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Building the STEM Talent Pipeline: The Impact of Project Lead the Way

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## Abstract

Project Lead the Way (PLTW) is an applied STEM Career Technical Education program that has been adopted widely across the country. Using data from Missouri, we investigate the impact of PLTW course expansion on program participation and early post-secondary outcomes overall and by gender. Our identification strategies rely on within-school between-cohort variation in PLTW course availability, which serves as an instrument to identify program participation impacts. We find that greater PLTW course availability is related to higher program participation, college enrollment, and STEM major declaration with greater benefits for students with strong prior STEM preparation. Males are more responsive to Engineering course expansion and females to Biomedical Science expansion. Participation impacts on five-year STEM major declaration are positive for males and females, but larger for the latter.

Keywords: High School Applied STEM Program, Career Technical Education, Post-Secondary Outcomes, Quasi-Experimental Design

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## Introduction

Strengthening the education to workforce pipeline in science, technology, engineering, and mathematics (STEM) is an important national policy goal. STEM occupations represent a large and growing share of U.S. employment. In 2021, 37 million workers, or 24 percent of the U.S. workforce were employed in STEM occupations. Between 2011 and 2021 both the number and share of the workforce in STEM fields increased. The U.S. Department of Labor projects that between 2021 and 2031, employment in STEM occupations will increase by 10.8 percent versus 4.9 percent in non-STEM occupations.[1]

To expand K-12 student interest, applied STEM programs have grown over the last few decades. The aim of these programs is to engage students in meaningful STEM learning by connecting the traditional STEM disciplines to real-world problem solving through project-based learning. Project Lead the Way (PLTW) is the largest such program. First introduced in a handful of districts in New York more than two decades ago, the program is now offered in more than 12,000 schools in all 50 states (Project Lead the Way, 2024).

At the high school level, the PLTW program offers coursework in three of the largest STEM occupational fields—Engineering, Biomedical Sciences, and Computer Science. These courses are offered as electives and/or part of CTE training. In some schools, students can earn college credits by successfully completing PLTW courses and meeting the conditions set by specific colleges. In this regard, PLTW and other STEM-focused curricular programs are doubly important: they not only provide learning experiences that directly affect students' content knowledge, but also develop a pathway to STEM majors in college and thus related occupations.

Nationally, and in Missouri, the site of this study, Engineering PLTW was the first program introduced in high schools. This was followed by a Biomedical Sciences strand, and later, Computer Science. This sequence has implications for STEM participation gaps by gender.

While increasing female participation in STEM is an important policy goal (Committee on STEM Education, 2018), gender disparities in STEM occupations are particularly pronounced in Engineering with females representing only fifteen percent of its workforce (Lopez, 2025). The Engineering PLTW program offers courses in the fields that are largely male dominated (e.g., civil, aerospace, electrical, computer integrated manufacturing). As a national organization, PLTW encourages inclusive recruitment policies on the part of local school staff. For example, PLTW pushes potential Engineering recruits from underrepresented populations in the field. Thus, the expansion of this strand may encourage female participation in these areas although this may not necessarily reduce gender gaps. The expansion of Biomedical Sciences may attract female students as they offer courses are geared toward occupations with greater female representation (e.g., health related occupations, biomedical engineering, biomedical research).

Using data for public high school students in Missouri, this study investigates how expanding PLTW opportunities impacts students' early college outcomes overall and by gender. There are two ways in which PLTW opportunities become more available to students. The first mechanism is to broaden access as more schools adopt the program. In Missouri, the high school program grew from 13 schools in 2005 to 182 schools by 2024 – or 34.6% of all public high schools, serving 68.2 percent of students' population. The second mechanism is through increasing course offerings within the same high school. This includes adding more sections of the same course, new courses, and/or new subject areas.[2] The current study investigates the impacts of PLTW course availability/expansion within high school for schools that offered the program.[3] Specifically, we address the following research questions.

1) What is the average impact of increasing PLTW course availability in a given high school on PLTW participation and initial post-secondary outcomes?

2) Does the impact of increasing PLTW course availability within high school differ by gender or STEM skills at high school entry?
3) What is the average impact of PLTW participation on initial post-secondary outcomes for those who participate in the program?
4) Do the participation impacts differ by gender or STEM skills at high school entry?

We find that within-school PLTW course expansion increased initial STEM major declaration. The impact on five-year STEM declaration is particularly large, especially for students in the top quartile of STEM readiness. The impact of PLTW course expansion appears to increase college enrollment for male students, but the impact on female students is less conclusive. Program participation increases college enrollment and STEM major declaration. Participation impacts on five-year STEM major declaration are larger for females than males. In particular, it appears that expansion of the Biomedical Science track draws female participants broadly across a range of STEM readiness.

The remainder of this paper is organized as follows: The next section provides a brief description of PLTW followed by a literature review on the impact of high school applied STEM coursework on student outcomes. We then discuss our data and methods, followed by statistical analysis. We conclude with a summary of the findings, implications for policy, and future research.

## PLTW as an Applied STEM Career Technical Education Program

PLTW first launched the high school Engineering program in the late 1990's with a goal of better preparing students for the 21st-century workforce through a project-based curriculum (Symonds, Schwartz, and Ferguson 2011). It also attempted to raise the rigor of the traditional career and technical education (CTE) curriculum and better align high school training to the

changing workforce needs of business. Since that beginning, PLTW has grown to include five programs: Launch for Pre-K through 5th grade; Gateway for Grades 6 through 8; and the three high school "pathways," Engineering as before, but adding Biomedical Sciences, and Computer Science. In Missouri, the Engineering pathway was introduced first in AY 2004-05, followed by Biomedical Sciences in AY 2011-12 and Computer Science in AY 2014-15. PLTW courses are typically offered as "Practical Arts" electives, and the foundation courses have no prerequisites. Participation is voluntary and open to all students.[4]

In general, the PLTW curricula provide scaffolded and structured activities with real-world problems, while emphasizing student-centered instruction and collaborative learning. Each pathway follows a sequence of courses. Introductory and foundation-level courses provide an overview of the field, which are intended to develop students' understanding of major ideas of the field and stimulate enthusiasm for further study. In advanced courses, students are expected to deepen their understanding through more specialized content. The program ends with a capstone course which requires students to take their own ideas from design through development of a product or plans to produce one.

PLTW has several characteristics that suggest its potential efficacy for increasing STEM workforce readiness as well as students' interests in pursuing STEM or related fields after high school. Classroom instruction is consistent with prior research on effective STEM instruction. Specifically, benefits of student-centered hands-on activities, the instructional content relevant to students, co-operative learning, group activities, and organizational support for teachers are reported by several studies (Woolnough 1994; Capraro, Capraro, and Morgan 2013; Kokotsaki, Menzies, and Wiggins 2016; Thibaut et al. 2018; Hanif, Wijaya, and Winarno 2019; Rehmat and Hartley 2020). In addition, PLTW is designed to promote students' transition into postsecondary

STEM education and careers in two ways. First, the course sequences are delivered via year-long high school courses and represent intensive learning opportunities with rigorous content. Second, students have the potential to earn college-level credit (i.e., dual credit) for advanced-level courses, potentially facilitating their transition into college and STEM majors (e.g., Edmunds et al. 2023; Hu and Chan 2023).

Teacher professional development (PD) training is a key part of the PLTW program to support staffing and maintain quality instruction. In Missouri (and some other states), any certified teacher can become a PLTW instructor by attending a two-week summer institute (with prerequisites, such as reading and completing online modules). The training is delivered by colleges and universities that are PLTW network affiliates, and it aims to help teachers understand the major content within a pathway and become proficient in project-based and problem-based instructional methods. Teachers also receive various resources, including instructional modules, detailed daily lesson plans, an implementation guide, and other instructional and online resources. Ongoing PD and instructional support are provided to all PLTW-certified teachers. This includes online forums in which teachers receive updated or new materials, share resources, and get feedback/advice regarding additional resources (e.g., a reference resource catalog), and PD opportunities through optional webinars (Nathan et al., 2011). These PD opportunities aim to facilitate peer learning among PLTW teachers, often led by teachers with STEM backgrounds.

All of the above make it relatively easy to "scale up" and staff PLTW courses. PLTW courses are not STEM courses per se, but rather STEM-infused CTE courses with a more liberal certification requirement.[5] Existing teachers in any certification background can become a PLTW instructor which expands the potential pool of PLTW teachers.[6] Also, PLTW offers a scripted

curriculum with curricular materials and ongoing, extensive, support for teachers. All of this facilitated the relative rapid introduction and expansion of PLTW in Missouri schools.

## Literature Review

There is a growing body of studies that examine and the impact of applied STEM courses, including PLTW. Most prior studies rely on observed covariates to control for selection bias. Using the national survey data, enrollment in applied STEM courses is related to higher 12$^{th}$-grade math scores (Gottfried, Bozick, and Srinivasan 2014), higher rates of high school completion and college enrollment (Gottfried, 2022), and higher rates of STEM major declarations (Gottfried and Bozick 2016). Phelps et al. (2018) also showed enrolling in engineering and engineering technology courses during high school improves STEM enrollment in college. Among these studies, Gottfried (2022) analyzes gender differences and finds no significant difference in the impact of applied STEM coursework on high school graduation or college enrollment.

Recent research on CTE programs uses student administrative data and investigates how students' participation in different fields of CTE, including applied STEM and related fields, is associated with their subsequent outcomes. For example, in Massachusetts, Ecton and Daugherty (2022) find that CTE concentrators in healthcare and engineering/manufacturing tend to have higher rates of college attendance and/or higher earnings. Liu et al. (2024) investigated the impact of computer science expansion in Maryland by taking advantage of the staggered adoption of computer science (CS) courses. Specifically, using difference-in-differences and instrumental variable methods, this study shows a positive impact of CS course enrollment on CS major declaration by 10 percentage points and earning a CS degree by 5.5 percentage points although overall college enrollment and degree completion were unaffected. In another study, Xu and Backes (2024) examines the match between the CTE field of concentration and college

major declaration and completion, using four cohorts of public high school graduates in Kentucky. Their results find the strongest alignment for health-related fields. Also, applied STEM concentrators are more likely to choose and complete a degree in the applied STEM fields (Xu and Backes, 2024). These studies also note gender differences in the choice of applied STEM fields where females are overrepresented in health while males are more likely to take courses in non-health STEM CTE, such as Engineering, Manufacturing, and Information Technology (Daugherty and Macdonald, 2020; Ecton and Daugherty 2022; Xu and Backes, 2024).

The extant studies on PLTW are primarily focused on Engineering PLTW, which tends to attract male students, and their findings are generally consistent with those of applied STEM programs. Specifically, PLTW participants are found to have a higher likelihood of college enrollment (e.g., Rethwisch et al. 2013; Van Overschelde 2013; Camburn et al. 2022), a STEM major declaration (e.g., Pike and Robbins 2019; Starobin et al. 2013; Nomi et al. 2026a; Camburn et al. 2022), and second-year retention than non-participants (e.g., Utley et al. 2019). Another study, which focused on college students who were enrolled in a pre-Engineering program, found that high school PTLW participation status did not affect college persistence (Cole et al. 2013). Likewise, studies by Cole et al. (2013) and Utley et al. (2019) showed no evidence of improvement in STEM degree completion for PLTW students. However, these latter studies had very small sample sizes, and the sample selection (e.g., college engineering students) may be affected by PLTW participation.

An earlier study on PLTW (Nomi, DeChane, and Podgursky 2026a) used a difference-in-difference (DID) method to examine the effect of school adoption of PLTW (i.e., extensive margin) on early post-secondary outcomes (college enrollment and initial STEM major). It used

a subset of Missouri high schools that began offering the program after AY2012 and compared them to schools that never offered the program. The results showed positive effects of PLTW adoption on STEM major declaration for academically well-prepared students. Also, to estimate PLTW participation impacts, the study combined the DiD analysis with the principal stratification weighting method, using a comprehensive set of covariates. They found substantively meaningful impacts of PLTW participation on initial STEM major declaration (Nomi et al., 2026a).

The current study adds to this earlier work by addressing a different set of questions with a longer panel of outcomes and taking an alternative methodological approach to estimate the impact of PLTW course expansion in the same school. This study makes a unique contribution in the following ways. First, the earlier study used a subset of schools (N=96 schools) that began offering the program in AY2012 or later (late adopters with pre-adoption student observations). This excludes many high schools (N=129 schools) that began offering the program in earlier years (i.e., schools without pre-adoption student records). These early PLTW adopters tended to be suburban or urban high schools serving a much higher proportion of Black and Hispanic students than the late adopters. In comparison, the current study uses all high schools offering PLTW over our panel, including early adopters. This extends the generalizability of the findings.

