

2017

Student Participation and Postsecondary Outcomes:

Specialized Courses in Science, Technology, Engineering and Mathematics



AUTHORS

Carol Jenner

Education Research and Data Center

ABOUT THE ERDC

The research presented here utilizes data from the Education Research and Data Center (ERDC), located within the Washington Office of Financial Management (OFM). ERDC works with partner agencies to conduct powerful analyses of learning that can help inform the decision-making of Washington legislators, parents, and education providers. ERDC's data system is a statewide longitudinal data system that includes de-identified data about people's preschool, educational, and workforce experiences. The views expressed here are those of the author(s) and do not necessarily represent those of the OFM or other data contributors. Any errors are attributable to the author(s).

ADDRESS

Education Research and Data Center
210 11th Ave. SW, Room 318
PO Box 43113
Olympia, WA 98504-3113

PHONE

(360) 902-0599

FAX

(360) 725-5174

EMAIL

erdc@ofm.wa.gov

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Background

Project Lead the Way (PLTW) is a national organization that provides “real-world, applied learning experiences” in science, technology, engineering and mathematics (STEM). Individual Washington high schools offered PLTW curricula as early as 1999.¹ In recent years, the Office of Superintendent of Public Instruction (OSPI) has awarded grants to enhance high school offerings of PLTW curricula. These one-time awards may be used for the purchase of the lab equipment and professional development to integrate these advanced courses in the schools.²

In 2013, two PLTW curricula were offered in participating Washington high schools:

- The Engineering curriculum, which consists of two foundation courses: Introduction to Engineering Design and Principles of Engineering. Specialization courses offered through 2013 were Aerospace Engineering, Civil Engineering and Architecture, Computer Integrated Manufacturing and Digital Electronics. The capstone course for Engineering is Engineering Design and Development.
- The Biomedical Science curriculum, which consists of Principles of Biomedical Science, Human Body Systems, Medical Interventions and the capstone course, Biomedical Innovation.

Participating high schools most often offer a subset of available courses in a curriculum.

School participation in PLTW requires an agreement signed by the superintendent or school board president. There is also a participation fee that covers access to all program features for which a school has a trained teacher. In 2013, the annual participation fees were \$3,000 for Engineering and \$2,000 for Biomedical Science.

This report integrates information from K-12 education, postsecondary education and employment sectors to provide detailed enrollment, course-taking and employment information for the approximately 1,700 high school graduates in 2013 who participated in PLTW programs.³

The 2013 PLTW high school graduate cohort

Students may enroll in PLTW courses throughout high school, so identification of PLTW participants involves (1) identifying high schools offering PLTW courses, (2) identifying PLTW courses at the high school level and (3) examining course-specific student enrollment over a period of four years for students in each high school graduation year cohort.

1 Project Lead the Way (www.pltw.org/)

2 OSPI Budget Provisos 2011–13 Biennium: Project Lead the Way (www.k12.wa.us/Finance/Agency-FinancialServices/Provisos/2013/EACodeQN2ProjectLeadtheWay.docx)

3 RCW 28A.188.070 directs the Education Research and Data Center in the Office of Financial Management to study postsecondary enrollment; mathematics and science course-taking patterns; and employment of students completing PLTW in a series of annual reports running from 2015 through 2018.

Students graduating in 2013 who completed at least one PLTW course between 2010 and 2013 are the focus of this report. OSPI's Comprehensive Education Data and Research System⁴ — specifically the student grade history file — was used to identify students completing PLTW courses.

Characteristics of program participants⁵

Among the 2013 high school graduates, approximately twice as many male students completed PLTW courses as females. Free and reduced-price lunch (FRPL) eligible graduates are represented among the PLTW graduates at levels (43 percent) higher than those at high schools that offer PLTW courses (37 percent) and at high schools in general (35 percent). Schools offering PLTW courses have race/ethnic distributions among their graduates similar to high schools in general. PLTW graduates have relatively high representation in Asian, Hispanic/Latino and Black/African-American groups.

