Dual-Credit Access, Participation and Outcomes in Washington State

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ABSTRACT

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Dual-credit has become a prominent topic in education as states look for additional opportunities to prepare students to succeed in college. Research has shown that students who earn college credit in high school are more likely to enroll in college. In Washington, there is currently a policy in place to increase enrollment in dual-credit courses. In addition, the Every Student Succeeds Act (ESSA) has given states more flexibility in how they are held accountable and Washington is one of the states that adopted dual-credit participation as an accountability measure. This study is informed by the results of a previous pilot study and includes all six dual-credit programs offered in Washington state. The six programs are AP, Cambridge, College in the High School, IB, Running Start and Tech Prep. Both descriptive and predictive approaches are taken to answer the questions 1) who has access and participates in different dual-credit programs, and 2) does dual-credit participation predict high school graduation and college enrollment after controlling for demographics and GPA?

The results of this study provide a more nuanced picture of dual-credit access in Washington when only basic statistics at the state level have been produced thus far. Tech Prep has the highest participation rate, and Cambridge the lowest. Students from outside the greater Puget Sound area have access to fewer dual-credit options and have lower participation rates. Students from smaller districts are also less likely to participate in dual-credit but have higher participation in Running Start compared to larger districts. Results from the predictive Hierarchical Linear Models show that AP, Running Start and College in the High School are all significant predictors of any college enrollment. Running Start participation is associated with an increased probability of any college enrollment for underrepresented minority students and College in the High School participation is associated with an increased probability of any college enrollment for students who are English language learners. Implications for policy and future research are discussed.

Keywords: Dual-credit, access, participation, graduation, college enrollment

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Chapter 1: Introduction

1.1 Rationale and Focus of the Research

Dual-credit has become a prominent topic in education as states look for additional opportunities to prepare students to succeed in college. In 2011, the Launch Year Act (E2SHB 1808) was signed into law in Washington state. This policy requires public high schools to work toward increasing the number of dual-credit offerings (WSAC, 2016). In 2015, E2SHB 1546 was enacted and made additional funding available for dual-credit opportunities. The impetus for this policy was based on prior national research which shows that students who earn college credit in high school are more likely to graduate from high school, enroll in college and complete college (WSAC, 2016). Governor Inslee's Vision 2021 document also references dual-credit in a goal to prepare Washington's future workforce by increasing attainment of technical credentials, two- and four-year degrees and contributing to Washington's 70 percent attainment goal (STEM Alliance, 2017).

The federal Every Student Succeeds Act (ESSA) has given states more flexibility in how they are held accountable and this includes using dual-credit participation as a measure of accountability. Washington is one of the states that adopted dual-credit completion as a measure for ESSA. This measure is the percent of high school students completing at least one dual-credit course. All six of Washington's dual-credit programs (Advanced Placement (AP), Cambridge, College in the High School, International Baccalaureate (IB), Running Start and Tech Prep) are treated equally in this measure, yet there is no evidence indicating these programs all produce the same outcomes seen in the national research. With so much energy being placed in dual-credit programs, it is worth studying the impact of these programs. Are students who take any type of dual-credit course more likely to enroll in postsecondary education and persist?

This dissertation is informed by the results of my previous pilot study with a focus on AP and Running Start courses. In that study, the sample consisted of students from the graduating class of 2013 in a single urban school district in the Pacific Northwest with an enrollment of about 20,000 students. An HLM approach was used and results indicated that both Running Start and AP course enrollment uniquely predicted college enrollment even after controlling for demographic variables and GPA. These were important findings given the policy in place in Washington to increase the number of dual-credit courses offered. From this pilot study, it appears that AP and Running Start programs are putting students on a path to college.

The pilot study also found that minority status and poverty status were not significant predictors of college enrollment when Running Start and AP course enrollment variables were included in the model. While they did have negative coefficients, indicating that being classified as a minority student or student in poverty reduces the probability of college enrollment, they were small and ultimately not significant. In the one district pilot, dual-credit enrollment was a stronger predictor than minority and poverty status and indicated that enrollment in these courses could be a good way to increase college enrollment rates for all student groups.

A limitation of the pilot study was that the results only pertain to one school district. Results cannot be generalized to other districts and the positive association dual-credit courses were having with college enrollment in this district could only be known for the time period examined. Additionally, the sample in the pilot study only contained high school graduates and did not account for AP and Running Start courses taken by non-graduates. As a next step, this research uses state-level data for all districts in the state of Washington and includes both graduates and non-graduates. This allows for the creation of a three-level HLM model with students nested in schools and schools nested in districts. The study also examines all dual-credit options available to students in a particular district, including, but not limited to AP and Running Start.

