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Mathematics Coursetaking Pathway to College STEM for Washington State High School Students

ERDC
Education Research & Data Center

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ABOUT THE ERDC

The research presented here uses data from the Education Research and Data Center, located in the Washington Office of Financial Management. ERDC works with partner agencies to conduct powerful analyses of learning that can help inform the decisionmaking 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.

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Executive Summary

This study describes 9th graders' coursetaking pathways in science, technology, engineering, and mathematics (STEM) from high school to Washington public higher education, from 2013 to 2017. Focusing on the association between 4-year mathematics coursetaking sequences in high school and the first year college STEM course outcome, major findings include:

- The initial mathematics course taken in 9th grade is a momentum factor driving how far a student progresses, in terms of the final course level in high school and STEM credits earned and GPA in the first year of college.
  - Students who took mathematics courses lower than algebra I in 9th grade were less likely to proceed to a standard or advanced mathematics level by the end of high school; whereas, those who started higher than algebra I were more likely to advance to a higher course level.
  - Remaining in a high mathematics course pathway through the high school years is crucial for earning credits and a high GPA from college-level STEM courses.
- Heterogeneity in STEM educational outcomes by students' demographics and family income status is present, particularly among those going through higher mathematics pathways.
  - Females outperformed males in earning college-level STEM credit and GPA, and the gender difference are profound among those experiencing higher mathematics pathways.
  - Asians and Whites are more likely to take college STEM credits and achieve a higher GPA, compared to the other racial/ethnic groups. The racial/ethnic differential is significant among only those in high mathematics pathways.
  - Students from higher family income level were more likely to earn college STEM credits in 4-year institutions. There is not much difference in STEM GPA by family income level.

Introduction

Over a decade, employment in science, technology, engineering, and mathematics (STEM) has outgrown other industries, and is projected to continue increasing till 2024[1]. Meanwhile, the demand for college graduates with STEM majors has also increased, as most STEM occupations require some postsecondary education in a STEM field. In Washington state, where STEM industries are highly concentrated and the demand for STEM human capital is high, the cultivation of STEM education pipelines plays an important role of meeting local STEM workforce needs. Among factors associated with the development of STEM human capital, high school mathematics and science courses taken are crucial predictors to students' postsecondary success in a STEM field[2]. However, little is known about how Washington public high students progress through mathematics and science learning in preparation for college and future work in STEM occupations.

In 2015, Washington's Education Research and Data Center (ERDC) received a grant from the U.S. Department of Education to improve the quality, accountability, and transparency of the Statewide Longitudinal Data System (SLDS), in an attempt to inform policymaking. This study is one of the SLDS grant projects aiming to examine Washington public school students' STEM learning pipelines across educational sectors. This report serves as an initial step toward identifying key factors associated with STEM pipeline and success, by focusing on the high school mathematics coursetaking pathways to postsecondary STEM education. The purpose of this study is twofold: (1) to portray high school mathematics coursetaking pathways and their association with college STEM learning; and (2) to provide baseline information for future research related to STEM pipelines at the state and local level.

Specifically, this study aims to answer three research questions:

- What mathematics coursetaking pathways do students take in Washington public high schools?
- What is the association between mathematics coursetaking pathways and college STEM outcomes?
- Does the association between mathematics coursetaking pathways and college STEM differ by student demographics and family socioeconomic status?

The report is organized as follows- the next section summarizes the data and analytic approaches used for analysis, followed by a brief description and visual presentation of the main findings, and concludes with a discussion for future research.

1 Fayer, S., Lacey, A., & Watson, A. (2017). STEM Occupations: Past, Present, and Future. Washington, DC: U.S. Bureau of Labor Staistics.

2 Hinojosa, T., Rapaport, A., Jaciw, A., LiCalsi, C., & Zacamy, J. (2016). Exploring the foundations of the future STEM workforce: K–12 indicators of postsecondary STEM success (REL 2016–122). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southwest.

Data

The source data for this study includes student longitudinal administrative records across sectors- from K12 to higher education. Student high school enrollment, course grade history, and completion are extracted from the Comprehensive Education Data and Research System (CEDARS), provided by the Office of Superintendent of Public Institution (OSPI). The study cohort includes all 9th graders who ever enrolled in Washington public high schools in the 2012-13 school year. Their school records from 2012-13 through 2015-16[3] are used for analysis. In addition, postsecondary education data from Washington's Public Centralized Higher Education Enrollment System (PCHEES) and the State Board for Community and Technical College (SBCTC) are matched to the cohort for college enrollments and coursetaking outcomes in Washington public institutions from the 2012-13 to 2016-17 academic years[4].