Table 1: Characteristics of 2013 PLTW Graduates (1,690 high school graduates)

Student Characteristics	PLTW Graduates	All Graduates	
		Schools Offering PLTW	All Schools
Gender			
Male	68%	49%	49%
Female	32%	51%	51%
Special Programs			
FRPL-eligible	43%	37%	35%
Special education	1-5%	8%	8%
Bilingual education	1-5%	2%	2%
Race/ethnicity			
American Indian or Alaska Native	≤1%	1%	1%
Asian	14%	8%	9%
Black/African-American	6%	4%	5%
Hispanic	17%	15%	14%
Native Hawaiian or other Pacific Islander	≤1%	1%	1%
Two or more races	1-5%	5%	5%
White	57%	65%	65%

4 See the OSPI CEDARS website (<http://www.k12.wa.us/CEDARS/>) for information.

5 Conventions to protect personally identifying information suggested by the U.S. Department of Education are followed in the following series of tables when cell sizes represent populations too small to report. Counts shown in tables are rounded to the nearest 10 students. See "Statistical Methods for Protecting Personally Identifiable Information in Aggregate Reporting" (NCES SLDS Technical Brief #3) (nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2011603).

Breaking the PLTW students into subgroups based on subject area sheds light on additional patterns of enrollment. Males participate to a greater degree than females in the Engineering programs, while women participate at higher levels in the Biomedical area. Table 2 illustrates this and also categorizes the PLTW graduates by the number of units of credit earned in each PLTW curriculum area.

Table 2: PLTW Course Completions by Program, Gender and PLTW Units Completed

PLTW Course-Completion Category	High School Graduates (rounded to nearest 10)	Male	Female
All PLTW Students	1,690	68%	32%
PLTW Engineering	1,330	79%	21%
< 1 unit	360	73%	27%
1 unit	700	80%	20%
2 or more units	280	85%	15%
PLTW Biomedical	440	35%	65%
< 1 unit	90	40%	60%
1 unit	290	35%	65%
2 or more units	60	28%	72%

Note: Some students completed both Engineering and Biomedical courses and are represented in both categories. Totals in programs may not add due to rounding.

Table 3 shows the high school grade point average (GPA) for 2013 PLTW graduates overall, by PLTW program and for students completing two or more units in a PLTW program.

Table 3: GPA Distribution of PLTW Graduates, 2013

PLTW Curriculum	Percentage in GPA Category					Total
	3.50-4.00	3.00-3.49	2.50-2.99	2.00-2.49	Below 2.00	
All PLTW Students	26%	27%	22%	17%	8%	100%
PLTW Engineering	26%	27%	21%	18%	9%	100%
2 or more units	29%	23%	22%	18%	7%	100%
PLTW Biomedical	26%	26%	25%	18%	6%	100%
2 or more units	31%	31%	25%	*	*	100%

Note: Totals in programs may not add due to rounding. An asterisk (*) indicates that data is suppressed because it represents a cell size of fewer than 10.

Postsecondary enrollment follow-up⁶

⁶ Postsecondary enrollment rates for the 2013 PLTW high school graduates have been updated from previous reports based on the most current data available to the Education Research and Data Center (ERDC). Academic years used in this report are expressed using the last year of the academic term.

Table 4 summarizes one year of postsecondary education follow-up for 2013 PLTW graduates. Included in the postsecondary enrollment data are four types of enrollment: Washington public four-year institutions, the state's community and technical colleges (CTCs), Washington private institutions and out-of-state institutions.⁷ Overall, 67 percent of PLTW graduates enrolled in postsecondary education in 2014. Postsecondary enrollment rates, as well as enrollment rates by type of institution, are related to high school GPA. PLTW graduates with GPAs in the 3.50 to 4.00 range attended mainly Washington public four-year institutions (47 percent) and private or out-of-state institutions (37 percent).