This dissertation is also motivated by the need to examine whether or not systematic inequities exist in access to dual-credit opportunities for students in poverty, students of color, and students who are English language learners (ELL) or receive Special Education services. For example, in Washington, "Hispanic students make up 19 percent of the total population yet are represented at rates of 12 percent in Advanced Placement and Running Start programs, and 13 percent in College in the High School Programs" (WSAC, 2016, p. 10). Furthermore, this dissertation also addresses whether inequity in access to dual-credit programs is associated with differences in district size, region of the state, or property wealth.

1.2 Research Questions

This study contributes to the topic of dual-credit programs by asking the following research questions:

1. What differences exist in dual-credit options for students across the state of Washington? What factors contribute to these differences by district, school, and student characteristics?
2. Does dual-credit course enrollment uniquely predict college enrollment for high school graduates? Is dual-credit course enrollment also associated with high school completion?

Chapter 2: Literature Review

2.1 Dual-credit definitions

Dual-credit has many definitions in the literature. Depending on the researcher, the terms dual enrollment or concurrent enrollment can either be used synonymously or have an entirely different meaning. The Washington Student Achievement Council (WSAC), which provides strategic planning and program administration to support increased student success and higher levels of educational attainment in Washington, defines dual-credit programs as those that allow students to earn both high school and college credit by passing a college course (Running Start, College in the High School), by examination (AP, IB, Cambridge) or by articulation (Tech Prep). By contrast, the Hawaii Department of Education (2017) defines dual-credit courses as those that satisfy requirements for a high school diploma and a University of Hawaii degree with the two most common programs being Early College and Running Start. In Hawaii, exam-based credit programs are not included. It is important to note that college credit is not guaranteed by taking an AP or IB course and students must receive a certain score on end of year exams to receive college credit. In addition, different postsecondary institutions have different policies on what scores they will accept for college credit and how these credits will be applied. A question has emerged regarding how or whether to include courses that require a passing score on an exam as dual-credit.

Allen (2010) refers to dual-credit programs as those "in which students earn high school and college credit simultaneously" (p. 2). He also speaks to the difference between dual enrollment programs, dual-credit programs and other college transition programs. For the purposes of his work, AP and IB courses are college transition programs. In a study of state college readiness policies, Blume and Zumeta (2014) defined dual enrollment similar to Allen's definition of dual-credit. Dual enrollment refers to high school juniors or seniors taking college-level courses while advanced coursework offerings refer to AP and IB courses. Research conducted by Eimers and Mullen (2003) and Nash (2015) also separate AP programs from dual-credit programs.

Definitions by Allen and by Blume & Zumeta are broad in that they do not specify where the high school students are taking the college-level courses. Eimers and Mullen (2003) studied dual-credit courses taught by high school teachers on the high school campus that could yield both high school and college credit. Dual-credit courses could also be taken on a college campus and students would be able to earn high school and college credit. It is important to understand the details of the different dual-credit options being studied because a variable like “course location” could have an impact on outcomes.

Bailey, Hughes & Karp (2002) researched the role of dual enrollment programs in easing the transition from high school to postsecondary and noted that these programs are often called concurrent enrollment or dual-credit programs. They are a way to expose students to the academic demands of college prior to high school graduation while allowing them to earn high school and college credit simultaneously. The authors also discuss Tech Prep programs, but they are not included as a dual enrollment/dual-credit program, a position that differs from the WSAC definition above. It can also be inferred that AP/IB courses are not included in Bailey et al.’s (2002) definition of dual enrollment as the authors state that dual enrollment requires a formal linkage between high schools and colleges. It appears that Washington’s definition of dual-credit is the most all-encompassing of different programs and is not completely in alignment with most definitions found in the literature.

As one can see based on the literature above, there is a lack of consistency in the definition of dual-credit and this has effects on policy creation and implementation. Researchers can be using the same terms, but the specifications for that term can vary. Consumers must read the research carefully to understand what types of programs are being studied and the outcomes they are associated with. Because of different definitions of dual-credit and the programs it includes, states may take different approaches to increase participation. A state like Washington may try to enroll more students in Advanced Placement (AP) courses while other states that don't include AP as dual-credit may create programs where students can take college courses at their high school or on a college campus.

2.2 Current dual-credit programs and how they differ

For the purposes of this study, I will include programs that encompass all of the definitions presented in the previous section. Dual-credit programs generally fall into two categories: programs taken at a high school or college where high school and college credit is earned and high school programs that include an exam component that must be passed to earn college credit. This study focuses on six programs from both categories. AP, IB and Cambridge have an exam component and College in the High School, Running Start and Tech Prep are credit based. The programs described below are not an exhaustive list, but they do illustrate the variety of dual-credit programs available across the country.

