#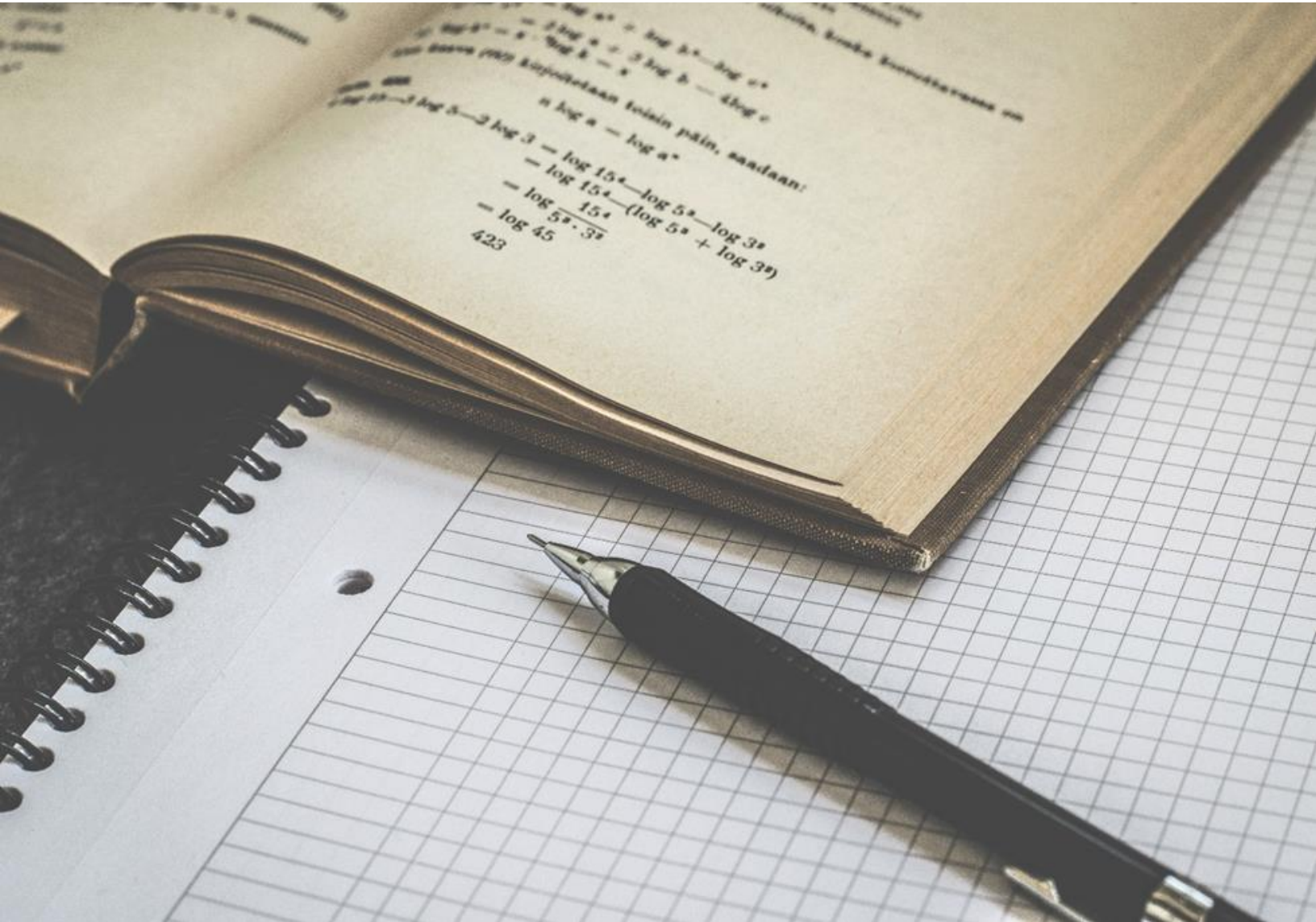 An Exploration of Math Course Taking: How Do High School Students Satisfy the Third Credit of the Mathematics Graduation Requirement?

ERDC
Education Research & Data Center

AUTHOR

Carol Jenner, PhD
Education Research and Data Center (ERDC)

ABOUT THE ERDC

The research presented here uses data from the Education Research and Data Center (ERDC), located in the Washington Office of Financial Management. 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.