Table 4: 1-Year Postsecondary Follow-Up for 2013 PLTW High School Graduates by High School GPA

High School GPA	Postsecondary Enrollment Rate (2014)	Share of Postsecondary Enrollment (for Students Enrolled in 2014)		
		CTC	Public Four-Year	Private and/or Out-of-State Institution
3.50-4.00	91%	20%	46%	37%
3.00-3.49	81%	40%	43%	21%
2.50-2.99	62%	62%	28%	14%
<2.50	37%	81%	7%	14%
Total	68%	43%	36%	24%

Note: Shares may not add to 100% because some students enrolled in more than one type of postsecondary institution in 2014.

Typically, high school graduates with the highest GPA have the highest rates of postsecondary enrollment and the greatest tendency to enroll in either Washington public four-year institutions or in private or out-of-state institutions.⁸ This holds true for the PLTW graduates. More than 90 percent of PLTW graduates with a GPA of 3.50 or above participated in postsecondary education in the year after high school graduation. Of those, 84 percent attended either a Washington public four-year institution or a private and/or out-of-state institution.

Table 5 shows a full two-year postsecondary enrollment follow-up (through 2015) for the 2013 high school graduates.

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so "2013" refers to the academic year 2012-13. The two years of follow-up for the 2013 graduates are 2014 (i.e., 2013-14) and 2015 (i.e., 2014-15).

7 Enrollment data for the ERDC data warehouse is provided by the State Board for Community and Technical Colleges and the six public baccalaureate higher education institutions of the state (University of Washington, Washington State University, Central Washington University, Eastern Washington University, The Evergreen State College and Western Washington University). Additionally, the National Student Clearinghouse is the source of information about enrollment in Washington private higher education institutions and out-of-state institutions.

8 See the ERDC High School Feedback Report (<http://www.erd.wa.gov/data-dashboards/high-school-feedback-report>).

Table 5: 2-Year Postsecondary Follow-up for 2013 PLTW High School Graduates by High School GPA

High School GPA	Postsecondary Enrollment Rate	Share of Postsecondary Enrollment (for Students Enrolled)		
		CTC	Public Four-Year	Private and/or Out-of-State Institution
3.50-4.00	92%	26%	48%	39%
3.00-3.49	86%	49%	43%	22%
2.50-2.99	70%	69%	25%	17%
<2.50	50%	78%	6%	22%
Total	75%	51%	35%	26%

Note: Shares may not add to 100% because some students enrolled in more than one type of institution in 2014.

In Table 5, individuals were considered enrolled if, at any time during the two years after high school graduation, they were enrolled in a postsecondary institution.

- PLTW high school graduates with lower high school GPAs are more likely to defer college enrollment by a year than those with higher GPAs. At the end of one year, 61 percent of graduates with GPAs in the 2.50 to 2.99 range had enrolled in postsecondary education. After two years, 67 percent had enrolled. Comparable rates for those in the 3.50–4.00 GPA range were 90 to 91 percent.
- PLTW graduates who defer postsecondary enrollment until the second year after high school graduation were more likely to enroll in a CTC. In the first year after graduation, 43 percent of the graduates enrolled in a CTC. After the second year, more than 50 percent of those enrolling in postsecondary institutions had enrolled in a CTC.

Table 6 shows a follow-up by PLTW curriculum and gender for the two-year period after high school graduation.

Table 6: 2-Year Postsecondary Follow-Up by PLTW Program and Gender

PLTW Curriculum	Postsecondary Enrollment Rate			
	Any Institution	CTC	Public Four-Year	Private and/or Out-of-State
All PLTW Students	75%	38%	26%	20%
Engineering	74%	37%	27%	19%
Biomedical	75%	40%	23%	22%
Male	72%	36%	24%	20%
PLTW Engineering	72%	35%	25%	20%
PLTW Biomedical	72%	41%	20%	22%
Female	80%	41%	29%	19%
PLTW Engineering	83%	44%	35%	17%
PLTW Biomedical	77%	40%	24%	21%

Note: Some students completed both Engineering and Biomedical courses. Some students attended more than one type of institution in 2013–14. Totals in programs may not add due to rounding.