Three key measurements are generated for this analysis:

- *Mathematics coursetaking pathways* summarize students' first core mathematics course in 9th grade and the last core course taken by 2016. Such pathway taxonomy is generated based on the high school mathematics course requirements, state mathematics assessment standards, and the majority pathways students went through[5]. The classification matrix is presented as below:

Math pathway	9th -grade course in 2013	Last course by 2016
Low to Low	Pre-algebra/foundation mathematics	Pre-algebra/foundation mathematics or algebra I
Low to standard	Pre-algebra/foundation mathematics	Algebra II or geometry
Low to High	Pre-algebra/foundation mathematics	Algebra III, trigonometry, statistics/other non-core advance mathematics, pre-calculus, calculus
Standard to Low	Algebra I	Pre-algebra/foundation mathematics or algebra I
Standard to Standard	Algebra I	Algebra II or geometry
Standard to High	Algebra I	Algebra III, trigonometry, statistics/other non-core advance mathematics, pre-calculus, calculus
High to Standard	Beyond algebra I	Algebra II or geometry
High to High	Beyond algebra I	Algebra III, trigonometry, statistics/other non-core advance mathematics, pre-calculus, calculus

3 The selection of this cohort is based on conversations with OSPI staff who suggested course data quality was better improved since 2013.

4 The National Student Clearinghouse data does not provide college course information. Thus, the analysis of college-level STEM outcomes are limited to only students enrolled in Washington public institutions.

5 In 9th grade, algebra I is a standard course level. A core math course lower than algebra I is defined as low level, while above is high. In four years of high school, achieving geometry or algebra II is a standard norm in order to fulfill high school graduation requirement. Thus, the ending course level lower than geometry or algebra II is defined as low, while going beyond is high.

College STEM course outcomes are measured by a flag identifying whether a student earned any college-level STEM course credit after high school graduation up to 2016-2017 academic year[6], and the GPA achieved from college-level STEM course.

Analytic Approaches

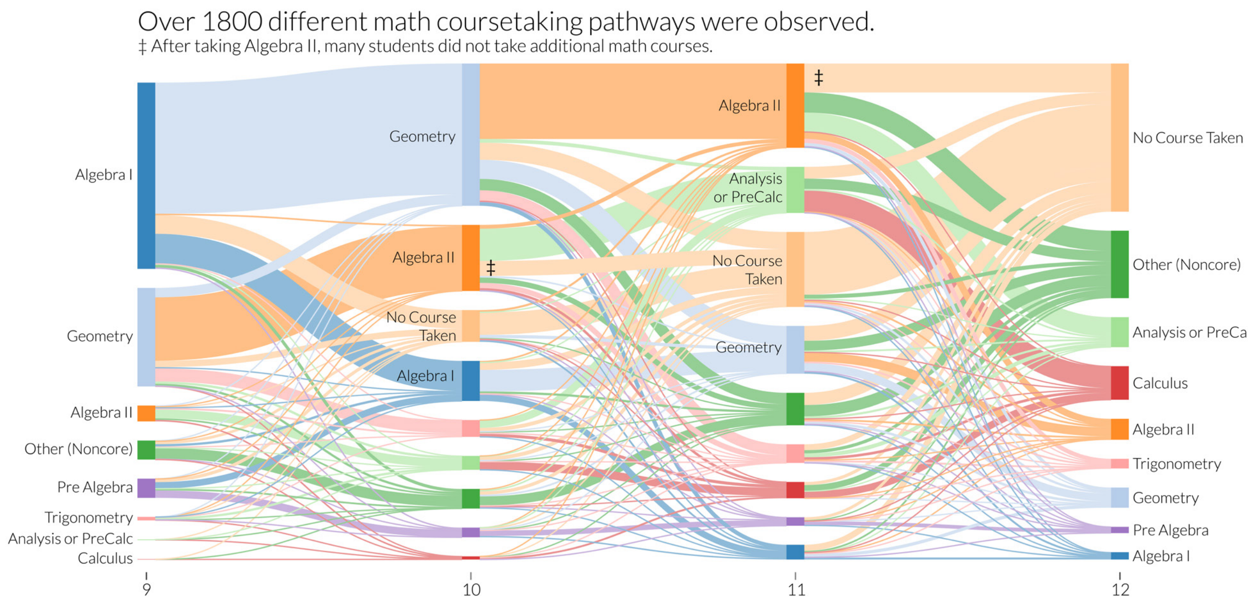
This study uses descriptive analysis to examine 9th graders' STEM pipelines from high school mathematics coursetaking pathways to the first year after the majority graduated from high school. T-statistics are used to test difference in mean between groups, and Z-statistics to test difference in proportion. No causation is implied from the results shown in the following sections.

Findings

Part 1. What mathematics courses do students take in high school?

Among 80,540 9th graders who had valid mathematics course records, Figure 1 shows that students completed 1,889 mathematics coursetaking pathways in the 4-year course sequence from 2013 to 2016. The order of the most frequent pathway (about 32 percent) is starting from algebra I, followed by geometry and ending with algebra II. This pattern

Figure 1. Mathematics coursetaking from 9th to 12th grade.