Second, this study adds subgroup analysis by gender and prior STEM academic readiness. In the earlier study, the PLTW treatment schools, consisting of late adopters, primarily offered Engineering courses which are largely male students. In these schools, Biological Sciences, which is much more popular among female students, was largely absent. Moreover, PLTW participation rates were relatively low for early adopters (approximately, 4% of the first cohort and 9% of the second cohort). Both of these factors precluded subgroup analysis by

gender. In addition, in the initial study, most program participants were high-performing students partly because schools tend to enroll such students when they first offer the program (see Endnote 4). However, as schools expand the program, student participation broadens, and more students with varying skills take advantage of these opportunities. Thus, by utilizing all available cohorts and all schools, this study can reveal how male and female students of varying skills may differ in program participation patterns and the PLTW impacts. It may also better identify the effect of "mature" PLTW programs.

Lastly, to identify the PLTW participation impact (overall and by gender and skill levels), this study uses arguably exogenous within-school between-cohort variation in PLTW course offerings as an instrument. By contrast, the earlier study relied on observed covariates to control for student selection to PLTW participation. We believe these two methodological approaches together bring greater credibility to causal inferences regarding the program impact.

In related work (not on PLTW), several researchers use exogenous variation in high school course offerings to examine post-secondary outcomes (Altonji 1995; Levine and Zimmerman 1995; Rose and Betts 2004; Federman 2007; Darolia et al. 2018). Of these, all but Darolia et al. (2018) use cross-sectional national data where the researchers utilize between-school or between-state variation in course offering. However, as Darolia et al. (2018) note, endogeneity is still a concern in these studies as high school curricular opportunities or state graduation requirements are not random. Also, differences in curricular opportunities may affect students' decisions on which high school to attend, and this is also likely to affect later outcomes.

To address these limitations, Darolia et al. (2018) used multiple cohorts of public college students in Missouri and data on high school course offerings in the traditional STEM subjects. Specifically, to estimate the impact of STEM course offerings on post-secondary outcomes, the

authors isolated within-school between-cohort variation in STEM course availability by including cohort and high school fixed effects. They used this variation as an instrument to identify the impact of students' STEM course enrollment on post-secondary outcomes. Their findings indicate that, unlike earlier studies, greater access to traditional STEM courses, or STEM course enrollment, has few effects on STEM major declaration or degree attainment (Darolia, et al., 2018). This finding differs from a study by Federman (2007) who used between-state variation in high school graduation requirements as an instrument for STEM course enrollment, and finds much larger impacts on STEM degree declaration.[7]

We use the identification strategy of Darolia et al. (2018), but also note two important differences in our context. First, Darolia, et.al (2018) find relatively modest within-school year-to-year variation in course availability in the traditional STEM subjects that is only weakly related to students' STEM course enrollment. This limits the ability to identify the impact of STEM course offerings or students' enrollment in STEM courses. As will be shown below, within-school variation in PLTW course availability for our five cohorts is large, which yields a strong instrument. Second, their study population consists of Missouri public college enrollees. This is problematic if high school STEM course completion affects the likelihood of enrolling in college. To address this limitation, we use the first-time ninth-grade students as the study population. We note as well that many of these ninth-grade students will ultimately attend non-public or non-Missouri higher education institutions, all of whom we track in our dataset.

The institutional context of the roll out of PLTW in Missouri provides support for our approach. We interviewed the PLTW senior leadership team, who identified three important external factors that led schools to implement and expand the program in Missouri. The first, and earliest, was foundation support. A large Kansas City based foundation subsidized introduction

of PLTW into several Kansas City area high schools that may not otherwise have had resources to do so. Corporate partners also joined in 2011 with other philanthropic organizations to support implementation. Second, PLTW staff also conducted many outreach activities in the state. Third, as the program expanded, the Missouri Department of Elementary and Secondary Education (MODESE) began providing financial support through its Career and Technical Education (CTE) office. Additionally, MODESE began to include measures of successful completion of PLTW courses in its high school accountability performance measures. Another regulatory factor that encouraged implementation was a liberal policy by MODESE regarding teacher certification to teach PLTW courses as noted earlier.

All of these factors suggest that within-school cross-cohort changes in PLTW provisions were largely driven by supply-side or "push" factors such as subsidies and regulatory nudges. However, even if the latter were true, given the uneven rollout it is possible that changes in the availability of PLTW courses altered observed high school enrollment patterns (i.e., more STEM oriented students sorting to high schools offering PLTW). We examine this question below.

## Data and Methods

The current study uses five cohorts of first-time 9th-grade students in Missouri who began public high school between AY2010 and AY2014. Each cohort has approximately 68,000 students attending 501 public high schools in operation throughout the entire study periods.[8] Of the total student population, the racial composition was approximately 76 percent White, 16 percent Black, 4 percent Hispanic, and 4 percent Other. Nearly 53 percent of entering 9$^{th}$-graders qualified for Free or Reduced Price Lunches (FRL). Descriptive statistics are shown in Table 1.

(Table 1)

We utilize K-12 student data from the Missouri Department of Elementary and Secondary Education (DESE) linked to National Student Clearinghouse data for post-secondary outcomes.[9] All analyses are based on 9th-grade cohorts, and the outcome variables include college enrollment within six months after high school graduation (any college, two-year college, and four-year college) and, STEM major declaration upon college entry, and STEM major declaration within five years of entering college. The last outcome is not available for the 2014 cohort, and the analysis of this outcome uses data from four cohorts of 9th-grade students.

In this study, STEM majors include those defined by the Department of Homeland Security (DHS) and all health science majors[10]. The student data include demographic variables (race/ethnicity, gender, and FRL status); 8th-grade Missouri Assessment Program (MAP) scores in math, science, and English Language Arts (ELA) that are converted into Z-scores; a relative strength in Math, measured by the ratio of standardized scores in Math to that in ELA; and Algebra enrollment in 8th-grade.

To measure students' STEM readiness upon high school entry, we construct a composite measure, defined as the predicted probability of obtaining a four-year STEM degree within 5 years of entering college given 8th-grade academic covariates in the absence of PLTW. This is analogous to "prognostic scores" in the medical literature, defined as the predicted outcome, given pre-treatment covariates under the control condition (see Hansen 2008; Leacy and Stuart, 2014). This provides a convenient scalar summary of STEM preparation prior to high school entry. To generate prognostic scores for all students, we first predict the outcome (four-year STEM degree completion) using the baseline (2010) cohort in schools that did not introduce the PLTW program. This is estimated using logistic regression, and the coefficients are applied to other schools and cohorts to obtain their prognostic scores. The predictors include 8th-grade MAP

scores in math, science, and ELA and completing Algebra in 8th grade. Table 2 shows the results of the logistic regression.

Using this composite measure of STEM readiness, we classify students into quartiles for subsequent analyses as discussed in the method section. Table 3 shows that the mean predicted probability (in percentages) of four-year STEM degree completion is 3.62 for the overall population, 3.77 for male and 3.47 for female students. Male students have slightly greater variance (SD=6.7) than females (SD=5.9) with slightly higher average for males in the top quartile than that for females (12.4 vs 11.12 percentage points).

(Tables 2 and 3)

High school course offerings data contain all courses and course sections offered each semester by the school. This is available for all years during which each cohort attended high school. Using these data, and following Darolia et al. (2018), a variable measuring PLTW course availability is constructed for each cohort. This is defined as the total number of PLTW course sections offered by the school per 100 students during high school.[11] Pathway specific PLTW course availability measures were also created. In this case, we combined the Engineering and Computer Science pathways because only a small number of schools adopted the Computer Science pathways during the study period (38 schools), overall participation rates were small (3.4 percent), and student participation behavior is similar between Engineering and Computer Science (male students are much more likely to participate in these two pathways).

A total of 225 schools offered PLTW during the years when students in the current study were in high school (i.e., anytime between AY2010 and AY2017). These schools are considered "treatment" schools.[12] The remaining 276 schools did not offer PLTW during the period under

study, and they constitute "control" schools. The control schools are used to adjust for between-cohort outcome variation (i.e., cohort effects) unrelated to changes in PLTW availability.

School characteristics differ considerably by the school treatment status. Table 4 shows descriptive statistics for the baseline, 2010 cohort. On average, PLTW schools are racially more diverse, are located in larger cities and suburban areas, have lower FRL rates, and have higher 8$^{th}$-grade test scores than non-PLTW schools. In contrast, non-PLTW schools are much smaller, located in rural areas with higher FRL rates, and attended by predominantly White students. This pattern of results suggests the challenge of offering a resource intensive program with elective courses in small, rural high schools where the organizational capacity is often limited.

(Table 4)

Among the treatment schools, PLTW course availability increased over time. Table 5 shows that, on average, schools offered 1.29 PLTW courses per 100 students for the 2010 cohort, mostly in Engineering. The total number of PLTW courses increased to 3.47 courses for the 2014 cohort and the share of Biomedical Science courses increased over time. Figure 1 shows this trend graphically.

(Table 5 and Figure 1)

Likewise, the overall program participation increased during the study period (Table 6 and Figure 2). The top panel of Table 6 shows that 9.7% of the 2010 cohort in the treatment schools participated in PLTW with most students enrolling in Engineering courses (the other two subjects were not offered in early years). Participation rates increased for each cohort and doubled for the 2014 cohort. Gender specific participation rates, presented in the middle and lower panels, show that female students are less likely to participate in PLTW than male students overall. Across the subjects, female students are much more likely to choose Biomedical

Sciences whereas male students favored Engineering. These gender differences are persistent across cohorts (see Figure 2)

(Table 6 and Figure 2)

**Statistical Models**

***Effects of Course Availability (ITT)***

The first analysis estimates the impact of increases in course availability on program participation and post-secondary outcomes (both represented by Y) for student *i*, cohort *c*, and school *j*. The statistical model is:

$$Y_{icj} = \alpha_0 + \lambda(Z_{cj}) + \alpha_1(X_i) + \alpha_2(W_{cj}) + Coh_c + \varphi_j + \varepsilon_i \quad (1)$$

where $Z_{cj}$ is PLTW course availability variable for cohort c in school *j*, $Coh_c$ are cohort fixed effects, $X_i$ is a vector of student covariates (STEM readiness, relative strength in Math, gender, race, and FRL), $W_{cj}$ is a vector of school-by-year covariates (e.g., average 8th-grade test scores of incoming 9th-grade cohort, percent of incoming 9th-grade students who completed Algebra 1 in 8th-grade, FRL rates, and cohort size ), $\varphi_j$ are school fixed effects based on the school students first entered as a ninth grader, and $\varepsilon_i$ is a random error term for student i. The cohort fixed effects capture cohort-to-cohort outcome fluctuations unrelated to $Z_{cj}$, assumed to be common to all schools (the "common trends" assumption), and $\lambda$ is the effect on students' outcomes associated with changes in PLTW availability.

***Effects of Course Participation (Local Average Treatment Effects, LATE)***

We then use 2-stage least squares (2SLS) to identify the impact of PLTW participation on participants in schools that ever offered PLTW. The first stage model estimates program participation with Z as an instrument, using the following model:

$$T_{icj} = \beta_0 + \eta(Z_{cj}) + \beta_1(X_i) + \beta_2(W_{cj}) + Coh_c + \varphi_j + \mu_i, \quad (2)$$

where the outcome *T* indicates program participation during high school, defined as enrolling in at least one PLTW course (1=yes and 0=no), and the coefficient $\eta$ represents the impact of an increase in PLTW course offerings by one section per 100 students on program participation. To estimate the impact of PLTW participation on the outcomes, we estimate the following second stage model using the predicted probability of program participation from Equation 2 as a predictor:

$$Y_{icj} = \gamma_0 + \delta(\hat{T}_{icj}) + \gamma_1(X_i) + \gamma_2(W_{cj}) + Coh_c + \varphi_j + \epsilon_i. \quad (3)$$

The parameter of interest is $\delta$, representing the effect of PLTW participation, instrumented by PLTW expansion, on the outcome among students who are induced to participate in the program due to PLTW course expansion.

We use two sets of instruments for Z. Our first analysis uses overall PLTW course availability per 100 students as a measure of $Z_{cj}$. The second analysis uses pathway specific course availability entered as two measures of $Z_{cj.}$ All statistical models are analyzed for the overall student population, separately for male and female students, and by the quartiles of STEM readiness, and by the STEM readiness quartiles by gender.