Examining Table 6, we see that:

- While participation in PLTW programs is higher for men than for women (see Table 1), postsecondary enrollment rates are higher for women (80 percent) than for men (72 percent).
- Participants in the Biomedical programs are slightly more likely than PLTW Engineering program participants to enroll in CTCs, while Engineering participants are more likely to enroll in Washington public four-year institutions.

By the second postsecondary year, 75 percent of PLTW graduates had enrolled in postsecondary education.

Postsecondary mathematics course taking

Postsecondary mathematics and science course-taking patterns for the 2013 PLTW graduates were assessed for students enrolled in Washington public institutions.⁹ Mathematics courses were classified as:

- pre-college mathematics
- general college-level mathematics
- pre-calculus
- calculus and higher level mathematics

Pre-calculus, calculus and higher-level mathematics courses are foundational courses for further work in STEM fields.

Table 7 shows enrollment in mathematics courses for two years after high school graduation.

Table 7: Postsecondary Mathematics Course Taking by 2012 –13 PLTW Graduates, 2014 and 2015

PLTW Course- Completion Category	Year 1		Years 1 and 2	
	Any	College-Level	Any	College-Level
All PLTW Students	73%	51%	80%	62%
PLTW Engineering	74%	54%	81%	64%
< 1 unit	73%	55%	79%	63%
1 unit	72%	53%	81%	65%
2 or more units	79%	56%	83%	63%
PLTW Biomedical	68%	40%	76%	52%
< 1 unit	68%	40%	79%	48%
1 unit	67%	39%	75%	51%
2 or more units	71%	40%	75%	58%

⁹ Course-taking details are not available for institutions other than Washington public colleges and universities.

Overall, 73 percent of PLTW graduates who enrolled in Washington public institutions in the year after graduation enrolled in at least one mathematics course. More than half these students enrolled in a college-level mathematics course in the first year after high school graduation. After two years, 62 percent of those enrolled in public postsecondary institutions had enrolled in college-level mathematics.

Table 8 shows the highest-level mathematics courses taken by the 2013 PLTW graduates during 2014 and 2015 postsecondary enrollment. Mathematics course-taking rates are calculated as a share of students enrolled in any mathematics course rather than as a percentage of all students enrolled.

Table 8: Highest Level Mathematics Course

PLTW Course-Completion Category	Highest Level Mathematics Course (for those enrolled in mathematics)							
	Year 1				Years 1 and 2			
	Pre-College	General	Pre-Calculus	Calculus or Higher	Pre-College	General Mathematics	Pre-Calculus	Calculus or Higher
All PLTW Students	30%	18%	22%	30%	23%	22%	21%	34%
PLTW Engineering	27%	18%	21%	35%	21%	19%	20%	39%
< 1 unit	24%	20%	17%	39%	19%	18%	18%	45%
1 unit	26%	19%	23%	32%	20%	22%	21%	37%
2 or more units	30%	13%	20%	38%	24%	16%	22%	38%
PLTW Biomedical	41%	23%	27%	9%	30%	30%	25%	15%
< 1 unit	41%	31%	*	*	39%	30%	20%	11%
1 unit	41%	23%	29%	*	30%	32%	25%	13%
2 or more units	*	*	*	*	*	*	*	*

Note: Some students completed both Engineering and Biomedical courses. An asterisk (*) indicates that data is suppressed because it represents a cell size of fewer than 10.

- At the completion of two years after high school graduation, approximately one-third of the 2013 PLTW graduates enrolled in Washington public postsecondary institutions who took mathematics courses had completed courses at the calculus or higher level.
- Not unexpectedly, students who completed PLTW Engineering coursework in high school enrolled in calculus or higher-level mathematics at rates higher than those who took PLTW Biomedical coursework, where more-advanced study is less mathematics-intensive.
- After the second postsecondary year (2015), 23 percent of the PLTW students enrolled in pre-college mathematics as their highest-level mathematics. The rate was lower for PLTW Engineering students (21 percent) than for PLTW Biomedical students (30 percent).