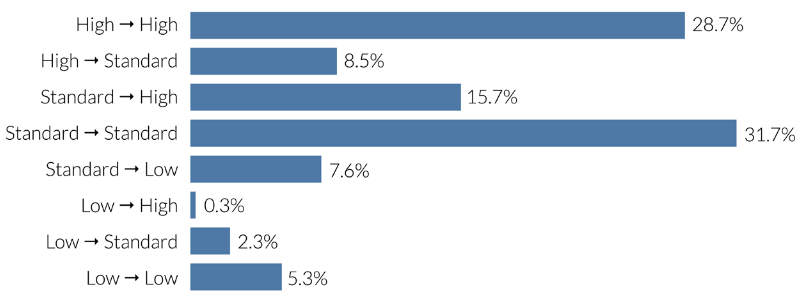
6 Postsecondary education attainment is not available for this study because college degree completion is normally measured with at least six years of length. (See [Adelman, C. 2006. The Toolbox Revisited: Paths to Degree Completion From High School Through College. Washington, D.C.: U.S. Department of Education](#).)

is consistent with a national report recently published by the U.S. Department of Education[7]. After taking Algebra II, many students chose not to proceed to advanced core mathematics courses, such as trigonometry, pre-calculus, and calculus.

To practically investigate the association between high school mathematics pathway and college educational outcomes, the 4-year course sequences are consolidated by the level of course sequences in accordance with grade level and summarized by eight pathway categories.

Figure 2 shows that, in their Washington public high school years, about 32 percent of 2013 9th graders kept a standard mathematics pathway (starting with algebra I and achieving geometry or algebra II as the highest mathematics course by 2016). About 29 percent were early achievers and ended with a higher course level (high-to-high), and 16 percent started with standard and moved beyond to a higher level. However, students who started with a lower mathematics level are more likely to end at a low level. The starting mathematics level in 9th grade plays a critical role in projecting a students' final mathematics course achievement in high school. (See Table B1 in Appendix B for detail summary statistics.)

Figure 2. Percentage distribution of mathematics coursetaking pathways.



Part 2. Mathematics coursetaking pathways and college course outcomes

Most students earned college-level course credits while enrolled anytime during 2016-17 academic year – the year right after the majority of 2013 9th graders graduated from high school (see Figure 3). Among those college enrollees, students who took a mathematic course level beyond high school requirements (standard-to-standard pathway) were more likely to earn STEM course credits. They also tended to achieve a higher GPA from college STEM courses, especially in 4-year institutions[8] (see Figure 4).

7 Brown, J., Dalton, B., Laird, J., and Ifill, N. 2018. ***Paths through Mathematics and Science: Patterns and Relationships in High School Coursetaking***. (NCES 2018-118). National Center for Education Statistics, Institute of Education Sciences. U.S. Department of Education. Washington, DC.

8 GPA is not comparable by sector or even by institution, because course content, requirements, and standards of STEM courses are quite different in 4-year and 2-year institutions. It is important to compare GAP across mathematics pathways by sector.

Figure 3. Percentage earning college course credit in 2016-2017 academic year by high school math pathway. (See also Table B2 for more details.)

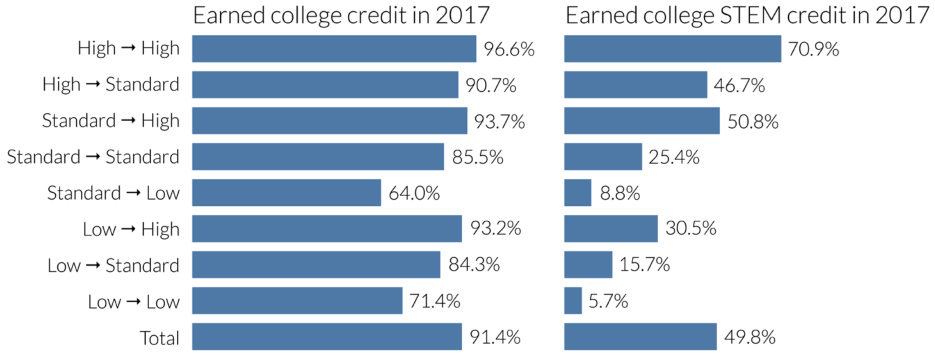
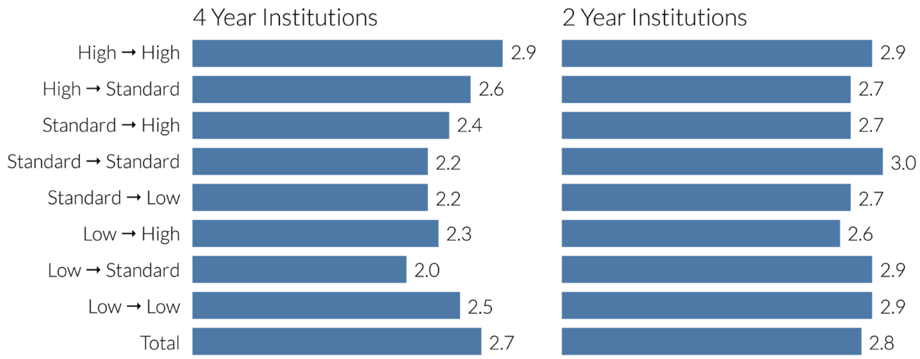


Figure 4. College STEM GPA one year after high school, by institution sector and high school math pathway. (See also Table B2 for more details.)