Key identification assumptions for the IV analysis are the exogeneity of the instruments (within-school PLTW expansion), given covariates and the exclusion restriction assumption. For the former, we include pre-treatment student-level covariates and school-by-year covariates (e.g., prior achievement, demographic characteristics, and cohort size of the rising 9$^{th}$-grade students) as additional controls. The key covariates that capture student and/or parental demand are math and science achievement and taking Algebra in 8$^{th}$-grade since both are strongly related to students' post-secondary outcomes. Taking Algebra in 8$^{th}$-grade is a particularly important behavioral measure for students who wish to pursue a STEM degree, as this allows them to reach

advanced math courses prior to entering college. Also, it is likely that unobserved demand factors would change rather slowly while the introduction and/or expansion of PLTW can happen abruptly (see Endnote 2). However, the exogeneity assumption can be violated if, for example, more able (conditional on covariates) students increasingly choose PLTW high schools as the latter expanded their course offerings. We investigate this possibility below.

The second assumption is that the PLTW course expansion within high school only affects student outcomes through program participation (the exclusion restriction assumption). This is violated if PLTW course offer/expansion had spillover effects. This could happen, for example, if PLTW course offer/expansion improved teaching skills of PLTW teachers who may teach non-PLTW courses and benefit non-PLTW participants taking these courses.[13] Also, if PLTW course offer/expansion improved the outcomes of program participants, these positive impacts may affect their peers who did not participate in the program. Moreover, both ITT and participation impacts would be biased if PLTW program adoption/expansion is part of larger curricular initiatives carried out by high schools to strength college and career readiness. Such concurrent changes may affect both program participants and non-participants.

An earlier study by Nomi et al. (2026a) investigated the spillover effects of PLTW program adoption on the outcomes of non-participants who are observationally similar to PLTW participants in the same school and finds no such evidence. Likewise, a more recent study by Nomi et al., (2026b) investigated other curricular changes that may confound PLTW impacts. While this study provides evidence of curricular expansion in other advanced coursework (e.g., dual-credit and AP courses) in non-STEM subjects among schools that adopted PLTW, and in those schools, both PLTW participants and non-PLTW participants earned more advanced non-STEM credits post-PLTW adoption. However, post-secondary outcomes were unaffected for

non-participants who are observationally similar to PLTW participants, and PLTW participants are the only students who improved post-secondary STEM outcomes.[14]

## Results

### Impact of PLTW Course Availability on Program Participation (ITT)

The top panel of Table 7 presents results for all students and by gender and STEM achievement quartiles. Comparing students across cohorts in the same school, we find that PLTW participation rose when schools increased course availability. Specifically, for the overall student population, an increase in PLTW course availability by one section per 100 students leads to an increase in program participation by 3.2 percentage points ($p<0.001$). From descriptive statistics in Table 5, the average increase in PLTW course sections from the 2010 to 2014 cohorts is about two courses per 100 students. Based on our statistical model, this would lead to an increase of 6.2 percentage points in PLTW participation over five cohorts. The magnitude of impact is similar by gender with an estimated increase of 3.0 percentage points ($p<0.001$) for male students and 3.4 percentage points ($p<0.001$) for female students. The analysis by the quartiles of STEM readiness shows that the impact is larger for students in the higher quartiles. An increase in one course section per 100 students is associated with a nearly 5 percentage point increase in program participation for students in the top quartile ($p<0.001$) as compared to 1.7 percentage points for students in the bottom quartile ($p<0.001$). The pattern of results by STEM quartiles is similar for male and female students.

(Table 7)

The results of pathway specific analysis (bottom panel, Table 7) show that the Engineering pathway is most likely to draw participants from students with high STEM readiness. The analysis, using all students, showed an estimated impact of 5.9 percentage points

($p<0.001$) for students in the top quartile. Also, male students are more likely to respond to increases in Engineering course offerings. Adding one Engineering course section per 100 students is associated with an increase in male program participation by 7.5 percentage points for the top quartile ($p<0.001$) and 5.8 points for the third quartile as compared to an increase of 4.1 and 2.5 percentage points for their female counterparts ($p<0.001$). By comparison, female students are much more likely to respond to Biomedical Science course availability with an overall participation increase of 4.6 percentage points as compared to 1.1 percentage points for males ($p<0.001$). Increases in Biomedical Science course offerings appear to affect female program participation relatively evenly across STEM readiness quartiles with an estimated increase ranging from 2.8 percentage points for the bottom quartile to 5.4 percentage points for the top quartile ($p<0.001$). For female students, Engineering course offerings also affect their PLTW participation, particularly among the top performing students (4.1 percentage points in the top quartile, $p<0.001$), while the impact is smaller for female students in lower quartiles.

**The Effect of PLTW Course Availability on Student Outcomes (ITT)**

***College Enrollment***

The top two panels of Table 8 present the estimated impact of PLTW course expansion on overall college enrolment (left columns), and this outcome is broken down by two-year and four-year enrollment (middle and right columns, respectively). For all students, adding one PLTW course section per 100 students is associated with a 0.3 percentage points increase in any college enrollment, on average ($p<0.01$). This is primarily driven by male students with an estimated impact of 0.4 percentage points ($p<0.01$) as compared to a .01 percentage points increase for females (n.s.). Moreover, enrollment increases for male students come from two-year colleges with an estimated impact of 0.3 percentage points, while four-year enrollment is unaffected. For

females, the pattern of results indicates an enrollment switch from two-year (-0.02 percentage points) to four-year colleges (0.02 percentages points) although neither coefficient is statistically significant. Supplemental analyses, formally testing the interaction effect between PLTW expansion and gender, showed these gender differences are statistically significant (Online Appendix Table A1).

The results of the pathway specific analysis (second panel) are consistent with gender differences in PLTW enrollment patterns reported earlier. For male students, we find a statistically significant impact of Engineering course expansion on overall college enrollment (0.5 percentage points, $p<0.01$), and this likely stems from two-year enrollment (0.4 percentage points, n.s.). For females, we find a 0.6 percentage points increase in overall college enrollment associated with biomedical science course expansion (n.s.), and a statistically significant increase is found for four-year college enrollment (0.7 percentage points, $p<0.05$). Their two-year enrollment declined slightly (-0.2 percentage points, n.s.). This pattern of results is supported by the pooled analysis with the interaction terms between PLTW variables and gender (Online Appendix Table A1).

(Table 8)

***STEM Major Declaration***

The ITT impacts on STEM major declaration are shown in the bottom two panels of Table 8. Note that the five-year STEM declaration was not available to the research team for the 2014 cohort at the time of this study; thus, this outcome is analyzed based on four cohorts of students (the 2010 through 2013 cohorts). Overall PLTW course expansion is associated with higher rates of both initial and five-year STEM major declarations with a greater increase for five-year STEM major declaration (0.6 percentage points, $p<0.01$) than initial declaration (0.2

percentage points, $p<0.01$). The impact on initial declaration is similar for males and females (0.3 and 0.2 percentage points, respectively), but only the coefficient for males is statistically significant at five percent. The estimated impacts on five-year STEM major declaration are 0.8 percentage points for females ($p<0.001$) and 0.5 percentage points for males ($p<0.01$).

The most notable finding is observed for pathway specific impacts on five-year STEM major declaration (bottom right panel). For the overall population, the estimated impacts are similar for both Engineering and Biomedical Science expansion (0.6 percentage points, $p<0.05$). However, further analysis shows clear gender differences that are consistent with their PLTW pathway choice as reported earlier. For male students whose PLTW participation is driven more by Engineering expansion than Biomedical Science expansion, we find a 0.7 percentage points increase in five-year STEM declaration ($p<0.05$) associated with an additional Engineering course section (per 100 students). The expansion in Biomedical Science does not appear to affect this outcome for males (0.1 percentage points, n.s.). In contrast, for female students, adding one Biomedical Science course section (per 100 students) is likely to increase their five-year STEM major declaration with an estimated effect of 1.1 percentage points ($p<0.01$). Also, Engineering course expansion would increase their five-year STEM major outcome by 0.5 percentage points (n.s.). As noted above, this analysis does not include the 2014 cohort which has the highest number of course offerings and the highest participation rates (see Table 5 and Table 6).

**The Effect of PLTW Course Availability by STEM Readiness and Gender**

The first three panels of Table 9 show the ITT results on college enrollment outcomes by the quartiles of STEM readiness. For all students, the estimated impacts of PLTW course expansion on any college enrollment are positive for Quartiles 2 through 4 with estimates ranging from 0.3 (n.s.) to 0.6 percentage points ($p<0.05$). For students in Quartile 2, the PLTW

impact comes from two-year enrollment experienced by male students (0.7 percentage points, $p<0.05$). In contrast, for the top two quartiles, enrollment increase appears to come from four-year college (0.4 percentage points, n.s.) with gender specific impacts ranging from 0.2 to 0.5 percentage points although none of them are statistically significant.

For STEM major outcomes (Table 9, bottom two panels), the impact of PLTW course expansion is only found for students in the top quartile. Specifically, adding one PLTW course per 100 students is likely to increase initial STEM major by 0.5 percentage points for the overall population in the top quartile (n.s.). Gender specific analysis reveals increases in initial STEM major for males (0.5 percentage points, $p<0.05$), but not for females (0.1 percentage points, n.s.). However, importantly, five-year STEM major declaration rates increased by approximately 1 percentage point ($p<0.05$) for both male and female students in the top quartile, and 1.3 percentage points across all students in the top quartile ($p<0.001$).

(Table 9)

Larger ITT impacts on five-year STEM major declaration than on initial STEM major declaration indicate that students may not declare a major immediately upon college entry or switch majors. Missouri offers a scholarship for free community college to students who meet specific (modest) academic standards. Higher-achieving students who first enroll in a community college may declare a STEM major after transferring to a four-year college (community colleges offer an Associate of Science or Arts for students who intend to transfer).

Next, we conducted the pathway specific analysis by the quartile of STEM readiness. Here we only report the results based on all students as quartile-by-gender estimates appear too noisy, and it is difficult to draw conclusions (the results are available in Online Appendix, Tables A2). In general, the result of this analysis (Table 10) follows the pattern of results observed

earlier. For both Engineering and Biomedical Science pathways, we see a slight increase in overall college enrollment with estimates ranging from 0.3 to 0.6 percentage points for Quartiles 2 through 4 (n.s.). Enrollment increases due to Engineering expansion tend to come from two-year enrollment particularly for students in Quartile 2 with an estimated impact of 0.5 percentage point (n.s.). In contrast, Biomedical Science expansion is related to four-year enrollment with estimates ranging from 0.4 to 0.7 percentage points. The estimates for two-year enrollment are null for Quartile 2 and negative for higher quartiles with the latter indicating enrollment switch from two to four-year colleges.

The estimated impacts on the initial STEM declaration among students in the top quartile are 0.2 and 0.5 percentage points for, respectively, Engineering and Biomedical Science course expansions, although neither is statistically significant. For both subjects, the impact on five-year STEM major declaration is much larger for students in the top quartile. One additional course section in Engineering and Biomedical Science per 100 students raises the five-year STEM major rate by 1.3 ($p<0.05$) and 1.1 percentage points (n.s.), respectively. The Biomedical Science course offering effect is similar for students in Quartile 2 (1 percentage point, $p<0.05$).

(Table 10)

**The Effect of PLTW Participation on Students' Outcomes (Local Average Treatment Effects)**

To identify PLTW participation impacts, we conducted two sets of analyses: one using PLTW expansion as an instrument (IV1) and the other using pathway specific expansions as instruments (IV2). These instruments are quite strong. For IV1, excluded instrument F-statistics are 2,029.45 for the overall population, and 734.61 and 1536.16 for males and females, respectively. The F-statistics by STEM readiness quartiles for males ranges from 46.5 for

Quartile 1 to 325.83 Quartile 4 and those for females range from 152.84 for Quartile 1 to 496.65 for Quartile 4. Pathway specific instruments are somewhat weaker (see Online Appendix Table A3 for the F-statistics). The results of the two IV analysis are similar, and we report the IV1 results here for conciseness. The OLS results are also presented for comparison.

***College Enrollment***

The results of college enrollment outcomes (Table 11) are consistent with those of ITT results reported earlier. The IV1 results for the overall population showed that PLTW participation increases college enrollment, on average, by 9.3 percentage points ($p<0.05$), and this is much larger for males (16.1 percentage points, $p<0.01$) than females (4.9 percentage points, n.s.). Also, the impacts for males are only found for two-year enrollment. For females, the results provide suggestive evidence that PLTW participation affected their college enrollment choice with negative impacts on two-year enrollment (-5.4 percentage points, n.s.) and positive impacts on four-year enrollment (6.4 percentage points, n.s.). In contrast, OLS estimates are all positive and statistically significant.