Running Start is a dual-credit program designed for 11th and 12th grade students and is available in both Washington and Hawaii. In 2013, more than 18,000 students were enrolled in Running Start in Washington (Smith, 2014). The program allows students to enroll in college-level courses at selected two and four-year colleges to obtain both high school and college credit. While the programs have the same name in both states, there are some differences in how it is implemented. In Washington, tuition is covered by the state, while other fees, books and transportation costs are left to be paid by the student. A student's high school loses partial funding when the student enrolls in Running Start. In Hawaii, tuition payment is left to the student, with some support available for low-income students. If a Washington student enrolls in Running Start full-time in both 11th and 12th grade, they have the opportunity to graduate from high school with both a diploma and an associate's degree which would allow them to begin courses at a four-year university as a third-year transfer student.

In both states, students must take college placement exams in order to participate in Running Start. In Washington, only 100 level courses and above are paid for by the state and in Hawaii, students must place into a 100-level course to be eligible for the program. If a Washington student does not test into college level courses, they can register for remedial courses, but they must pay the tuition. Research shows that "not only are students of color and low-income students more likely to be placed into remedial education, they are more likely to be placed in both remedial math and English (Complete College America, 2016, para. 3)." This has implications for Running Start in both Washington and Hawaii as this study analyzes who is accessing the program and benefiting from it.

Florida has a dual enrollment program similar to Running Start that allows students to earn both high school and college credit by taking college courses at their high school, a local career education center or college campus (Adams, 2012). Unlike Running Start, tuition and fees are waived and textbooks are provided free of charge for public high school students. However, to be eligible for the program, students must meet minimum GPA requirements and pass college placement tests. Eligible students can take as many dual enrollment courses as they like and many students earn enough credit to earn both a high school diploma and associate's degree

(Adams, 2012). Cost is less of a barrier for dual enrollment students in Florida, and students accessing the program are seeing positive effects on postsecondary enrollment and first year college GPA (Karp, Calcagno, Hughes, Jeong & Bailey, 2007). These effects are seen overall and in low income students and students with lower GPAs.

New York City's College Now is one of the largest dual enrollment programs in the country, with over 20,000 students enrolled annually (College Now, 2017). Taking college-credit courses is just one of College Now's offered activities. Eligible students can take college level courses at their high school or college campus for free in 11th and 12th grade and can earn up to twelve credits. Additionally, students who do not meet the requirements to take college-credit courses (based on Regents, SAT or ACT scores) may be eligible to take pre-college (remedial) courses free of charge (College Now, 2017). This is not something that is available for free in other states.

Tech Prep is a program that offers "students planned career pathways that link high school classes to advanced technical education at the colleges" (Bailey et al., 2002). The programs usually start the last two years of high school and continue into the first two years of college and lead to an associate's degree or two-year certificate. In Washington, all Tech Prep courses offer dual-credit and students will earn high school and college credit upon successful completion of the course (SBCTC, 2017). Tech Prep courses are offered in fields such as agriculture, health, business and mechanical and industrial arts. Examples of specific courses include Medical Terminology, Welding and Intro to Marketing. Tech Prep received federal funding starting in 1990, but the federal funding was eliminated in 2011 (Bailey et al., 2002; SBCTC, 2017). This program is different than the others mentioned as it has a vocational focus and is aligned to career pathways. Given the elimination of federal funding and the limited number of Tech Prep programs across the county, dual-credit research often does not include vocational programs, but this study does include Tech Prep.

The AP program, which is part of the College Board suite of programs, allows students across the country to take rigorous courses while in high school with the option of taking an AP exam at the end of the course. Students may earn college credit and/or advanced placement into upper-level college courses if they receive a high enough score on their exam (Dorn, 2014). The cost of an AP exam is $93 and most of these exams are paid for by the students. The College Board offers a fee reduction for low income students.

In the 2015 school year, nearly 63,000 students in the state of Washington were enrolled in at least one AP course and AP was available in 180 of the 295 districts in the state (WSAC, 2016). The College Board does not have specific criteria for students to be able to participate in AP and requirements to participate vary by school. Some schools will place students into AP courses based on teacher recommendation or students may self-select into the courses. Other schools are trying an “AP for All” model where all students are placed into a specific AP course, such as AP Literature and Composition for all 11th grade students.

The IB program is similar to AP in that students take exams after the completion of IB courses. These courses are designed to provide challenging programs of international education and rigorous assessment. Schools must be authorized by IB to offer one of their programs and this authorization process typically takes between two and three years (IB, 2015). Between 2012 and 2017, the number of IB programs offered worldwide has grown by 39.3% (IB, 2017).

If students pass a certain number and type of IB exams, they can earn a Diploma Programme which often results in advanced standing, course credit and other benefits in college (IB, 2017). Students currently pay a $172 registration fee in addition to a $119 fee for each exam they take. Unlike AP, there are no fee reductions available for low income students and there is more ambiguity around how and if IB credits will transfer over for college credit. Because of the cost associated with IB for both schools and students, this program is not likely to see a major increase in support of students earning college credit in Washington state.