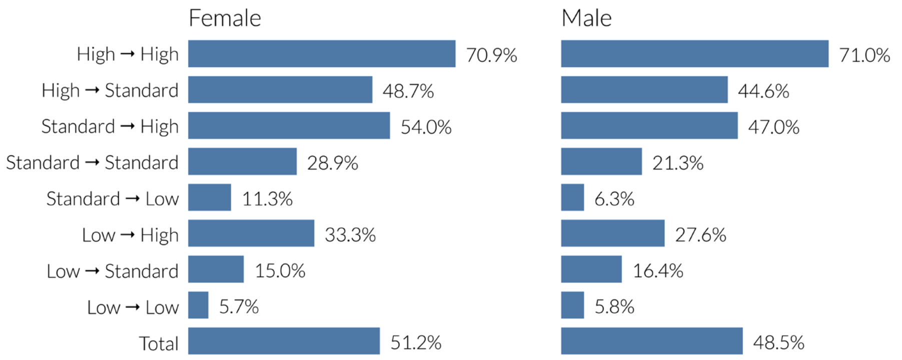
Part 3. STEM pipeline from high school to college by student demographics and family income status

Given the STEM coursetaking pathways from high school to college shown above, this section further examines the 5-year STEM pathways by taking into consideration of students' demographics and family income status. (The variation in high school mathematics pathways by students' demographics and family income status is presented in Tables B3 in Appendix B.)

Gender difference

Overall, Figure 5 shows that a higher proportion of females earn college-level STEM credits than males. However, the gender difference is not profound among most students experiencing the same mathematics pathways, except for those who go through standard-to-standard or standard-to-high pathways. The gender differences in STEM course GPA are only found among those high mathematics course achievers. Because of trivial gender difference in GPA achieved from college-level STEM courses, the results are not presented here but detailed in Appendix B- Table B4.

Figure 5. Percentage of college enrollees who earned college-level STEM credits in 2017, by gender and mathematics course pathway. (See also Table B4 for more details.)

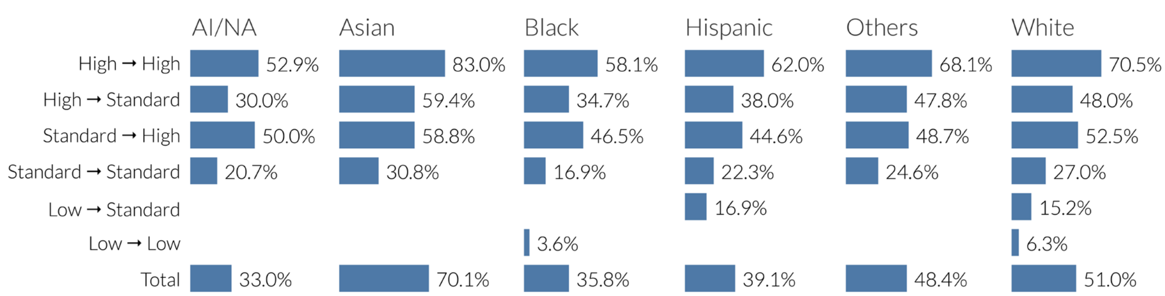


Racial/ethnic difference

Figure 6 demonstrates racial/ethnic differences in the percentage of earning college-level STEM credits in 2017, by holding high school mathematics coursetaking pathway constant. Compared to Whites, Asians have a higher proportion (by about 1.4 ratio=70 percent/51 percent, retrieved from the "total" category) and the other groups have lower proportion. Because very few students who went through low mathematics course pathways in high school took college STEM credits (see prior analysis), there is not much racial/ethnic difference found. The overall racial/ethnic differences are mostly found among those who went through high level of course pathways (standard-to-high, high-to-standard, and high-to-high).

Racial/ethnic differences in college STEM GPA are mostly found among those going through a high-to-high mathematics pathway and enrolling in 4-year institutions. Since the pattern from STEM GPA is similar to STEM credit earned, the results are only presented in Table B5 in Appendix B.

Figure 6. Percentage earning college-level STEM credit in 2017, by race/ethnicity and mathematics course pathway. (See also Table B5 for more details.)

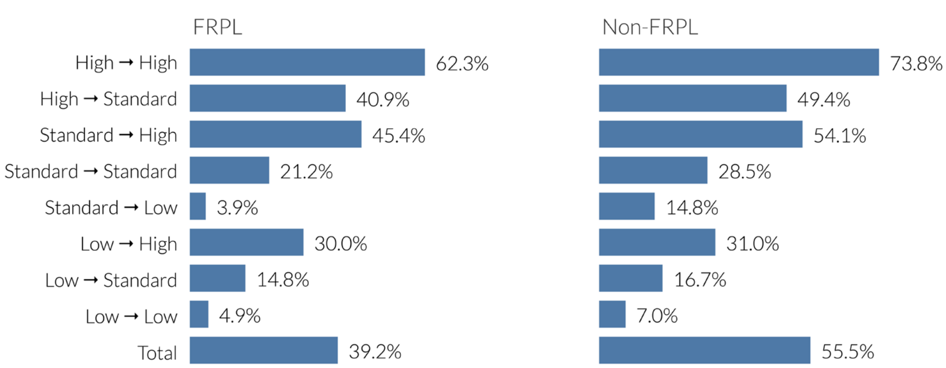


Differential by family income status

Existing research found that low-income students are less likely to go to college, especially 4-year institutions, and also less likely to take STEM courses, compared to their counterparts[9] Possible explanations include lack of financial resources, rising college tuition, under-preparation for college in high school, and low aspiration for degree completion[10]. This section explores the association between student family income status and STEM coursetaking pathways from high school to college. Student family income status is measured by their eligibility for free-/reduced- price lunch (FRPL) [11].