(Table 11)

Table 12 shows the IV estimates of PLTW participation impacts on college enrollment outcomes by STEM quartiles. As consistent with our ITT analysis, we find a significant and large impact on male two-year enrollment (41.5 percentage points, $p<0.01$). We also see statistically significant positive impacts on any college enrollment for the overall population in Quartiles 3 and 4 (19.7 and 12.3 percentage points, respectively, $p<0.01$). This likely results from four-year enrollment increases in these quartiles (but to lesser extent for females in Quartile 4). In comparison, the OLS result (bottom panel, Table 12) is vastly different. All estimates are positive and statistically significant, with exceptions for female two-year enrollment in Quartiles 3 and 4.

(Table 12)

***STEM Major Declaration***

Our final analysis estimates PLTW participation impacts on STEM major declaration (Table 13), and the IV1 results are reported here as well (see Online Appendix A4 for IV2 results). For the overall population, PLTW participation is associated with increases in initial STEM major declaration by 7.8 percentage points ($p<0.01$) and five-year STEM major declaration by 22.2 percentage points ($p<0.001$). The gender specific impacts on initial declaration are relatively similar with the estimated impacts of 8.3 percentage points for males and 7.4 points for females ($p<0.05$ for both estimates). In contrast, the impact on five-year STEM major declaration is somewhat larger for females (25.3 percentage points, $p<0.001$) than for males (19.8 percentage points, $p<0.01$).

(Table 13)

The analysis by STEM readiness (Table 14) reveals that PLTW participation raises initial STEM major declaration for male students in the top quartile. The estimated impact for the overall population in Quartile 4 is 8 percentage points (n.s.) and 12.2 percentage points for male students ($p<0.05$). For female students, we find a similar magnitude of participation impact in Quartile 2 (11.5 percentage points) although this was not statistically significant. By contrast, the participation impacts on the five-year STEM declaration are much larger in the top STEM readiness quartile. Specifically, among program participants in the top quartile, we estimate an increase in five-year STEM major declaration by 27.9 percentage points ($p<0.001$) for the overall population, 23.3 percentage points for male participants ($p<0.01$) and 24.4 percentage points for female participants ($p<0.01$). We also note that for female participants in the second and third quartiles, the magnitude of the impact is quite large (20 and 19.8 percentage points for

Quartiles 2 and 3, respectively) although they are not statistically significant. As noted earlier, the analysis of five-year STEM does not include the 2014 cohort. In future work we plan to investigate this outcome as well as degree attainment outcomes using all the cohorts.

The OLS results are shown in the bottom panel of Table 14. All estimates are positive and statistically significant.

(Table 14)

**Test of Common Cohort Trends Assumption**

A key identification assumption required for our ITT analysis is that the cohort effects (i.e., between-cohort outcome differences in the absence of PLTW, that is, Z=0) are constant for the treatment schools (schools that offered/expanded PLTW course sections) and the control schools (schools that never introduced PLTW). Specifically, the impact of PLTW expansion (Z) would be biased if the treatment schools had different outcome trajectories than the control schools in the absence of PLTW.

While the common trends assumption is not directly testable, we investigate the plausibility of this assumption by conducting a DiD analysis, using pre PLTW adaptation data. This analysis uses the control schools and a subset of treatment high schools that did not offer PLTW for the 2010 and 2011 cohorts, but expanded PLTW sections for later cohorts (the 2012 cohort or later). We expect the equality of the cohort effects between the treatment and control schools during the periods when the treatment schools had not yet introduced PLTW to their students. This analysis uses four cohorts (the 2010 through 2013 cohort). The 2014 cohort is not included since almost all treatment schools offered PLTW by then.

The total number of schools used for this analysis is 56 treatment schools (28,321 students) and 274 control schools (72,667 students). The statistical model includes cohort fixed

effects with the 2010 cohort as the reference group, the interactions between cohort fixed effects and the school treatment status, as well as student and school-by-cohort covariates that are used in the main analysis, and school fixed effects. The parameter of interest is represented by the coefficients on the interaction terms, indicating the average within-school between-cohort outcome differences between the treatment and control schools during years in which the treatment schools had not yet introduced PLTW to their students.

The results are provided in Online Appendix Table A5. We find little evidence of differential trends between the treatment and control schools prior to PLTW offer/expansion overall or by gender and achievement quartiles. The only statistically significant result is found for initial STEM major declaration for the 2011 cohort. The analysis based on all students and male students show slightly greater increases (by 1.4 percentage points, $p<0.05$) for the 2011 cohort in the treatment schools than those in the control schools. However, none of the other estimates are statistically significant.

**Addressing Validity Threat due to Students' Sorting to Schools due to PLTW Expansion**

Our analysis assumes that within-school between-cohort variability in PLTW course offerings is exogenous, conditioning on covariates. This assumption is violated if, for example, more motivated students are increasingly choosing high schools that are expanding PLTW opportunities and motivation is not captured by the covariates. We controlled for key time-varying confounders for incoming 9th-grade cohorts (average 8$^{th}$-grade math and science test scores, 8$^{th}$-grade Algebra completion rates, FRL rates, racial composition, and cohort size) as well as students' own demographic and academic characteristics.

Additionally, we assess the possibility of selection bias due to students' sorting to high schools associated with PLTW expansion, given covariates. Specifically, we examine the relationship between our instrument (PLTW availability for cohort c) and the likelihood of incoming 9$^{th}$-grade students attending a high school that differs from the assigned high school based on their middle school in the prior year. The outcome takes a value of one if students deviated from the feeder patterns and zero otherwise. If PLTW course expansion affects high school choice, we would expect a positive association between PLTW expansion and this outcome in a given high school.

The first model only includes year fixed effects and our instrument without any control variables. The results for all students (Appendix Table A6, first column) show a positive and statistically significant association, that is, PLTW expansion by one section per 100 students is associated with a 2.9 percentage point increase in students from non-feeder middle schools ($p<0.01$). The pathway specific analysis also shows the coefficients of similar magnitude (2.9 percentage points for Engineering/Computer Science and 2.3 percentage points for Biomedical Science) although they are not statistically significant. Once student and cohort covariates and school fixed effects are controlled for, these relationships are eliminated (a coefficient of -0.003, n.s.). The pattern of results is similar when the same analysis is conducted for each gender group. These results together suggest that the observed covariates sufficiently control for time-varying confounders of PLTW impacts that operate through student sorting to high schools.

## Conclusion

High school is a critical period for the development of STEM knowledge and skills as well as STEM career interests through coursework and learning experiences (e.g., Bottia et al. 2015; Corin, Sonnert, and Sadler 2020). Most students with STEM degrees enter the pipeline in

high school (Tai et al. 2006; Maltese and Tai 2011). Project Lead the Way is an applied STEM program, first introduced during the 1990's and expanded rapidly to thousands of schools since then, is now the largest applied STEM program of its kind in US schools. PLTW offers curricula that are focused on hands-on, problem-based learning and real-world applications with a goal of strengthening STEM workforce training and broadening student participation in meaningful STEM learning. Nationally, PLTW staff have encouraged participation from students who are traditionally underrepresented in STEM fields. As noted, PLTW courses are STEM-infused CTE courses with considerable flexibility in staffing. Extensive curriculum support and professional development also makes expansion and staffing easier and helps explain the relatively rapid expansion (and persistence) in Missouri public schools.

This study, using the data on all public high school students in Missouri, examines how program participation increased following the expansion of PLTW provisions, and how this, in turn, affected college enrollment and the choice of STEM or health science as a college major. Our evidence suggests that offering this type of applied STEM program during high school has the potential to increase student STEM participation in college. We also find notable differences by gender and prior STEM skill levels. The main findings are summarized as follows:

1) Overall student participation increased as schools expanded PLTW course offerings. Males, particularly those with strong STEM readiness, were responsive to Engineering course expansion. Female participation was driven more by Biological Science expansion, and this was observed relatively evenly across levels of STEM readiness.
2) College enrollment increased with PLTW course expansion for males. In particular, male students with moderate skills (Quartile 2) showed increases in two-year college

enrollment primarily driven by Engineering course expansion. In contrast, for females, Biomedical Science expansion is related to higher rates of four-year college enrollment.

3) STEM major declaration rose for students in the top quartile of STEM readiness as schools increased PLTW course offerings, and for females, increases were only observed for five-year major declaration.
4) PLTW participation had statistically significant and substantial impacts on STEM major declaration, on average, with larger impacts for five-year than initial declaration for both genders. Participation impacts on five-year STEM major declaration were larger for females than males.

The findings of this study provide a number of implications for policy and practice. First, this study highlights the importance of earlier schooling to strengthen math and science skills (and interest) in STEM. Our results showed positive impacts on STEM degree declaration primarily among students in the top quartile of pre-high school STEM readiness. At the same time, broadening PLTW availability may also expand a pipeline to STEM occupations through community college programs for students with moderate skills. We note that PLTW is now offering courses in middle school (Gateway) and elementary school (Launch) with a goal of increasing engagement, interests, and academic preparation in STEM. Future research will address how these earlier interventions impacted academic skills, high school course taking, and long-term academic trajectories.

Second, with regard to female STEM participation, our study revealed clear differences in choice of programs. Creating more opportunities is likely to increase participation for both gender groups, but at different rates, which have implications for gender gaps. Engineering expansion is likely to induce more male participations; thus, if the goal is to reduce gender gaps

in Engineering, it is important to increase female participations. In contrast, Biomedical Sciences is the more preferred choice for females.

We also note that not all students who declare a STEM major do so upon college entry. Thus, for policy evaluations to capture a fuller scope of post-secondary impacts, it is important to consider major declaration beyond the first year of college. Particularly for female students, the impact of course expansion on initial major declaration was not statistically significant although the direction of impact was positive. PLTW participation impacts on five-year declaration were larger than those on initial declaration for both gender groups.

Third, for female students, increases in Biomedical Science participation were observed broadly across the range of STEM readiness. Moreover, participation impacts on five-year major declaration were relatively similar across the top three achievement quartiles although the result is only statistically significant for the highest quartile. These findings are promising. The five-year outcomes were not available for all cohorts at the time of this study. However, as more data becomes available, it will be possible to examine in a systematic way whether the increase in STEM majors induced by PLTW translates into more completed STEM degrees.

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Endnotes

[1] See https://ncses.nsf.gov/pubs/nsb20245/u-s-stem-workforce-size-growth-and-employment and https://blog.dol.gov/2022/11/04/stem-day-explore-growing careers#:~:text=At%20the%20Bureau%20of%20Labor,grow%20much%20faster%20than%20average

[2]In Missouri, PLTW began with 60 Engineering sections in 2005 and increased to 411 sections by the first year of this study (AY 2009–10). Biomedical Science was first introduced in AY 2011–12 with 186 sections, alongside 593 Engineering sections. Computer Science began in AY 2014–15 with 11 sections, joining 864 Engineering and 423 Biomedical sections. By the final study year (AY 2016–17), total PLTW offerings had grown to 2,125 sections: 1,121 in Engineering, 754 in Biomedical Science, and 250 in Computer Science. Missouri is now the fourth largest state in terms of number of PLTW sections taught.

[3]The effect of within-school PLTW course expansion is estimated from schools that offered PLTW to any of the five cohorts under study (treatment schools). Of 255 such schools, 129 schools offered the program for all cohorts, while 96 schools adopted the program for later cohorts.

[4] All Missouri public high school students must take one practical arts credit and at least seven electives for graduation. As with any course, these choices must be approved by a high school counselor. National and regional

staff of PLTW work closely with schools to assist in implementation. When we posed a question to PLTW staff about how/whether students are recruited for participation, they mentioned that teachers and/or counselors tended to recruit students who are academically stronger in STEM when they first adopted the program. However, as mentioned in the introductory section, the PLTW organization also pushed strongly for inclusive recruitment to encourage participation from students who are underrepresented in STEM. In any event, we have extensive controls for pre-high school STEM preparation.

[5] Importantly, PLTW does not require prior coursework or other STEM state certification for foundational courses. For example, a licensed English teacher who completes the PLTW training could become certified to teach foundational PLTW courses. This seems to work because, as compared to a traditional STEM course, the content and projects in PLTW courses are heavily scripted. To teach more advanced PLTW courses may require prior certification and experience in the foundation courses.