The tables above relate to students enrolled in Washington public postsecondary institutions who enroll in mathematics courses. The most commonly cited “remedial course-taking rate” calculation uses as a denominator *all* students enrolled in Washington public postsecondary institutions, whether they are enrolled in mathematics courses or not. Comparisons of the remedial mathematics course-taking rates for the 2013 high school graduates are shown in Table 10.

Table 9: Remedial Mathematics Course-Taking Rates (traditional calculation)

Category	
All high school graduates	30%
All graduates from PLTW schools	27%
All PLTW Graduates	28%
PLTW Engineering	26%
PLTW Biomedical	37%

The traditional remedial course-taking measure shown in Table 9 is a snapshot and does not tap into the analytical capabilities possible using longitudinal data. Table 10 takes the PLTW graduates who enrolled in remedial mathematics in their first postsecondary year and shows the highest level of mathematics course taking over the two postsecondary follow-up years.

Table 10: Highest-Level Mathematics Course Taken by Those Enrolled in Remedial Mathematics in Year 1 (2014)

PLTW Course-Completion Category	Highest-Level Mathematics Course (for those enrolled in mathematics)					
	Year 1			Years 1 and 2		
	Pre-College	General Mathematics	Pre-Calculus or Higher	Pre-College	General Mathematics	Pre-Calculus or Higher
All PLTW Students	74%	10%	16%	47%	20%	32%
PLTW Engineering	74%	11%	16%	45%	19%	36%
PLTW Biomedical	72%	13%	14%	49%	28%	23%

Of the students who enrolled in remedial mathematics in the first year after high school graduation, 26 percent had moved on to college-level mathematics by the end of the first year — 10 percent in general mathematics and 16 percent in pre-calculus or higher-level mathematics. By the end of the second year, 32 percent had enrolled in pre-calculus or higher mathematics and more than half had taken a college-level mathematics course.

Postsecondary STEM Science Course-Taking

Science courses, including computer science, offered by Washington public postsecondary institutions were classified into two categories: those foundational for further study in STEM fields and those designed for nonscience majors.

Table 11 shows enrollment in foundational science courses in the following categories:

- Physics, Engineering, Engineering Technology
- Chemistry
- Biology and Medical
- Computer Science (including programming courses, but excluding courses that cover the use of software)

Table 11: Postsecondary Science Course Taking by 2012–13 PLTW Graduates, 1- and 2-Year Follow-up

PLTW Course- Completion Category	Physics, Engineering		Chemistry		Biology, Medical		Computer Science	
	1 Year	2 Years	1 Year	2 Years	1 Year	2 Years	1 Year	2 Years
All PLTW Students	11%	16%	20%	27%	11%	17%	20%	25%
PLTW Engineering	14%	20%	22%	27%	8%	12%	24%	29%
<1 unit	12%	19%	21%	28%	10%	17%	25%	31%
1 unit	11%	17%	21%	27%	9%	12%	21%	27%
2 or more units	23%	26%	25%	29%	*	7%	30%	33%
PLTW Biomedical	*	*	15%	24%	21%	31%	5%	7%
<1 unit	*	*	*	19%	*	21%	*	*
1 unit	*	*	12%	23%	25%	34%	*	7%
2 or more units	*	*	*	33%	*	30%	*	*

Note: An asterisk (*) indicates that data is suppressed because it represents a cell size of fewer than 10.

Table 11 shows that:

- PLTW Engineering students enrolled in Physics/Engineering and Computer Science foundational courses at relatively high levels.
- PLTW Biomedical students enrolled in Biology/Medical foundational courses at relatively high levels.
- All PLTW students enrolled in foundational chemistry courses at relatively high rates.
- Computer science courses were almost exclusively in the domain of the PLTW Engineering students.