Students from a low-income family (eligible for FRPL) are less likely to earn college-level STEM credits than those from a higher-income (non-FRPL) family. Figure 7 (Table B6 in Appendix B) shows the proportional difference is about 16 percent (=55.5 percent-39.2 percent). For students experiencing low mathematics course sequences in high school, the difference by income status is not as significant as the difference among those who went through higher mathematics pathways (standard-to-standard and above). That said, family income status does not seem to matter in earning college STEM credits for students who were already previously left behind, in terms of high school mathematics course level. On the other hand, among high course achievers, higher family income level plays a role in helping students earn college STEM credits and high GPA in 4-year institutions.

Figure 7. Percentage earning college-level STEM credit in 2017, by family income status and mathematics course pathway. (See also Table B6 for more details.)



9 Holzer, H. J. and Baum, S. 2017. ***Making college work: pathways to success for disadvantaged students.*** The Brookings Institution, Washington, DC.

10 Dynarki, S. 2015. "For the poor, the graduation gap is even wider than the enrollment gap." The New York Times.

11 Whether a student is eligible for free-/reduced- price lunch (FRPL) program was a self-reported data by students or their parents. If a low-income parent did not apply for FRPL program for his/her child, the data would not be recorded. However, even not ideal, it is currently the only available indicator from P-20 DW that we could use to proxy students' family socioeconomic status.

Conclusion and Future Research

This report serves as the first step to examine how STEM pipelines flow from high school to college, using Washington state's statewide longitudinal data system (SLDS). By portraying 9th graders' 4-years coursetaking sequences, the findings show that students' outcome measures – credits earned and GPA from college-level STEM courses, differ by high school mathematics pathway. The initial mathematics course taken in 9th grade is a momentum factor driving how far a student progresses, in terms of the final course level in high school, and STEM credits earned and GPA in the first year of college. Heterogeneity in educational outcomes by gender and race/ethnicity is present, particularly among those going through higher mathematics pathways. And differences by family income status are found regardless of mathematics pathways.

Based on the results, there are limitations, unanswered questions, and considerations to be addressed that can inform future research. First, more years of college data are needed to follow up on student enrollment, coursetaking, and even completion in STEM. The longitudinal coursework data for high school students is more complete from the 2013 school year forward[12]. Thus, the most complete high school cohort for a like study is 2013 9th graders, who are mostly the graduation class of 2016. At the time when this analysis was conducted, the most current college data is up to 2017 - one year after high school graduation. However, not all high school graduates enroll in college in one year after high school[13]. More years of college follow-up could provide a more complete picture about the STEM pipeline toward college STEM major choice and degree completion.

Second, further investigation is needed to understand how students strategically plan their pathway to college success through their high school course portfolio. This study focuses on mathematics courses, which does not reflect the whole map of STEM cultivation in high school. Including analysis of other STEM subjects could help put together the puzzle. In addition, research about how school resources, particularly high school counselors, facilitate student planning for college would be informative.

Third, the association between institutional resources and STEM pathways is currently unclear. Whether the variation in pathways to STEM success is dominated by mainly individual student factors, or more by educational opportunities/resources being unequally distributed at the school, district, or locale level requires further analysis.

Fourth, one result shows that the variation in college STEM outcomes by demographics and family income status is mainly among those taking higher mathematics pathways.

12 For more details about the quality of course data used in this study, see Chen, Pyle, and Weller. 2018. "A Data Quality Evaluation of Administrative Data." Education Research and Data Center, Office of Financial Management. WA: Olympia.

13 Education Research and Data Center, 2012. "*Postsecondary Education Enrollment Patterns*." Office of Financial Management, State of Washington. WA: Olympia.

It could be attributed to the fact that very few low-mathematics-pathway students enrolled in college and took STEM course. Small number of observations could make it challenging to compare outcomes across groups. The finding here is thus not conclusive, and needs further study to take into consideration of such sample selection bias.

Lastly, to what extent statewide coursework policies, such as Common Core State Standard and high school graduation requirements, impacted high school coursework selection and, thus, affected college educational outcomes is left unanswered. To evaluate such policy effects, it requires quality coursework data that could navigate policy changes over time. Yet current data is still immature for this type of evaluation.

In addition, anticipated future improvements to K12 course data quality will allow more in-depth analysis of student STEM learning, which could inform policy efforts to improve Washington's STEM human capital.