[6] We have examined the teaching credentials of the educators who were the first PLTW teachers over the period covered by this study. Not surprisingly, these differed by the PLTW track. Most Engineering teachers came from a STEM or Industrial Arts background, with a small share coming from other fields. The largest share of Biomedical PLTW teachers were biology teachers. Computer Science PLTW teachers primarily came from Industrial Arts or math backgrounds. This diversity is a reflection of the fact that MODESE requires PLTW certification and a valid teaching certificate in any high school teaching field.

[7] Studies by Altonji (1995), Levine and Zimmerman (1995), and Rose and Betts (2004) examined labor market outcomes associated with high school STEM course taking. These studies find that taking more rigorous courses has only a small effect on wages (Altonji 1995); taking more math and science courses increases wages and the likelihood of entering STEM fields only for females (Levine and Zimmerman 1995); enrolling in more advanced courses has positive impacts on earnings ten years after high school graduation (Rose and Betts 2004).

[8] 37 schools were closed or opened during the study period and not included in the study.

[9] Under the current Memorandum of Agreement (MOA) with MODESE, we have five cohorts of student administrative data.

[10] While the DHS does not consider health science majors as STEM majors, we will consider it as such. Since the Biomedical Science PLTW pathway enrolls many students, it would make little sense to exclude post-secondary bioscience training or careers in our evaluation. For brevity, we refer to "STEM" in the text but use longer, more accurate label "STEM/Health Sciences" in the statistical tables.

[11] We also constructed a variable measuring the total number of unique PLTW courses offered during high school to capture course variety. However, once course availability measure is included in the model, adding this variable did not improve the overall model fit and the results remained the same, so we removed this variable from our analysis.

[12] Some treatment schools (88 schools) also have access to Career Centers which offer various CTE courses, including PLTW courses. Course availability through career centers is also used as an additional predictor in the statistical model. However, addition of this variable did not change the results.

[13] All teachers who teach PLTW are required to complete a two-week (80 hour) summer institute which is delivered by colleges and universities that are PLTW network affiliates, and they are provided with ongoing professional development training.

[14] To investigate these questions question, Nomi, DeChane, and Podgursky (2026a; 2026b) used principal score weighting methods to equate PLTW participants and non-participants attending the same school. Their outcome difference is compared to that of similar students (non-participants) attending schools that never offered PLTW.

## References


Altonji, Joseph G. 1995. "The Effects of High School Curriculum on Education and Labor Market Outcomes." *Journal of Human Resources* 30: 409–438.

Bottia, Martha C., Elizabeth Stearns, Roslyn Arlin, Stephanie Moller, and Ashley Dawn. 2015. "The Relationships among High School STEM Learning Experiences and Students' Intent to Declare and Declaration of a STEM Major in College." *Teachers College Record* 117 (3): 1–46.

Camburn, Eric, Karin Chang, Takako Nomi, Michael Podgursky, Darrin DeChane, Anwuli Okwuashi, Mark Ehlert, Jeongmi Moon, and Xinyi Mao. 2022. Final Report of the Impact of Project Lead the Way on Missouri High School Students: A Report to the KC STEM Alliance. Urban Education Research Center, University of Missouri–Kansas City.

Capraro, Robert M., Mary Margaret Capraro, and Jeffrey R. Morgan, eds. 2013. *STEM Project-Based Learning: An Integrated Science, Technology, Engineering, and Mathematics (STEM) Approach*. New York: Springer.

Cole, Brian, Karen High, and Kurt Weinland. 2013. "High School Pre-Engineering Programs: Do They Contribute to College Retention?" *American Journal of Engineering Education* 4 (1): 85–98.

Committee on STEM Education. 2018. "Charting a course for success: America's strategy for STEM education." https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

Corin, Elyse, Gerhard Sonnert, and Philip M. Sadler. 2020. "The Role of Dual Enrollment STEM Coursework in Increasing STEM Career Interest among American High School Students." *Teachers College Record* 122 (2): 1–26.

Darolia, Rajeev, Cory Koedel, Joyce B. Main, J. Felix Ndashimye, and Junpeng Yan. 2018. "High School Course Access and Postsecondary STEM Enrollment and Attainment." *Educational Evaluation and Policy Analysis* 42 (1): 22–45.

Dougherty, Shaun M., and Isabel Harbaugh Macdonald. 2020. "Can Growth in the Availability of STEM Technical Education Improve Equality in Participation?: Evidence from Massachusetts." *Journal of Vocational Education & Training* 72 (1): 47-70.

Ecton, Walter G., and Shaun M. Dougherty. 2023. "Heterogeneity in High School Career and Technical Education Outcomes." Educational Evaluation and Policy Analysis 45 (1): 157-181.

Edmunds, Julie A., Fatih Unlu, Brian Phillips, Christine Mulhern, and Bryan C. Hutchins. 2023. "CTE-Focused Dual Enrollment: Participation and Outcomes." *Education Finance and Policy*, 1–22.

Federman, Maya. 2007. "State Graduation Requirements, High School Course Taking, and Choosing a Technical College Major." B.E. *Journal of Economic Analysis & Policy* 7: 1–34.

Gottfried, Michael. "Linking applied STEM Coursetaking beyond STEM Outcomes: Examining high school completion and college-going behavior." *High School Journal* 105 (3): 175-198.

Gottfried, Michael A., and Robert Bozick. 2016. "Supporting the STEM Pipeline: Linking Applied STEM Course-Taking in High School to Declaring a STEM Major in College." *Education Finance and Policy* 11 (2): 177–202.

Gottfried, Michael A., Robert Bozick, and Sanduja V. Srinivasan. 2014. “Beyond Academic Math: The Role of Applied STEM Coursetaking in High School.” *Teachers College Record* 116 (7): 1–35.

Hanif, Sofi, Agus Fancy Chandra Wijaya, and Nanang Winarno. 2019. “Enhancing Students’ Creativity through STEM Project-Based Learning.” *Journal of Science Learning* 2 (2): 50–57.

Hansen, Ben B. 2008. "The prognostic analogue of the propensity score." *Biometrika* 95 (2): 481-488.

Hu, Xiaodan, and Hsun-Yu Chan. 2023. “Preparing for the STEM Pathways? Dual Enrollment and College Major Choice in STEM.” *Journal of Higher Education* 95 (5): 607–638.

Leacy, Finbarr P., and Elizabeth A. Stuart. 2014. "On the joint use of propensity and prognostic scores in estimation of the average treatment effect on the treated: a simulation study." *Statistics in medicine* 33 (20): 3488-3508.

Liu, Jing, Cameron Conrad, and David Blazar. (2024). Computer Science for All? The Impact of High School Computer Science Courses on College Majors and Earnings. (EdWorkingPaper: 24-904). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/k0w5-pg15

Kokotsaki, Dimitra, Victoria Menzies, and Andy Wiggins. 2016. “Project-Based Learning: A Review of the Literature.” *Improving Schools* 19 (3): 267–277.

Levine, Phillip B., and David J. Zimmerman. 1995. “The Benefit of Additional Math and Science Classes for Young Men and Women.” *Journal of Business & Economic Statistics* 13: 137–149.

Lopez, Estela. 2025. “Gender Earnings Gap in Engineering Occupations.” https://alltogether.swe.org/2025/10/gender-earnings-gap-in-engineering-occupations

Maltese, Adam V., and Robert H. Tai. 2011. “Pipeline Persistence: Examining the Association of Educational Experiences with Earned Degrees in STEM among U.S. Students.” *Science Education* 95 (5): 877–907.

Nomi, Takako, Darrin DeChane, and Michael Podgursky. 2026a. “Project Lead the Way: Impacts of a High School Applied STEM Program on Early Postsecondary Outcomes.” *Journal of Research on Educational Effectiveness* 19 (2): 1–29.

Nomi, Takako, Darrin DeChane, and Michael Podgursky. 2026b. “Expanding STEM Pipeline through Applied STEM CTE Programs in High School: Impacts of Project Lead the Way on STEM Course Taking Patterns and Post-secondary Degree Completion” (paper presented at the Association for Education Policy Finance, Chicago, IL, March, 2026.)

Phelps, Laura Allen, Eric M. Camburn, and Sookweon Min. 2018. “Choosing STEM College Majors: Exploring the Role of Pre-College Engineering Courses.” *Journal of Pre-College Engineering Education Research* 8 (1): 1.

Pike, Gary, and Kirsten Robbins. 2019. “Expanding the Pipeline: The Effect of Participating in Project Lead the Way on Majoring in a STEM Discipline.” *Journal for STEM Education Research 2* (1): 14–34.

Project Lead the Way. 2024. *Annual Report*. https://issuu.com/pltworg/docs/pltw_2024_annual-report_web

Rehmat, Abeera P., and Kendall Hartley. 2020. “Building Engineering Awareness: Problem-Based Learning Approach for STEM Integration.” *Interdisciplinary Journal of Problem-Based Learning* 14 (1).

Rethwisch, David G., Soko S. Starobin, Frankie Santos Laanan, and Melissa Chapman Haynes. 2013. “A Study of the Impact of a National Project-Based Learning Curriculum (PLTW) on Student Continuation to Postsecondary Institutions.” Paper presented at the ASEE Annual Conference & Exposition, June.

Rose, Heather, and Julian R. Betts. 2004. “The Effect of High School Courses on Earnings.” *Review of Economics and Statistics* 86: 497–513.

Starobin, Soko S., Timothy Schenk Jr., Frankie Santos Laanan, David G. Rethwisch, and Darin Moeller. 2013. “Going and Passing through Community Colleges: Examining the Effectiveness of Project Lead the Way in STEM Pathways.” *Community College Journal of Research and Practice* 37 (3): 226–236.

Symonds, William C., Robert B. Schwartz, and Ronald Ferguson. 2011. *Pathways to Prosperity: Meeting the Challenge of Preparing Young Americans for the 21st Century*. Cambridge, MA: Harvard Graduate School of Education.

Tai, Robert H., Christine Qi Liu, Adam V. Maltese, and Xitao Fan. 2006. “Planning Early for Careers in Science.” *Science* 312 (26): 1143–1144.

Thibaut, Lieve, Stijn Ceuppens, Haydee De Loof, Jolien De Meester, Leen Goovaerts, Annemie Struyf, and Fien Depaepe. 2018. “Integrated STEM Education: A Systematic Review of Instructional Practices in Secondary Education.” *European Journal of STEM Education* 3 (1): 2.

Utley, Juliana, Toni Ivey, John Weaver, and Mary Jo Self. 2019. “Effect of Project Lead the Way Participation on Retention in Engineering Degree Programs.” *Journal of Pre-College Engineering Education Research* 9 (2): Article 3.

Van Overschelde, James P. 2013. “Project Lead the Way Students More Prepared for Higher Education.” *American Journal of Engineering Education* 4 (1): 1–12.

Woolnough, Brian E. 1994. “Effective Science Teaching.” In *Effective Science Teaching*, chap. 4. Buckingham: Open University Press.

Xu, Zeyu, and Ben Backes. 2024. "Linkage Between Fields of Focus in High School Career Technical Education and College Majors." *Educational Evaluation and Policy Analysis* 46 (3): 435-457.

