increase the share of college graduates with a STEM degree, and specifically also increasing the share of students graduating with an engineering degree. There is also an increased share of students for groups that are underrepresented in STEM and engineering fields.

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