Appendices

Appendix A. Technical Notes

Analytical sample

The total number of 2013 9th graders identified from OSPI P-210 summary data is 86,579. After removing those in the school districts without mathematics record at any point of time between 2013 and 2016, the number count drops to 84,884. For this sample, about 84 percent enrolled full 4 years, 7 percent for 3 years, and 9 percent less or equal to 2 years. For most of analysis describing the association between coursetaking pathways and educational outcomes, only those who enrolled in high school for 3 or 4 years are kept in the sample. This selection criteria is based on the state high school course requirements- three credits of mathematics for the graduation class of 2016. Assuming students earn one course credit per school year, the minimum number of years required to fulfill this requirement is 3.

Mathematics course coding

The NCES School Codes for the Exchange of Data (SCED)[14] is used to identify mathematics courses in each grade year. The coding scheme is listed below:

Mathematics course	State course code (SCED)
Core course	
Pre-algebra or foundation math	02001, 02002, 02003, 02047, 02049, 02051
Algebra I	02052, 02053, 02054, 02071, 02074
Geometry	02072, 02073, 02075, 02079, 02055
Algebra II	02056
Algebra III/Trigonometry	02057, 02058, 02103, 02105, 02106, 02107
Analysis or pre-calculus	02104, 02108, 02109, 02110, 02111, 02112, 02113, 02149
Calculus	02121, 02122, 02123, 02124, 02125, 02126
Other non-core math	
Statistics/probability	02201, 02202, 02203, 02204, 02207, 02209
Other advanced math	02131, 02132, 02133, 02134, 02141, 02149
Applied math	02151, 02152, 02153, 02154, 02155, 02156, 02157
Other math	First two digit="02" but not identified by any category above
No math	(Blank)

14 Bradby, D., Pedroso, R., and Rogers, A. 2007. "Secondary school course classification system: School codes for the exchange of data (SCED) (NCES 2007-341). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Student t-statistics

To test difference in mean GPA across groups, T statistics extracted from regression analysis are used to present statistical significance.

Z statistics

Z statistics obtained from logistic or multinomial logistic regression analyses are used to test difference in proportion across groups.

Appendix B. Tables

Table B1. Mathematics coursetaking patterns from 2013 – 2016

Math coursetaking pathways	N	%
Low to Low: lower than algebra 1 to lower than algebra 2/geometry	4,295	5.3
Low to Standard: lower than algebra 1 to algebra 2/geometry	1,838	2.3
Low to High: lower than algebra 1 to higher than algebra 2/geometry	202	0.3
Standard to Low: algebra 1 to lower than algebra 2/geometry	6,078	7.6
Standard to Standard: algebra 1 to algebra 2/geometry	25,489	31.7
Standard to High: algebra 1 to higher than algebra 2/geometry	12,654	15.7
High to Standard: higher than algebra 1 to algebra 2/geometry	6,846	8.5
High to High: higher than algebra 1 to higher than algebra 2/geometry	23,138	28.7
Total	80,540	100.0

Table B2. Percent distribution of educational outcomes, by mathematics coursetaking pathways

	Math coursetaking pathways across four high school years									
	Low->Low	Low->Standard	Low->High	Standard->Low	Stand.->Stand.	Standard->High	High->Standard	High->High	Total	Total
On-time high school graduate										
No	61.3%	36.2%	38.5%	78.2%	30.9%	7.2%	24.6%	5.2%	22.5%	16,991
Yes	38.7%**	63.8%**	61.5%*	21.8%**	69.1%	92.8%**	75.4%**	94.8%**	77.5%	58,389
<	3,743	1,824	200	3,549	24,819	12,632	5,748	22,865		75,380
Enrolled in college in 2017										
No	86.4%	76.9%	70.5%	82.5%	67.0%	46.5%	55.4%	44.9%	57.9%	43,655
Yes	13.6%**	23.1%**	29.5%	17.5%**	33.0%	53.5%**	44.6%**	55.1%**	42.1%	31,725
M	3,743	1,824	200	3,549	24,819	12,632	5,748	22,865		75,380
College enrolled by institution sector										
Public 4-year	2.2%**	10.5%**	23.7%	4.8%**	19.0%	41.2%	40.1%	62.8%	42.2%	13,374
Public 2-year	97.8%**	89.5%**	76.3%	95.2%**	81.0%	58.8%**	59.9%	37.2%**	57.8%	18,351
N	510	421	59	622	8,199	6,761	2,561	12,592		31,725
Earned college-level credit in 2017										
No	28.6%	15.7%	6.8%	36.0%	14.5%	6.3%	9.3%	3.4%	8.6%	2,720
Yes	71.4%**	84.3%**	93.2%	64.0%**	85.5%	93.7%**	90.7%**	96.6%**	91.4%	29,005
N	510	421	59	622	8,199	6,761	2,561	12,592		31,725
Earned college-level STEM credits in 2017										
No	94.3%	84.3%	69.5%	91.2%	74.6%	49.2%	53.3%	29.1%	50.2%	15,917
Yes	5.7%**	15.7%**	30.5%$^{+}$	8.8%**	25.4%	50.8%*	46.7%**	70.9%**	49.8%	15,808
N	510	421	59	622	8,199	6,761	2,561	12,592		31,725