Employment characteristics

Approximately 1,130 PLTW 2013 graduates were employed in Washington in 2014 or 2015. Table 12 shows the median earnings of the graduates by postsecondary enrollment status and by the number of calendar quarters in which they were employed. Individuals earning at least \$100 in a quarter are considered employed. Individuals working at least 30 hours per week are considered to be employed full time.

Table 12: Earnings by Employment Status

Enrollment Status	2014			2015		
	Number of Graduates	Share of Graduates	Median Earnings	Number of Graduates	Share of Graduates	Median Earnings
Employed	1,130	100%	\$6,500	1,120	100%	\$10,100
<i>Employed 4 quarters</i>	480	42%	\$13,900	610	54%	\$16,700
<i>Employed full-time 4 quarters</i>	60	5%	\$26,200	130	11%	\$28,900
Not enrolled	290	27%	\$11,900	270	26%	\$17,000
<i>Employed 4 quarters</i>	160	14%	\$18,000	190	18%	\$22,300
<i>Employed full-time 4 quarters</i>	40	3%	\$25,500	80	7%	\$29,900
Enrolled	850	73%	\$5,400	850	74%	\$8,200
<i>Employed 4 quarters</i>	320	28%	\$12,000	420	36%	\$14,700
<i>Employed full-time 4 quarters</i>	20	2%	*	50	4%	\$26,900

Note: Numbers of graduates are rounded to the nearest 10. Earnings are rounded to the nearest \$100. Totals may not add due to rounding. An asterisk (*) indicates that data is suppressed because it represents a cell size of fewer than 30. All earnings are inflation-adjusted to 2015 dollars using the Implicit Price Deflator for Personal Consumption.

Many factors are in play in assessing employment outcomes, particularly for a group wherein many members are combining work with postsecondary enrollment. Table 12 shows that the median earnings of all employed PLTW graduates in 2014 was approximately \$6,500. For those not enrolled in postsecondary education, median earnings were \$11,900 — more than twice the median of \$5,400 for those enrolled. Adding the number of quarters worked into the equation illustrates the obvious: Those working all four quarters in 2014 had significantly higher earnings than those working fewer quarters, and those working full time for all four quarters had even higher earnings.

Median earnings for graduates in general increased in 2015 for those employed two or more quarters.

Table 13: Earnings by Industry Group, Selected Enrollment and Employment Status

Industry Group	All Employed Graduates				Employed 4 Quarters			
	2014		2015		2014		2015	
	Count	Median	Count	Median	Count	Median	Count	Median
Construction	50	\$7,200	60	\$12,000	20	*	30	\$25,000
Manufacturing	70	\$9,800	70	\$22,300	30	\$21,600	50	\$25,400
Trade, Transportation & Utilities	380	\$7,700	360	\$12,000	180	\$13,800	220	\$16,700
Information, Financial Activities	40	\$6,400	50	\$11,100	20	*	30	\$13,700
Professional & Business Services	90	\$6,000	100	\$8,700	30	\$15,500	40	\$19,300
Education & Health Services	90	\$6,400	120	\$7,700	40	\$13,300	60	\$16,200
Leisure & Hospitality	300	\$6,200	270	\$8,600	120	\$12,600	150	\$13,700
Other industries	130	\$4,700	90	\$6,800	40	\$13,900	30	\$14,500

Note: Numbers of graduates are rounded to the nearest 10. Earnings are rounded to the nearest \$100. Totals may not add due to rounding. An asterisk (*) indicates that data is suppressed because it represents a cell size of fewer than 30. All earnings are inflation adjusted to 2015 dollars using the Implicit Price Deflator for Personal Consumption.

When employment and earnings are broken out by industry group, several things stand out:

- The two industry groups employing the greatest numbers in the PLTW graduates are Trade, Transportation & Utilities, which includes retail trade employment, and Leisure & Hospitality, which includes employment in restaurants.
- Highest median earnings for those employed four quarters were in Manufacturing and Construction.



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