Figures and Tables

Figure 1. Average PLTW Course Sections Per 100 Students by Cohort (N=225 Treatment Schools)

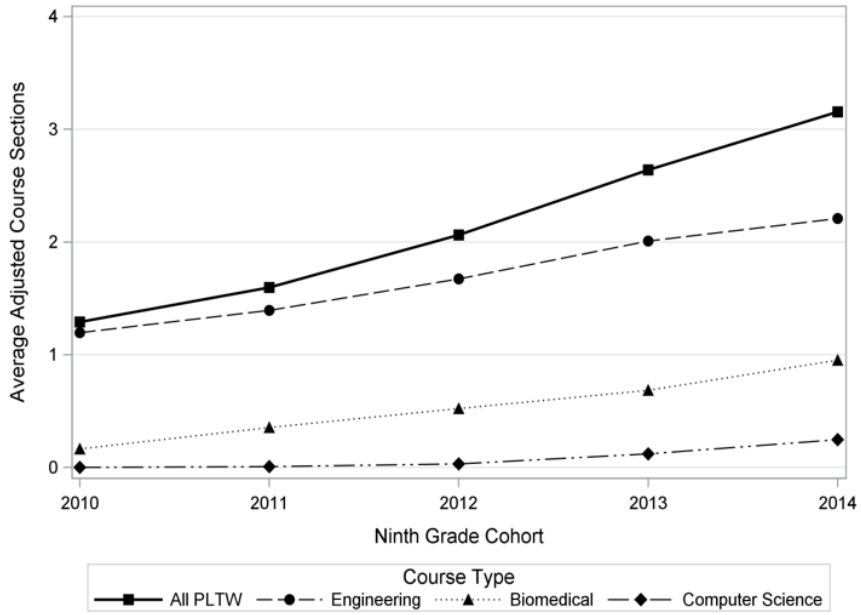
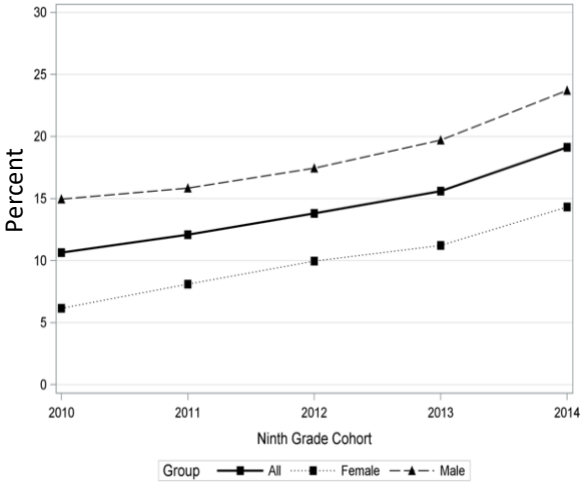
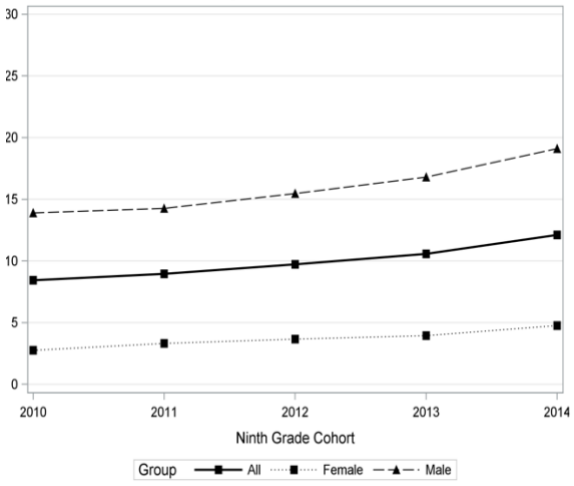


Figure 2: Average PLTW Participation Rates (Overall and Pathway Specific)

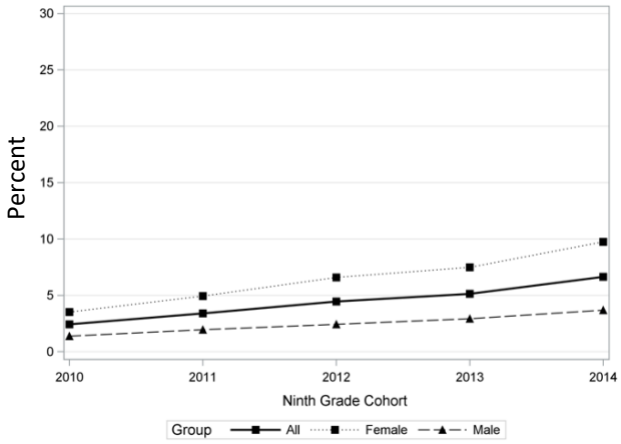
1) Overall PLTW




2) Engineering Pathway




3) Biomedical Science




4) Computer Science

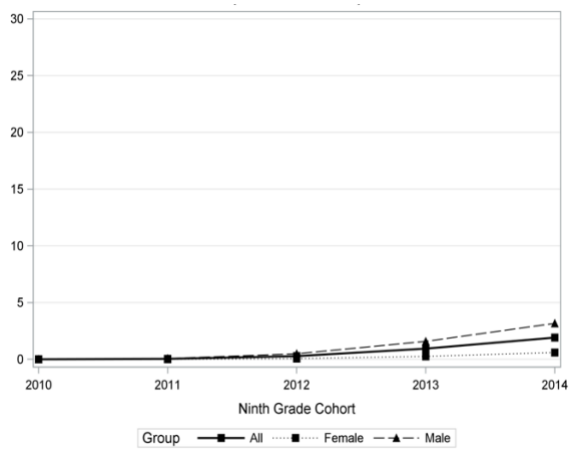


Table 1. Descriptive Statistics

| | Mean | SD |
|---|---|---|
| C2010 | .199 | .400 |
| C2011 | .194 | .395 |
| C2012 | .193 | .395 |
| C2013 | .208 | .406 |
| C2014 | .206 | .405 |
| Female | .488 | .500 |
| White | .759 | .428 |
| Black | .157 | .364 |
| Hispanic | .043 | .202 |
| Asian | .017 | .131 |
| Other | .024 | .152 |
| FRL | .528 | .499 |
| MAP ELA | .000 | 1.000 |
| MAP Math | .000 | 1.000 |
| MAP Science | .000 | 1.000 |
| $8^{th}$ Grade Alg. | .188 | .391 |
| N students | 333,507 | |
| N schools | 501 | |

Table 2. Logistic Coefficients from a Model Predicting a Four-year STEM Degree within Five Years of High School Graduation, Estimated from the 2010 Cohort in Schools without PLTW

| | 2010 Cohort |
|---|---|
| Intercept | -4.65*** |
| | (.05) |
| Math MAP | 1.292*** |
| | (.08) |
| Math MAP$^2$ | -.161*** |
| | (.021) |
| Science MAP | .638*** |
| | (.101) |
| Science MAP$^2$ | .061 |
| | (.039) |
| Comm. Arts MAP | .084 |
| | (.059) |
| Comm. Arts MAP$^2$ | -.034 |
| | (.018) |
| Alg. 1 in Grade 8 | .429*** |
| | (.049) |
| N students | 66,375 |
| AUC / c-Statistic | .872 |

Note: Standard errors are in parentheses. *<.05. **<.01. ***<.001

Table 3. Predicted Probability of Four-year STEM Degree Attainment (in Percentage Points)

| | Overall | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|---|
| All | 3.624 | .094 | .577 | 2.177 | 11.649 |
| | (6.327) | (.066) | (.237) | (.810) | (8.435) |
| Males | 3.774 | .091 | .577 | 2.179 | 12.139 |
| | (6.702) | (.066) | (.237) | (.809) | (8.947) |
| Females | 3.467 | .098 | .577 | 2.175 | 11.118 |
| | (5.903) | (.066) | (.236) | (.812) | (7.808) |
| | | | Sample Sizes | | |
| All | 333,507 | 83,377 | 83,377 | 83,377 | 83,377 |
| Males | 170,820 | 44,645 | 41,475 | 41,313 | 43,387 |
| Females | 162,687 | 38,732 | 41,902 | 42,064 | 39,989 |

Note: Standard deviations are in parentheses.

Table 4. Descriptive Statistics on PLTW High Schools and Non-PLTW High Schools in AY2010

| | Non-PLTW schools | | PLTW schools | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| % Female | .475 | .096 | .478 | .053 |
| % White | .867 | .439 | .720 | .289 |
| % Black | .094 | .236 | .201 | .287 |
| % Hispanic | .023 | .062 | .043 | .055 |
| % Other | .016 | .028 | .036 | .032 |
| % Free/Reduced Lunch | .599 | .279 | .381 | .235 |
| Ave. ELA scores | -.152 | .978 | -.016 | .987 |
| Ave. Math scores | -.190 | .960 | -.048 | .984 |
| Ave Science scores | -.165 | .963 | -.065 | .992 |
| % Completed Algebra in Grade 8 | .108 | .131 | .177 | .116 |
| Mean GPA in Grade 9 | 2.636 | .962 | 2.663 | .993 |
| *District Locale* | | | | |
| -City | 8.87 | 6.8 | 19.99 | 16.0 |
| -Suburban | 2.86 | 2.8 | 45.93 | 24.8 |
| -Town | 17.97 | 14.7 | 18.52 | 15.1 |
| -Rural | 56.07 | 2.9 | 15.56 | 13.1 |
| Average School Enrollment | 291.060 | 311.847 | 1117.252 | 603.497 |
| School N | 276 | | 225 | |

Table 5. PLTW Course Sections Per 100 Students (Adjusted Course Sections) in Treatment Schools (N=225) by Cohort

| | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| All PLTW courses | 1.290 (1.477) | 1.596 (1.866) | 2.062 (2.315) | 2.639 (2.667) | 3.154 (2.549) |
| Engineering courses | 1.195 (1.361) | 1.393 (1.668) | 1.672 (1.856) | 2.008 (2.065) | 2.208 (1.852) |
| Biomed courses | .164 (.426) | .354 (1.013) | .522 (1.135) | .684 (1.294) | .951 (1.482) |
| CS courses | .000 (.000) | .007 (.036) | .031 (.093) | .120 (.264) | .246 (.442) |

Note: Standard deviations are in parentheses.

Table 6. Average PLTW Participation Rates by Cohort (Treatment Schools)

| | All | | | | |
|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 |
| PLTW | .097<br>(.295) | .112<br>(.315) | .129<br>(.335) | .146<br>(.353) | .181<br>(.385) |
| Engineering | .077<br>(.266) | .083<br>(.276) | .092<br>(.289) | .099<br>(.299) | .116<br>(.320) |
| Biomedical | .022<br>(.146) | .031<br>(.173) | .040<br>(.196) | .047<br>(.211) | .062<br>(.241) |
| CS | .000<br>(.000) | .001<br>(.022) | .003<br>(.050) | .009<br>(.094) | .018<br>.133) |
| N | 48,825 | 47,654 | 47,848 | 51,424 | 51,410 |

| | Female | | | | |
|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 |
| PLTW overall | .055<br>(.228) | .072<br>(.259) | .089<br>(.285) | .101<br>(.302) | .132<br>(.338) |
| Engineering | .024<br>(.154) | .029<br>(.168) | .033<br>(.179) | .035<br>(.183) | .043<br>(.202) |
| Biomedical | .032<br>(.176) | .045<br>(.207) | .059<br>(.235) | .068<br>(.252) | .091<br>(.288) |
| CS | .000<br>(.000) | .000<br>(.009) | .001<br>(.023) | .002<br>(.049) | .005<br>(.073) |
| N | 23,748 | 23,174 | 23,271 | 25,015 | 25,005 |

| | Male | | | | |
|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 |
| PLTW overall | .135<br>(.342) | .149<br>(.356) | .166<br>(.372) | .187<br>(.390) | .228<br>(.420) |
| Engineering | .126<br>(.332) | .134<br>(.341) | .148<br>(.355) | .161<br>(.367) | .185<br>(.389) |
| Biomedical | .012<br>(.109) | .018<br>(.131) | .022<br>(.147) | .026<br>(.160) | .034<br>(.182) |
| CS | .000<br>(.000) | .001<br>(.029) | .004<br>(.066) | .015<br>(.122) | .030<br>(.171) |
| N | 25,077 | 24,480 | 24,577 | 26,409 | 26,405 |

Note: Standard deviations are in parentheses.