ADDRESS

Education Research and Data Center

106 11th Ave SW, Suite 2200

PO Box 43124

Olympia, WA 98504-3113

PHONE

360-902-0599

FAX

360-725-5174

EMAIL

erdc@ofm.wa.gov

Background

Earlier work by ERDC has focused on the association between four-year mathematics course-taking sequences in high school and the first-year college STEM course outcomes.[1] For high school graduates in 2016 and 2017, mathematics course-taking patterns were classified based on the first math course taken and the subsequent highest level math course taken. Using the same cohorts, this report focuses on the middle part of the sequence —identifying the third math credit — and also introduces a method of classifying mathematics courses that may extend to future years.

Washington public high school students in the classes of 2016 through 2018 were subject to graduation requirements that specified a third credit of mathematics beyond Algebra 1/Integrated Mathematics I and Geometry/Integrated Mathematics II.[2] For this third credit, Algebra 2/Integrated Mathematics III was required of most students, but a student could pursue a third math credit other than Algebra 2 or Integrated Mathematics III if the choice was based on a career-oriented program being pursued by the student. Career and Technical Education (CTE) courses with equivalent mathematics content could be substituted for each of the required mathematics courses.[3] High school level mathematics courses taken in middle school could also count as part of this requirement if the credits for those courses were included on the student's high school transcript.

The range of mathematics courses offered by a high school can vary. The most basic offerings include:

- Algebra1
- Geometry
- Algebra 2
- Pre-Calculus
- A math-based CTE course, such as Financial Math or Construction Math
- Support courses, which include credit recovery courses[4] and math electives designed for students who need extra support to be successful in required math courses.

---

[1] Chen, V., 2019. "Mathematics Coursetaking Pathway to College STEM for Washington State High School Students." Education Research and Data Center, State of Washington.

[2] Some high schools offer a series of Integrated Mathematics courses instead of Algebra 1, Geometry and Algebra 2. In this analysis, references to Algebra 1, Geometry and Algebra 2 include Integrated Mathematics 1, 2 and 3, respectively.

[3] These requirements are defined in WAC 180-51-067. For students in the classes of 2019 and 2020, Algebra 2 was no longer specified as a requirement for the third credit of math. Instead, the requirement was for "a third credit of high school mathematics, aligning with the student's interests and high school and beyond plan, with agreement of the student's parent or guardian." See WAC 180-51-068. Washington's public baccalaureate institutions require three credits of high school mathematics, including Algebra 2. See Washington Student Achievement Council, "Admissions Standards Policy," April 2017 Update.

[4] Credit recovery allows students who fail to earn first-time credit in a course to enroll in that course or an approved substitute. By passing the course, students can earn credit counting toward high school graduation. Credit recovery courses are frequently offered as online courses. See U.S. Department of Education, "Issue Brief: Credit Recovery," March 2018.

On-line course offerings, Running Start courses, local CTE courses and CTE courses at a regional skills center could supplement these in-school offerings. [5]

Large schools offer a wider range of courses. Many high schools offer a selection from the following courses:[6]

- **Applied Algebra** and **Applied Geometry** as options to satisfy Algebra 1 and Geometry requirements.
- **Transition Algebra** - Transition Algebra courses review and extend algebra and geometry concepts for students who have already taken Algebra I and Geometry.
- Multiple options for **Algebra 2** – A basic Algebra 2 course and an option to take Algebra 2 with Trigonometry
- **Algebra III** - Algebra III courses review and extend algebraic concepts for students who have already taken Algebra 2.
- **Bridge to College Mathematics** – In 2016 and 2017, the Bridge to College Mathematics courses were designed for high school seniors who scored a 2 on the Smarter Balanced 11th grade assessment. This course was be taught using the Bridge to College Mathematics curriculum.[7] Note: More recent State Course Code files indicate that this course is designed for Seniors who have completed Algebra 2.[8]

Students may earn high school mathematics credits in middle school and enroll in Geometry or Algebra 2 in ninth grade. Others enroll in Pre-Algebra or in individualized courses specific to specialized learning plans. At any point along the sequence of math courses taken by a student, there may be opportunities for them to co-enroll in additional courses that support their regular coursework.

Students with Individual Education Plans (IEP) often enroll in courses that are tailored in pace and content to an appropriate level.

Study Cohorts and Data Sources

This analysis focuses on students graduating from Washington public high schools in 2016 and 2017. To allow for the consistent determination of the third high school math course, this analysis includes only those students who enrolled in Washington public high school for four years.[9]

---

[5] Running Start (RS) is a Washington State program that allows high school students to enroll in public colleges or universities and earn credits at both high school AND at the higher education institution (dual credit). College in the High School courses (CHS) are college-level courses offered at a high school and taught by high school teachers. Successful completion of CHS courses can lead to dual credit.