	Math coursetaking pathways across four high school years									
	Low->Low	Low->Standard	Low->High	Standard->Low	Stand.->Stand.	Standard->High	High->Standard	High->High	Total	Total
Ever earned college-level STEM credits before high school graduation										
No	98.6%	96.9%	96.6%	92.9%	88.5%	87.3%	52.1%	70.0%	78.4%	24,862
Yes	1.4% **	3.1% **	3.4% +	7.1% **	11.5%	12.7% *	47.9% **	30.0% **	21.6%	6,863
N	510	421	59	622	8,199	6,761	2,561	12,592		31,725
High school GPA										
	2.0 **	2.1 **	2.3	1.5 **	2.3	2.8 **	2.7 **	3.2 **		2.6
Cumulative GPA in public 4-year institution, 2017										
	3.3 **	2.6	2.2	2.8	2.6	2.8 **	2.9 **	3.1 **		3.0
GPA from STEM courses in public 4-year institution, 2017										
	2.5	2.0	2.3	2.2	2.2	2.4 **	2.6 **	2.9 **		2.7
Cumulative GPA in public 2-year institution, 2017										
	1.2 **	1.7 **	1.9	1.0 **	1.9	2.3 **	2.2 **	2.5 **		2.1
GPA from STEM courses in public 2-year institution, 2017										
	2.9	2.7	2.7	3.0 *	2.7	2.6	2.9 **	2.9 **		2.8

(Note: Z statistics are used to test proportional difference across mathematics pathways, and T statistics are applied to test GPA difference across groups. The reference group for cross-pathway comparison is standard-to-standard pathway. Significance level: + p<0.1, * p<0.05, ** p<0.01.)

Table B3. Percent distribution of mathematics coursetaking pathways, by students' demographics and family income level

	Math coursetaking pathways across four high school years								
	Low->Low	Low->Standard	Low->High	Standard->Low	Stand.->Stand.	Standard->High	High->Standard	High->High	Total
Gender									
Male	6.0%	2.7%	0.3%	5.1%	33.3%	16.2%	7.0%	29.4%	38,440
Female	3.9% **	2.2% **	0.2%	4.1% **	32.4%	17.5% **	8.2% **	31.5% **	36,565
Total	5.0%	2.4%	0.3%	4.6%	32.8%	16.8%	7.6%	30.4%	75,005
Race/ethnicity									
American Indian	10.7% **	5.6% **	0.7% **	10.0% **	41.5%	11.4% **	6.1% **	14.0% **	1,173
Asian	1.9%	1.0%	0.2% +	1.1% **	15.2%	16.6% **	6.3% **	57.6% **	5,371
Black	9.2% **	2.5%	0.6% **	6.9% **	33.0%	20.6% **	7.3% *	19.8% **	3,465
Hispanic	6.9% **	3.7% **	0.4% **	6.3% **	39.7%	18.4% **	5.6% **	18.9% **	14,330
White	4.2%	2.1%	0.2%	4.2%	32.5%	16.2%	8.4%	32.2%	45,592
Other	5.0% +	2.2%	0.3% +	5.3% **	33.6%	16.3%	7.6% *	29.6% **	5,074
Total	5.0%	2.4%	0.3%	4.6%	32.8%	16.8%	7.6%	30.4%	75,005
Eligible for free- or reduced-price lunch									
No	2.8%	1.6%	0.2%	3.0%	27.8%	17.2%	8.1%	39.2%	43,849
Yes	8.0% **	3.5% **	0.4% **	7.0% **	39.9%	16.3% **	6.9% **	18.1% **	31,156
Total	5.0%	2.4%	0.3%	4.6%	32.8%	16.8%	7.6%	30.4%	75,005

(Note: Z statistics are used to test proportional difference across mathematics pathways across groups. The reference group for group comparisons is standard-to-standard pathway, male for gender, White for race/ethnicity, and non-FRPL across family income status. Significance level: + p<0.1, * p<0.05, ** p<0.01.)

Table B4. College STEM outcomes, by mathematics coursetaking pathways and students' gender

	Math coursetaking pathways across four high school years									
	Low-> Low	Low-> Standard	Low-> High	Standard ->Low	Stand. ->Stand.	Standard ->High	High-> Standard	High ->High	Total %	Total N
%Earned college-level STEM credits in 2017										
Male	5.8%	16.4%	27.6%	6.3%	21.3%	47.0%	44.6%	71.0%	48.5%	7,336
Female	5.7%	15.0%	33.3%	11.3% *	28.9% **	54.0% **	48.7% *	70.9%	51.2%	8,445
GPA earned from STEM courses in public 4-year institution, 2017										
Male	N/A	2.3	N/A	2.7	2.2	2.3	2.6	2.8	2.7	
Female	N/A	1.8	N/A	2.0	2.2	2.5 **	2.6	2.9 **	2.7	
GPA earned from STEM courses in public 2-year institution, 2017										
Male	2.9	2.6	N/A	3.0	2.6	2.6	2.7	2.8	2.7	
Female	3.0	2.7	N/A	3.0	2.7	2.7	3.0 **	3.0 **	2.8	

(Note: "N/A" refers to those cells with number counts less than 10 and could not be reported for FERPA compliant. Z statistics are used to test proportional difference across mathematics pathways, and T statistics are applied to test GPA difference across groups. The reference group for cross-pathway comparison is standard-to-standard pathway. Significance level: + p<0.1, * p<0.05, ** p<0.01.)