Table 7. The Effect of Adjusted Course Sections on PLTW Participation

| *All students* | Overall | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|---|
| Intercept | .057*** | .016*** | .035*** | .037*** | .062*** |
| | (.003) | (.003) | (.005) | (.006) | (.007) |
| PLTW | .032*** | .017*** | .027*** | .036*** | .047*** |
| | (.001) | (.001) | (.001) | (.001) | (.002) |
| *Male students* | | | | | |
| Intercept | .048*** | .011* | .022** | .029*** | .046*** |
| | (.004) | (.005) | (.007) | (.008) | (.010) |
| PLTW | .030*** | .015*** | .024*** | .037*** | .047*** |
| | (.001) | (.002) | (.002) | (.002) | (.002) |
| *Female students* | | | | | |
| Intercept | .005 | -.005 | .002 | -.011 | -.017* |
| | (.003) | (.004) | (.005) | (.006) | (.008) |
| PLTW | .034*** | .017*** | .031*** | .036*** | .048*** |
| | (.001) | (.001) | (.002) | (.002) | (.002) |
| | Pathway Specific Analysis | | | | |
| *All Students* | Overall | Q1 | Q2 | Q3 | Q4 |
| Intercept | .044*** | .016*** | .035*** | .036*** | .059*** |
| | (.002) | (.003) | (.005) | (.006) | (.007) |
| Eng/CS | .035*** | .018*** | .028*** | .040*** | .059*** |
| | (.001) | (.002) | (.002) | (.002) | (.003) |
| Biomed | .028*** | .014*** | .025*** | .030*** | .033*** |
| | (.001) | (.002) | (.003) | (.003) | (.003) |
| *Male students* | | | | | |
| Intercept | .047*** | .011* | .020** | .025** | .039*** |
| | (.004) | (.005) | (.007) | (.008) | (.010) |
| Eng/CS | .044*** | .024*** | .033*** | .058*** | .075*** |
| | (.002) | (.003) | (.003) | (.004) | (.004) |
| Biomed | .011*** | .001 | .010* | .009 | .014** |
| | (.002) | (.003) | (.004) | (.004) | (.005) |
| *Female students* | | | | | |
| Intercept | .006 | -.004 | .004 | -.009 | -.014 |
| | (.003) | (.005) | (.005) | (.007) | (.008) |
| Eng/CS | .024*** | .010*** | .023*** | .025*** | .041*** |
| | (.001) | (.002) | (.003) | (.003) | (.004) |
| Biomed | .046*** | .028*** | .041*** | .049*** | .054*** |
| | (.002) | (.003) | (.003) | (.003) | (.004) |
| | Sample Size | | | | |
| All | 333,507 | 83,371 | 83,382 | 83,376 | 83,378 |
| Male | 171,296 | 44,651 | 41,257 | 41,689 | 43,699 |
| Female | 162,211 | 38,720 | 42,125 | 41,687 | 39,679 |

Note: Q4 is the highest level of preparation. The models include cohort fixed effects, student covariates, and high school fixed effects. Standard errors are in parentheses. *<.05. **<.01. ***<.001

Table 8. The Effect of PLTW Adjusted Course Sections on Student Outcomes

| | Any College Enrollment | | | Two-Year College Enrollment | | | Four-Year College Enrollment | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | Male | Female | All | Male | Female | All | Male | Female |
| Intercept | .464*** | .463*** | .598*** | .209*** | .207*** | .257*** | .265*** | .263*** | .354*** |
| | (.002) | (.003) | (.003) | (.002) | (.002) | (.003) | (.002) | (.002) | (.003) |
| PLTW | .003** | .004** | .001 | .001 | .003* | -.002 | .001 | 0 | .002 |
| | (.001) | (.002) | (.002) | (.001) | (.001) | (.002) | (.001) | (.001) | (.001) |
| N | 333,507 | 171,296 | 162,211 | 333,507 | 171,296 | 162,211 | 333,507 | 171,296 | 162,211 |

Pathway Specific Analysis

| | Any College Enrollment | | | Two-Year College Enrollment | | | Four-Year College Enrollment | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | Male | Female | All | Male | Female | All | Male | Female |
| Intercept | .464*** | .462*** | .598*** | .21*** | .207*** | .258*** | .264*** | .261*** | .354*** |
| | (.002) | (.003) | (.003) | (.002) | (.002) | (.003) | (.002) | (.002) | (.003) |
| Eng/CS | .002 | .005* | .001 | .002 | .004 | 0 | -.001 | 0 | -.001 |
| | (.002) | (.003) | (.003) | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) |
| Biomed | .004 | .003 | .006 | -.001 | 0 | -.002 | .004* | .001 | .007* |
| | (.002) | (.003) | (.003) | (.002) | (.003) | (.003) | (.002) | (.003) | (.003) |
| N | 333,507 | 171,296 | 162,211 | 333,507 | 171,296 | 162,211 | 333,507 | 171,296 | 162,211 |

Table 8 (continued). The Effect of PLTW Adjusted Course Sections on Student Outcomes

| | STEM/Health Science Major upon College Entry | | | STEM/Health Science Major within Five Years After Entering College | | |
|---|---|---|---|---|---|---|
| | All | Male | Female | All | Male | Female |
| Intercept | .107*** | .105*** | .155*** | .195*** | .198*** | .267*** |
| | (.003) | (.004) | (.005) | (.004) | (.006) | (.007) |
| PLTW | .002** | .003* | .002 | .006** | .005** | .008*** |
| | (.001) | (.001) | (.001) | (.001) | (.002) | (.002) |

Pathway Specific Analysis

| | STEM/Health Science Major upon College Entry | | | STEM/Health Science Major within Five Years After Entering College | | |
|---|---|---|---|---|---|---|
| | All | Male | Female | All | Male | Female |
| Intercept | .107*** | .105*** | .156*** | .193*** | .198*** | .269*** |
| | (.003) | (.004) | (.005) | (.004) | (.006) | (.007) |
| Eng/CS | .002 | .002 | .002 | .006* | .007* | .005 |
| | (.001) | (.002) | (.002) | (.002) | (.003) | (.003) |
| Biomed | .003 | .003 | .002 | .006* | .001 | .011** |
| | (.002) | (.002) | (.002) | (.003) | (.003) | (.004) |
| N | 333,507 | 171,296 | 162,211 | 264,655 | 136,052 | 128,603 |

Note: The models include cohort fixed effects, student covariates, and high school fixed effects. The analyses of college entry and STEM/Health Science major upon college entry use five cohorts of students, while those of five-year STEM/Health Science major are based on four cohorts. Standard errors are in parentheses. *<.05. **<.01. ***<.001

Table 9. The Effect of PLTW Adjusted Course Sections on Student Outcomes by Quartiles of STEM Readiness

| | Any College Enrollment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .175*** | .32*** | .463*** | .647*** | .168*** | .325*** | .469*** | .634*** | .286*** | .465*** | .604*** | .745*** |
| | (.004) | (.004) | (.004) | (.004) | (.005) | (.006) | (.006) | (.005) | (.006) | (.006) | (.006) | (.005) |
| PLTW | 0 | .003 | .006* | .005* | .001 | .005 | .007 | .007* | 0 | .002 | .005 | .003 |
| | (.002) | (.002) | (.002) | (.002) | (.002) | (.003) | (.003) | (.003) | (.003) | (.004) | (.003) | (.003) |
| | Two-Year College Enrollment | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .148*** | .227*** | .262*** | .213*** | .135*** | .22*** | .256*** | .198*** | .241*** | .312*** | .308*** | .217*** |
| | (.004) | (.004) | (.004) | (.004) | (.004) | (.005) | (.005) | (.005) | (.005) | (.005) | (.005) | (.005) |
| PLTW | 0 | .003 | -.001 | .001 | .003 | .007* | .001 | .001 | -.004 | 0 | -.002 | .001 |
| | (.002) | (.002) | (.002) | (.002) | (.002) | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) |
| | Four-Year College Enrollment | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .028*** | .099*** | .212*** | .451*** | .035*** | .111*** | .222*** | .451*** | .047*** | .16*** | .31*** | .55*** |
| | (.002) | (.003) | (.004) | (.004) | (.003) | (.004) | (.005) | (.006) | (.004) | (.005) | (.006) | (.006) |
| PLTW | -.002 | -.001 | .004 | .004 | -.004* | -.003 | .003 | .005 | 0 | .001 | .005 | .002 |
| | (.001) | (.002) | (.002) | (.002) | (.002) | (.002) | (.003) | (.003) | (.002) | (.003) | (.003) | (.003) |
| N | 83,371 | 83,382 | 83,376 | 83,378 | 44,651 | 41,257 | 41,689 | 43,699 | 38,720 | 42,125 | 41,687 | 39,679 |

Table 9 (continued). The Effect of PLTW Adjusted Course Sections on Student Outcomes by Quartiles of STEM Readiness

| | STEM/Health Science Major upon College Entry | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .016*** | .033*** | .082*** | .173*** | .015*** | .033*** | .077*** | .169*** | .034*** | .08*** | .143*** | .21*** |
| | (.003) | (.006) | (.008) | (.010) | (.003) | (.005) | (.008) | (.011) | (.004) | (.007) | (.01) | (.012) |
| PLTW | 0 | .002 | 0 | .005 | -.001 | 0 | 0 | .005* | .001 | .003 | -.001 | .001 |
| | (.001) | (.001) | (.002) | (.003) | (.001) | (.001) | (.002) | (.003) | (.001) | (.002) | (.003) | (.003) |
| N | 83,371 | 83,382 | 83,376 | 83,378 | 44,651 | 41,257 | 41,689 | 43,699 | 38,720 | 42,125 | 41,687 | 39,679 |

| | STEM/Health Science Major within Five Years After Entering College | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .039*** | .086*** | .157*** | .338*** | .037*** | .08*** | .157*** | .34*** | .078*** | .175*** | .244*** | .369*** |
| | (.004) | (.008) | (.010) | (.012) | (.005) | (.008) | (.011) | (.014) | (.007) | (.011) | (.013) | (.015) |
| PLTW | .001 | .004 | .004 | .013*** | .001 | .002 | .001 | .01* | 0 | .005 | .006 | .011* |
| | (.002) | (.002) | (.003) | (.003) | (.002) | (.003) | (.004) | (.004) | (.003) | (.004) | (.004) | (.005) |
| N | 66,173 | 66,154 | 66,533 | 65,795 | 35,253 | 32,809 | 33,365 | 34,625 | 30,920 | 33,345 | 33,168 | 31,170 |

Note: Q4 is the highest level of preparation. The models include cohort fixed effects, student covariates, and high school fixed effects. The analyses of college enrollment and STEM/Health Science major upon college entry use five cohorts of students, while those of five-year STEM/Health Science major are based on four cohorts. Standard errors are in parentheses. *<.05. **<.01. ***<.001

Table 10. The Effect of PLTW Pathway Specific Course Sections on Students' Outcomes by Quartiles of STEM Readiness: All Students

| | College Enrollment | | | | Two-Year College Enrollment | | | | Four-Year College Enrollment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .174*** | .319*** | .462*** | .647*** | .148*** | .226*** | .262*** | .215*** | .028*** | .099*** | .211*** | .449*** |
| | (.004) | (.004) | (.004) | (.004) | (.003) | (.004) | (.004) | (.004) | (.002) | (.003) | (.004) | (.004) |
| Eng/CS | .001 | .003 | .004 | .004 | -.001 | .005 | .002 | .003 | 0 | -.004 | .001 | .002 |
| | (.003) | (.004) | (.004) | (.004) | (.003) | (.003) | (.003) | (.003) | (.002) | (.003) | (.004) | (.004) |
| Biomed | -.001 | .003 | .006 | .006 | .001 | 0 | -.004 | -.001 | -.003 | .004 | .007 | .005 |
| | (.004) | (.005) | (.005) | (.004) | (.004) | (.004) | (.004) | (.003) | (.003) | (.004) | (.004) | (.004) |
| N | 83,371 | 83,382 | 83,376 | 83,378 | 83,371 | 83,382 | 83,376 | 83,378 | 83,371 | 83,382 | 83,376 | 83,378 |

| | STEM/Health Science Major upon College Entry | | | | STEM/Health Science Major within Five Years After Entering College | | | |
|---|---|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .017*** | .033*** | .082*** | .178*** | .038*** | .087*** | .156*** | .340*** |
| | (.003) | (.005) | (.007) | (.009) | (.004) | (.008) | (.010) | (.012) |
| Eng/CS | 0 | .001 | .001 | .002 | .002 | -.002 | .007 | .013* |
| | (.001) | (.002) | (.003) | (.004) | (.003) | (.004) | (.005) | (.006) |
| Biomed | .001 | .003 | -.001 | .005 | .001 | .01* | -.001 | .011 |
| | (.002) | (.003) | (.003) | (.004) | (.003) | (.005) | (.006) | (.006) |
| N | 83,371 | 83,382 | 83,376 | 83,378 | 66,173 | 66,154 | 66,533 | 65,795 |

Note: Q4 is the highest level of preparation. The models include cohort fixed effects, student covariates, and high school fixed effects. The analyses of college enrollment and STEM/Health Science major upon college entry use five cohorts of students, while those of five-year STEM/Health Science major are based on four cohorts. Standard errors are in parentheses. *<.05. **<.01. ***<.001