[6] Definitions are OSPI State Course Code Lists for 2015-16 and 2016-17.

[7] This is the description contained in the 2015-16 CEDARS State Course Code file. In subsequent years the course description for Bridge to College Mathematics specified that it was designed for

[8] State Course Code Lists beginning with 2019-2020 reflect this new description. See OSPI CEDARS Information.

[9] Over 95 percent of high school graduates are included in each study cohort.

The Comprehensive Education Data and Reporting System (CEDARS) of the Office of Superintendent of Public Instruction provided the K-12 data for this study.[10] The CEDARS Grade History File serves as the basis for determining high school mathematics course-taking. This file contains course-level data at the student level that identifies local course code and title and the corresponding generic state course code.[11] The Grade History file includes fields for indicators specifying courses that are Advanced Placement, International Baccalaureate, Cambridge International, College in the High School and Running Start.[12]

State Course Codes used in CEDARS are five-character codes. The first two characters of the code correspond to subject area. Mathematics courses use the prefix '02.'

This Grade History file allowed for the analysis of math course-taking sequences for each individual in the study cohorts. In addition, the placement of a course with ambiguous codes and/or titles could be evaluated for all students enrolled. If, for example, a math-related course title with no State Course Code consistently fell between Geometry and Pre-Calculus in the course-taking sequences of students enrolled in the course, then one could assume that it could be classified as Algebra 2.

All records related to mathematics were extracted from the stacked Grade History file for the 2013 — 2017 school years. The state course code and the course name were used to identify mathematics courses. Most Grade History File records for mathematics are associated with codes in the Mathematics Subject Area. However, courses with mathematics content are also listed in other subject areas and course names– particularly in Business and Marketing (Finance), Human Services (Consumer Economics/Personal Finance) and Miscellaneous. To identify these, course titles for all records were reviewed prior to inclusion in the study data file, including records with no state course code. Records were considered for inclusion if the course title included math-related words and abbreviations.[13] As a result, many CTE math-related courses, which are often coded to subject areas other than mathematics, could be included in the study data. A few records mis-coded to mathematics were excluded from the study.

Since many high school students enroll in dual credit courses offered in conjunction with the state's public postsecondary institutions, enrollment information from the state Community and Technical College System and from the public baccalaureate institutions in the state were also incorporated into

---

[10] See OSPI CEDARS for more details.

[11] The state course code is closely related to the NCES School Courses for the Exchange of Data (SCED).

[12] Advanced Placement (AP), International Baccalaureate (IB) and Cambridge International Education (CI) are programs that lead to exam-based dual credit possibilities.

[13] Records without math-related course codes were evaluated for a set of letter combinations that suggested mathematics subjects, including 'MATH,' 'MTH,' 'ALG,' 'GEOM,' 'TRIG,' 'STAT,' 'CALC' and 'PROB.'

the study data.[14] This was particularly useful in situations where the course detail is known in the postsecondary record but is listed generically (e.g., 'Running Start Math') in CEDARS.

Classifying Mathematics Courses

Math course enrollment records, including dual credit college records totaled over 800,000 for the two study cohorts. Over one hundred different State Course Codes were associated with CEDARS Grade History file records analyzed, and many more course titles were used locally. In addition to classes offered within the high school, many students enroll in college-level courses at nearby public universities and colleges. To make the analysis more manageable, a classification system was developed.

CEDARS State Course Codes were used for guidance for classification, but the course name in the Grade History file and the placement of the course in student math course-taking sequences was the determining factor. High school course catalogs available online were used to place specific math courses in appropriate categories.

The subject of the course was the basis for classification, rather than the delivery mode. For example, a Running Start statistics course is classified the same as AP Statistics, a statistics class offered within the high school, and a statistics course offered online.