Table B5. College STEM outcomes, by mathematics coursetaking pathways and students' race and ethnicity

	Math coursetaking pathways across four high school years								
	Low-> Low	Low-> Stand.	Low-> High	Stand. ->Low	Stand. ->Stand.	Stand. ->High	High-> Stand.	High-> High	Total %
% Earned college-level STEM credits in 2017									
American Indian (N=321)	11.1%	0.0%	33.3%	0.0%	20.7%	50.0%	30.0%	52.9% **	33.0%
Asian (N=3,410)	22.2% *	22.2%	33.3%	9.1%	30.8%	58.8% **	59.4% **	83.0% **	70.1%
Black (N=1,426)	3.6%	14.3%	27.3%	0.0%	16.9% **	46.5% *	34.7% *	58.1% **	35.8%
Hispanic (N=2,179)	3.1%	16.9%	25.0%	5.3%	22.3% **	44.6% **	38.0% **	62.0% **	39.1%
White (N=18,869)	6.3%	15.2%	33.3%	12.2%	27.0%	52.5%	48.0%	70.5%	51.0%
Other (N=2,023)	5.0%	14.3%	33.3%	12.2%	24.6%	48.7%	47.8%	68.1%	48.4%
GPA earned from STEM courses in public 4-year institution, 2017									
American Indian (N=76)			2.5		2.5	2.9	2.0	2.4 **	2.5
Asian (N=1,894)			3.3	4.0	2.2	2.5	2.5	3.0 **	2.9
Black (N=405)		3.7	2.2		1.7 **	2.1 **	2.4	2.5 **	2.2
Hispanic (N=1,570)	3.1	2.0	1.5		2.1	2.3 **	2.4 *	2.7 **	2.5
White (N=7,149)	3.6	1.8	2.8	2.4	2.2	2.5	2.7	2.9	2.7
Other (N=759)		2.6	1.5	0.3 *	2.2	2.4	2.8	2.7 **	2.6

	Math coursetaking pathways across four high school years								
	Low-> Low	Low-> Stand.	Low-> High	Stand. ->Low	Stand. ->Stand.	Stand. ->High	High-> Stand.	High-> High	Total %
GPA earned from STEM courses in public 2-year institution, 2017									
American Indian (N=35)	2.0				2.4	2.3	3.7	2.9	2.7
Asian (N=531)	3.1	2.3			2.8	2.8	2.9	2.9	2.9
Black (N=149)	2.8	2.3	1.9		2.5	2.6	2.9	2.6^{**}	2.6
Hispanic (N=686)	2.8	2.6		3.2	2.5^{*}	2.6	2.8	2.8	2.7
White (N=2,734)	3.0	2.9	2.8	3.0	2.7	2.6	2.9	2.9	2.8
Other (N=260)	2.8	1.9		2.6	2.6	2.7	3.0	2.9	2.8

(Note: Blank cells are due to lack of information, which comes from no observation. Z statistics are used to test proportional difference across mathematics pathways, and T statistics are applied to test GPA difference across groups. The reference group for cross-pathway comparison is standard-to-standard pathway. Significance level: + p<0.1, * p<0.05, ** p<0.01.)

Table B6. College STEM outcomes, by mathematics coursetaking pathways and students' family income status

	Math coursetaking pathways across four high school years								
	Low-> Low	Low-> Stand.	Low-> High	Stand. ->Low	Stand.	Stand. ->High	High-> Stand.	High-> High	Total %	Total N
% Earned college-level STEM credits in 2017										
FRPL	4.9%	14.8%	30.0%	$3.9\%^{**}$	$21.2\%^{**}$	$45.4\%^{**}$	$40.9\%^{**}$	$62.3\%^{**}$	39.2%	4,243
Non-FRPL	7.0%	16.7%	31.0%	14.8%	28.5%	54.1%	49.4%	73.8%	55.5%	11,538
GPA earned from STEM courses in public 4-year institution, 2017										
FRPL	N/A	2.3	N/A	N/A	2.1	2.3^{**}	2.4^{**}	2.7^{**}	2.5	
Non-FRPL	N/A	1.6	N/A	2.4	2.2	2.5	2.7	3.0	2.8	
GPA earned from STEM courses in public 2-year institution, 2017										
FRPL	2.8	2.7	N/A	N/A	2.6	2.6^{+}	3.0	2.9	2.7	
Non-FRPL	3.1	2.6	N/A	3.1	2.7	2.7	2.8	2.9	2.8	

Notes: "FRPL" indicates whether a student is eligible for free- or reduced-price lunch program in school. "N/A" refers to those cells with number of observations less than 10 and could not be reported for FERPA compliant. Z statistics are used to test proportional difference across mathematics pathways, and T statistics are applied to test GPA difference across groups. The reference group for cross-pathway comparison is standard-to-standard pathway. Significance level: + p<0.1, * p<0.05, ** p<0.01.)

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