Table 11. The Effect of PLTW Participation on College Enrollment Outcomes (Local Average Treatment Effects)

| | College Enrollment | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | | | Male | | | Female | | |
| | OLS | IV1 | IV2 | OLS | IV1 | IV2 | OLS | IV1 | IV2 |
| Intercept | .455*** | .451*** | .45*** | .452*** | .452*** | .452*** | .596*** | .598*** | .599*** |
| | (.002) | (.008) | (.008) | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) |
| Participation | .118*** | .093* | .108** | .108*** | .161** | .155** | .127*** | .049 | .087 |
| | (.003) | (.037) | (.038) | (.004) | (.056) | (.053) | (.005) | (.049) | (.05) |
| | Two-Year College Enrollment | | | | | | | | |
| | All | | | Male | | | Female | | |
| | OLS | IV1 | IV2 | OLS | IV1 | IV2 | OLS | IV1 | IV2 |
| Intercept | .205*** | .234*** | .234*** | .206*** | .207*** | .208*** | .254*** | .259*** | .258*** |
| | (.002) | (.002) | (.002) | (.002) | (.003) | (.003) | (.003) | (.003) | (.003) |
| Participation | .041*** | .019 | .03 | .039*** | .102* | .101* | .026*** | -.054 | -.033 |
| | (.002) | (.033) | (.033) | (.003) | (.049) | (.046) | (.004) | (.045) | (.045) |
| | Four-Year College Enrollment | | | | | | | | |
| | All | | | Male | | | Female | | |
| | OLS | IV1 | IV2 | OLS | IV1 | IV2 | OLS | IV1 | IV2 |
| Intercept | .26*** | .299*** | .299*** | .257*** | .255*** | .254*** | .355*** | .353*** | .355*** |
| | (.002) | (.002) | (.002) | (.002) | (.003) | (.003) | (.003) | (.003) | (.003) |
| Participation | .08*** | .031 | .037 | .072*** | .01 | .019 | .103*** | .064 | .085 |
| | (.002) | (.032) | (.033) | (.003) | (.048) | (.045) | (.004) | (.044) | (.045) |
| N | 333,507 | | | 171,296 | | | 162,211 | | |

Note: The models include cohort fixed effects, student covariates, and high school fixed effects. The analysis uses five cohorts of students. Standard errors are in parentheses. <.05. **<.01. ***<.001

Table 12. The Effect of PLTW Participation on College Enrollment Outcomes by Quartiles of STEM Readiness

| | IV Estimates with PLTW Expansion (IV1) as Instrument (Local Average Treatment Effects) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | College Enrollment | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .215*** | .391*** | .533*** | .685*** | .159*** | .313*** | .461*** | .631*** | .283*** | .467*** | .606*** | .747*** |
| | (.004) | (.004) | (.004) | (.004) | (.005) | (.006) | (.006) | (.006) | (.006) | (.006) | (.006) | (.005) |
| Participation | .077 | .16 | .197** | .123** | .088 | .306 | .229* | .173* | -.003 | .11 | .184 | .075 |
| | (.122) | (.092) | (.072) | (.047) | (.292) | (.167) | (.104) | (.07) | (.184) | (.109) | (.096) | (.062) |
| | Two-Year College Enrollment | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .178*** | .265*** | .284*** | .212*** | .128*** | .213*** | .256*** | .201*** | .236*** | .312*** | .31*** | .221*** |
| | (.003) | (.004) | (.004) | (.003) | (.004) | (.005) | (.005) | (.005) | (.005) | (.005) | (.005) | (.005) |
| Participation | -.016 | .159 | -.005 | .032 | .393 | .415** | .04 | .022 | -.212 | .029 | -.053 | .038 |
| | (.146) | (.082) | (.064) | (.04) | (.265) | (.149) | (.09) | (.059) | (.18) | (.1) | (.09) | (.056) |
| | Four-Year College Enrollment | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .04*** | .134*** | .262*** | .493*** | .033*** | .107*** | .215*** | .447*** | .049*** | .162*** | .311*** | .549*** |
| | (.002) | (.003) | (.004) | (.004) | (.003) | (.004) | (.005) | (.006) | (.003) | (.005) | (.005) | (.006) |
| Participation | -.134 | -.031 | .134* | .083 | -.387* | -.146 | .121 | .142 | .049 | .05 | .177 | .031 |
| | (.099) | (.071) | (.067) | (.051) | (.191) | (.124) | (.091) | (.075) | (.12) | (.088) | (.095) | (.071) |
| N | 83,371 | 83,382 | 83,376 | 83,378 | 44,651 | 41,257 | 41,689 | 43,699 | 38,720 | 42,125 | 41,687 | 39,679 |

Note: Q4 is the highest level of preparation. The models include cohort fixed effects, student covariates, and high school fixed effects. The analysis uses five cohorts of students. Standard errors are in parentheses. <.05. **<.01. ***<.001

Table 12 (continued). The Effect of PLTW Participation on Student Outcomes by Quartiles of STEM Readiness

| | OLS estimates | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | College Enrollment | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .176*** | .318*** | .455*** | .634*** | .17*** | .324*** | .463*** | .622*** | .29*** | .467*** | .603*** | .742*** |
| | (.004) | (.004) | (.004) | (.004) | (.004) | (.006) | (.006) | (.005) | (.006) | (.006) | (.006) | (.005) |
| Participation | .127*** | .113*** | .114*** | .095*** | .114*** | .102*** | .098*** | .099*** | .158*** | .129*** | .131*** | .083*** |
| | (.007) | (.006) | (.006) | (.004) | (.008) | (.008) | (.008) | (.006) | (.012) | (.011) | (.009) | (.007) |
| | Two-Year College Enrollment | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .148*** | .223*** | .258*** | .21*** | .136*** | .219*** | .253*** | .196*** | .24*** | .31*** | .305*** | .215*** |
| | (.003) | (.004) | (.004) | (.004) | (.004) | (.005) | (.005) | (.005) | (.005) | (.005) | (.005) | (.005) |
| Participation | .079*** | .055*** | .031*** | .021*** | .073*** | .055*** | .032*** | .023*** | .088*** | .046*** | .015 | .006 |
| | (.006) | (.006) | (.005) | (.004) | (.007) | (.007) | (.007) | (.005) | (.011) | (.01) | (.009) | (.006) |
| | Four-Year College Enrollment | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .03*** | .099*** | .207*** | .44*** | .035*** | .111*** | .219*** | .441*** | .052*** | .164*** | .312*** | .548*** |
| | (.002) | (.003) | (.004) | (.004) | (.003) | (.004) | (.005) | (.006) | (.003) | (.005) | (.005) | (.006) |
| Participation | .049*** | .061*** | .084*** | .082*** | .042*** | .05*** | .068*** | .081*** | .068*** | .085*** | .116*** | .086*** |
| | (.004) | (.005) | (.005) | (.005) | (.005) | (.006) | (.007) | (.006) | (.008) | (.009) | (.009) | (.008) |
| N | 83,371 | 83,382 | 83,376 | 83,378 | 44,651 | 41,257 | 41,689 | 43,699 | 38,720 | 42,125 | 41,687 | 39,679 |

Note: Q4 is the highest level of preparation. The models include cohort fixed effects, students' covariates, and high school fixed effects. The analysis uses five cohorts of students. Standard errors are in parentheses. <.05. **<.01. ***<.001

Table 13. The Effect of PLTW Participation on STEM Major Outcomes (Local Average Treatment Effects)

| | STEM/Health Science Major upon College Entry | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | | | Male | | | Female | | |
| | OLS | IV1 | IV2 | OLS | IV1 | IV2 | OLS | IV1 | IV2 |
| Intercept | .084*** | .102*** | .102*** | .101*** | .101*** | .102*** | .153*** | .154*** | .154*** |
| | (.003) | (.003) | (.003) | (.004) | (.004) | (.004) | (.005) | (.005) | (.005) |
| Participation | .116*** | .078** | .072** | .068*** | .083* | .065* | .128*** | .074* | .076* |
| | (.002) | (.024) | (.024) | (.002) | (.033) | (.031) | (.003) | (.035) | (.034) |
| N | 333,507 | | | 171,296 | | | 162,211 | | |
| | STEM/Health Science Major within Five Years After Entering College | | | | | | | | |
| | All | | | Male | | | Female | | |
| | OLS | IV1 | IV2 | OLS | IV1 | IV2 | OLS | IV1 | IV2 |
| Intercept | .159*** | .183*** | .184*** | .193*** | .189*** | .189*** | .266*** | .265*** | .265*** |
| | (.004) | (.005) | (.005) | (.005) | (.006) | (.006) | (.007) | (.007) | (.007) |
| Participation | .184*** | .222*** | .212*** | .119*** | .198** | .194** | .188*** | .253*** | .254*** |
| | (.003) | (.049) | (.049) | (.003) | (.071) | (.065) | (.005) | (.066) | (.064) |
| N | 264,655 | | | 136,052 | | | 128,603 | | |

Note: IV1 uses PLTW course sections per 100 students as an instrument. IV2 uses pathway specific course sections per 100 students as instruments. The models include cohort fixed effects, students' covariates, and high school fixed effects. The analysis of STEM/Health Science major upon college entry uses five cohorts of students, while that of five-year STEM/Health Science major is based on four cohorts. Standard errors are in parentheses. *<.05. **<.01. ***<.001

Table 14. The Effect of PLTW Participation on STEM Major Outcomes by Quartiles of STEM Readiness

| | IV Estimates with PLTW Expansion (IV1) as Instrument (Local Average Treatment Effects) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | STEM/Health Science Major upon College Entry | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .015*** | .03*** | .079*** | .172*** | .015*** | .032*** | .077*** | .165*** | .033*** | .079*** | .14*** | .21*** |
| | (.003) | (.005) | (.007) | (.01) | (.003) | (.006) | (.008) | (.011) | (.004) | (.007) | (.01) | (.012) |
| Participation | .024 | .061 | .013 | .08 | -.048 | .007 | .006 | .122* | .082 | .115 | -.015 | .017 |
| | (.05) | (.047) | (.047) | (.044) | (.059) | (.063) | (.057) | (.058) | (.081) | (.064) | (.071) | (.064) |
| N | 83,371 | 83,382 | 83,376 | 83,378 | 44,651 | 41,257 | 41,689 | 43,699 | 38,720 | 42,125 | 41,687 | 39,679 |
| | STEM/Health Science Major within Five Years After Entering College | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .038*** | .081*** | .149*** | .317*** | .036*** | .078*** | .154*** | .325*** | .078*** | .174*** | .245*** | .367*** |
| | (.005) | (.008) | (.011) | (.013) | (.005) | (.009) | (.013) | (.016) | (.007) | (.011) | (.013) | (.015) |
| Participation | .08 | .168 | .143 | .279*** | .031 | .096 | .036 | .233* | .029 | .200 | .193 | .244* |
| | (.109) | (.11) | (.101) | (.073) | (.123) | (.165) | (.125) | (.101) | (.186) | (.132) | (.135) | (.102) |
| N | 66,173 | 66,154 | 66,533 | 65,795 | 35,253 | 32,809 | 33,365 | 34,625 | 30,920 | 33,345 | 33,168 | 31,170 |

Table 14 (continued). The Effect of PLTW Participation on STEM Major Outcomes by Quartiles of STEM Readiness

| | OLS estimates | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | STEM/Health Science Major upon College Entry | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .015*** | .03*** | .075*** | .169*** | .014*** | .031*** | .074*** | .166*** | .033*** | .08*** | .139*** | .209*** |
| | (.003) | (.005) | (.007) | (.009) | (.003) | (.005) | (.008) | (.011) | (.004) | (.007) | (.01) | (.012) |
| Participation | .033*** | .055*** | .096*** | .119*** | .023*** | .035*** | .066*** | .107*** | .056*** | .089*** | .15*** | .146*** |
| | (.003) | (.003) | (.004) | (.004) | (.003) | (.004) | (.005) | (.005) | (.006) | (.007) | (.007) | (.007) |
| N | 83,371 | 83,382 | 83,376 | 83,378 | 44,651 | 41,257 | 41,689 | 43,699 | 38,720 | 42,125 | 41,687 | 39,679 |
| | STEM/Health Science Major within Five Years After Entering College | | | | | | | | | | | |
| | All | | | | Male | | | | Female | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Intercept | .038*** | .083*** | .149*** | .325*** | .036*** | .079*** | .15*** | .329*** | .078*** | .174*** | .245*** | .368*** |
| | (.004) | (.007) | (.01) | (.011) | (.004) | (.008) | (.011) | (.013) | (.007) | (.01) | (.013) | (.014) |
| Participation | .054*** | .092*** | .147*** | .192*** | .049*** | .062*** | .113*** | .186*** | .069*** | .145*** | .213*** | .215*** |
| | (.005) | (.006) | (.006) | (.006) | (.005) | (.006) | (.007) | (.007) | (.01) | (.01) | (.011) | (.01) |
| N | 66,173 | 66,154 | 66,533 | 65,795 | 35,253 | 32,809 | 33,365 | 34,625 | 30,920 | 33,345 | 33,168 | 31,170 |

Note: Q4 is the highest level of preparation. The models include cohort fixed effects, student covariates, and high school fixed effects. The analyses of college enrollment and STEM/Health Science major upon college entry use five cohorts of students, while those of five-year STEM/Health Science major are based on four cohorts. Standard errors are in parentheses. *<.05. **<.01. ***<.001