For the purposes of determining the third credit of math for a particular student, post-Geometry courses were assigned to eight categories, as follows:

- Transition Algebra (typically a review and expansion of topics covered in Algebra 1 and Geometry)
- Algebra 2 (sometimes combined with Trigonometry topics) and Integrated Math 3
- Three categories of post-Geometry courses that are part of a non-calculus sequence
    - CTE courses and other applied mathematics courses (Construction Math, Business Math, Financial Fitness)
    - Courses specific to high school curriculum (non-dual credit) such as Algebra 3, Bridge to College Mathematics, College-Prep Mathematics
    - Courses – often Running Start (RS) or College in the High School (CHS) – in subjects that overlap college curriculum (statistics, finite math, "Math in Society" and other CHS and RS courses)[15]
- Pre-calculus
- Calculus
- Advanced (Calculus prerequisite and all upper division university mathematics courses)

---

[14] Course-specific enrollment for Washington's six public baccalaureate institutions is derived from the Public Centralized Higher Education Enrollment System (PCHEES) and from data provided by the State Board for Community and Technical College (SBCTC).

[15] RS and CHS courses fall into this category, as well as non-dual credit courses with the same subject.

Figure 1 summarizes this classification system, the typical names of courses under each category. Examples of course titles included in each category are also shown. Running Start Courses are not included in the counts.

Figure 1: Classification System used for Math Course Sequence Analysis

Category and Typical Course Titles

Pre-Geometry
Basic: Informal Mathematics, General Mathematics, Foundation Mathematics, Pre-Algebra, individualized courses[16]
Algebra 1: Algebra 1, Integrated Math 1, Applied Algebra

Geometry
Geometry: Geometry, Informal Geometry, Integrated Math 2, Applied Geometry

Post-Geometry
Transition Algebra: Transition Algebra, Math Modeling, Algebra 2 Prep
Algebra 2: Algebra 2, Algebra 2/Trigonometry, Integrated Math 3
Non-Calculus: **Applied:** CTE Mathematics, including Construction Math, Business Mathematics, Consumer Mathematics, Financial Fitness
Non-Calculus High School Curriculum: Algebra III, IB Mathematical Studies, College Mathematics Preparation, Bridge to College Mathematics
Non-Calculus College Subject: Finite Mathematics, Statistics, Math in Society[17]
Pre-Calculus: Pre-Calculus, Trigonometry, College Algebra, Business Pre-Calculus
Calculus: Calculus, AP Calculus AB/BC, IB Mathematics SL/HL, Business Calculus, AICE Calculus/Mechanics
Advanced: Courses with calculus prerequisite and all upper-division college-level courses

Other
Support: Support courses, credit recovery courses
Unknown: Courses with codes and titles insufficient for classifying

Identification of all CTE courses that might be alternatives to Algebra 2 as a third math credit poses a challenge using this approach, since approved mathematics sequences within CTE are defined at the local level. Many of the CTE courses that might serve as a third credit of math are captured, however. Personal Finance and Business Math courses are often associated with State Course Codes in the mathematics subject area. Other CTE courses with a math focus could easily be identified by course title — Welding Math and Construction Math are examples.

---

[16] Courses offered specifically to support students with Individualized Education Programs or other independent study courses where an alternative course code assignment is not possible.

[17] These courses cover material that overlaps content of lower division college mathematics courses that are not on the calculus pathway. Non-Calculus RS and CHS courses are included in this category.

Approach

For graduates in each of the cohorts, the following items were compiled:

- Year-by-year mathematics course-taking
- First math course taken
- Highest level math course taken
- First course taken that was at a higher level than geometry.

This compilation permits a variety of analyses related student's math course-taking sequence.

Table 1 shows the distribution of first mathematics course taken by cohort in grades 9-12. Approximately half of students in the study cohorts started their mathematics sequence with Algebra 1, and another 35 percent started with Geometry.

Table 1. First Mathematics Course Taken in High School (Grades 9-12)

Category	Study Cohort			
	2016		2017	
Basic	2,690	5%	2,400	5%
Algebra 1	25,330	48%	25,000	48%
Geometry	18,710	35%	18,210	35%
Algebra 2	4,760	9%	5,570	11%
Pre-Calculus	260	<1%	240	<1%
Applied	550	1%	440	<1%
Other	400	<1%	340	<1%
No math courses	20	<1%	20	<1%
	52,710	100%	52,220	100%

Note: Numbers are rounded to the nearest 10. Totals may not add due to rounding.

The highest level of mathematics taken by students in the study cohorts is outlined in Table 2. Slightly over one third of the graduates enrolled in Algebra 2 as their highest-level math course. About half of the students took courses beyond Algebra 2.

Table 2. Highest Level of Mathematics Taken

| Category | Study Cohort | | | |
| | 2016 | | 2017 | |
	Count	Percent	Count	Percent
Basic	1,060	2%	790	2%
Algebra 1	550	1%	470	<1%
Geometry	1,680	3%	1,370	3%
Transition Algebra	310	<1%	240	<1%
Applied Mathematics	3,470	7%	3,020	6%
Post Geometry, Non-Calculus	660	1%	640	1%
Algebra 2	18,790	36%	18,900	36%
Pre-Calculus	15,120	29%	15,270	29%
Calculus	10,680	20%	11,070	21%
Advanced	340	<1%	380	<1%
unknown	70	<1%	70	<1%
	52,710	100%	52,220	100%

Note: Numbers are rounded to the nearest 10. Totals may not add due to rounding.

Identification of a post-geometry third credit of math is possible for graduates who took courses beyond geometry – 49,360 graduates in 2016 and 49,520 in 2017. To determine the first post-geometry course for a student, the following approach was taken:

- For students who took Algebra 1 in ninth grade, and who took geometry at some point in tenth through twelfth grades, the third math credit is associated with the first non-geometry course in grades ten through twelve.
- For students who took Geometry in ninth grade, it is assumed that they earned Algebra 1 credit in middle school. Their third math course is the first post-geometry course taken in grades ten through twelve.
- For students who took neither Algebra nor Geometry, it is assumed that they earned both Algebra 1 and Geometry credits in middle school. Their third credit corresponds to the first post-geometry course taken in high school.
- For students who took Algebra 1 or Geometry in high school, but not in ninth grade, the first post-geometry course taken is their third math credit.

Table 3 shows the resulting third math credit array. The majority of high school students enrolled in Algebra 2 as their third credit of math. Selected details within categories are shown.

Table 3: Third Math Credit

Category	2016 Count	2016 Percent	2017 Count	2017 Percent
Calculus or higher	80	<1%	70	<1%
Pre-Calculus	820	2%	720	1%
Algebra 2	42,800	81%	43,510	83%
Non-Calculus (Total)	730	1%	740	1%
Statistics	*380*		*360*	
Bridge to College Mathematics	*100*		*150*	
IB Mathematical Studies	*70*		*80*	
Algebra 3	*50*		*40*	
Applied (Total)	4,260	8%	3,830	7%
Consumer Mathematics	*1,890*		*1,800*	
Business Algebra	*860*		*740*	
Business Mathematics	*400*		*360*	
Computer Science	*40*		*80*	
Transition Algebra	670	1%	650	1%
No Post-Geometry course	3,360	6%	2,700	5%
	52,710	100%	52,220	100%

Note: Numbers are rounded to the nearest 10. Totals may not add due to rounding.

Conclusion

Approximately 85 percent of high school graduates in 2016 and 2017 enrolled in Algebra 2, which was specifically listed as a high school graduation requirement. For over 80 percent of the graduates, Algebra 2 was the third math course taken. Graduation requirements changed effective with students entering high school beginning in July 2015 and Algebra 2 is no longer considered a requirement for all students.[18] Instead, after Algebra 1 and Geometry or equivalent courses, a student selects a math course or courses that are appropriate for their education and career goals. Undoubtedly, Algebra 2 will continue to be the most common third-credit math course, since it remains a requirement for admission to many postsecondary institutions.

The major effort of the work presented here was the development of a classification system for math courses and the assignment of specific courses to the appropriate category. Sometimes this was done by determining the course-taking patterns of individual students to see where this course was placed – after Geometry? After Algebra 2? In many cases, course descriptions in high school course catalogs available online provided sufficient details about the course to assign it to the appropriate category.

CTE courses present a special case, and it was not possible to fully develop CTE math sequences in this study. Many of the approximately 4,000 graduates for whom a third math credit could not be identified undoubtedly fall into this group. Again, high school course catalogs provided clues as to what non-math courses could satisfy the third credit of math requirement, but catalogs for many schools are not

---

[18] WAC 180-51-068, *op. cit.*

available online. Many that are available suggest that certain courses offered to students in the 2016 and 2017 graduation classes are no longer offered.

Directions for Future Work

Several avenues of future work are possible:

- What are the differences in math course-taking sequences between small schools and large schools? What is the role of online offerings and Running Start courses in expanding opportunities for students in small schools?

- What are the relationships between math assessments in middle and high school, math course-taking sequence and postsecondary enrollment in math courses?

- What are the postsecondary mathematics outcomes for students who complete a Bridge to College Mathematics course?

- How do math course-taking patterns of Class of 2019 and subsequent classes compare with those of the cohorts that are the focus of this analysis?