Cambridge International is a program similar to IB in that schools must be approved to offer the program and there are exams at the end of the courses. Exams are offered in November and June and any college credit received is determined by the college a student attends. Cambridge is the world's largest provider of international education programs for 5 to 19 year olds and includes more than 10,000 schools in 160 countries (Cambridge, 2019). There are currently 345 Cambridge schools across the United States and 5 schools in Washington state. As shown by the relatively small numbers, this program is not as prevalent in the United States compared to other programs such as AP.

2.3 Purpose of dual-credit and change over time

While dual-credit programs were once limited to high-achieving students, there has been a more recent push to get students of various achievement levels into these programs (Karp, et al., 2007). This change comes as college completion has become a dominant topic in a national conversation around the position of the United States in the global economy (Hofmann, 2012). In response, more states have implemented policies around dual enrollment implementation. Forty-six states have policies that govern dual enrollment programs and twelve states require participation of public postsecondary institutions (Hofmann, 2012). While there are policies in place around these programs, implementation can vary depending on how high schools and colleges interpret the policy and its purpose.

In 2017, a dual-credit survey from The State of Washington's Office of Superintendent of Public Instruction (OSPI) was sent to K-12 and higher education staff through dual-credit listservs. The survey contained a question asking participants about the primary purpose of dual-credit and to rank order the five purposes below:

1. Experience the academic rigor of a college course
2. Build the skills (academic and social/emotional) to succeed in college
3. Meet students' unique learning needs
4. Earn college credit to reduce time and/or cost to degree completion
5. Depends on the student's post-high school plan

The results of this survey (OSPI, 2017) showed that the fifth purpose (depends on the student's post-high school plan) was most often ranked as the primary purpose with the fourth choice (earn college credit to reduce time and/or cost to degree completion) being the second most frequent response. These purposes are included as they were essentially the same purposes that showed up across the dual-credit literature. The five purposes above along with a few others are explored in further detail next.

Blume and Zumeta (2013) argue that dual enrollment policies are a type of college readiness policy that allow students to access more rigorous coursework than may be available at their high school and earn college credits that can be applied towards a college degree. Hofmann (2012) agrees with the college readiness purpose of dual-credit and also speaks to the opportunities that come from "linking high school and college more intentionally so that students are better prepared to confront the academic, social and financial challenges that await them after high school" (p. 2). Karp et al. (2007) also discuss the role dual-credit can play in strengthening links between the secondary and postsecondary sectors as well as its ability to increase the rigor of secondary education. It is the hope of both secondary and postsecondary institutions that this tighter link and increased rigor will lead to a higher rate of student success in college. Research shows that many students enter college unprepared for the expectations they face there (Conley, 2007). Dual-credit programs are just one way that increased levels of college readiness may be achieved.

In Washington, the purpose of dual-credit appears to be around earning college credit and reducing time to degree completion. The Washington Student Achievement Council (WSAC, 2016) cites national research that shows students who earned dual-credit took less time to complete an associate's or bachelor's degree compared to students who did not earn any college credit in high school. WSAC (2016) also cites national literature that students who earn college credit in high school are more likely to graduate from high school, enroll in college and complete college, which relates to the purpose of dual-credit as a way to build the skills needed for postsecondary success. Washington does have a policy in place that requires public high schools to work toward increasing the number of dual-credit offerings, and dual-credit enrollment is now part of Washington's newly revised accountability system in response to the federal Every Student Succeeds Act (ESSA). However, dual-credit may not be an appropriate choice for many students if the courses do not align with their interests or if they aren't prepared for the rigor of the courses. It can be easy to place more students in dual-credit program but if they aren't prepared for these programs, will they see the positive effects cited in the research?

In Florida, the Department of Education recognizes that dual-credit serves each of the five purposes listed above and specifically states that "students must be advised based on individual needs and carefully monitored to ensure continued success" (2017). They recognize that dual-credit is not a one-size-fits-all approach to college success and that students should have access to advanced coursework that is relevant to their postsecondary interests to remain engaged and motivated. There is not a state policy in place to increase the number of dual-credit offerings in Florida, but each year the number of students participating continues to grow.

New York's College Now has a clearly stated goal to "help students meet high school graduation requirements and prepare for success in college, both academically and socially" (2017). In addition, they have a goal around students being able to enter college without the need for remediation. This is an important goal as students taking remedial courses at four-year universities are about 20% less likely to graduate in six years than their peers who did not take remedial courses (Complete College America, 2012). While this is descriptive data and causation can't be inferred, outcomes do differ based on remedial course taking and African American students are even less likely to complete remedial course work and the associated college-level courses in two years (Complete College America, 2012). Another argument for expanding access to dual enrollment programs assumes that some students, particularly low-income or low-achieving students, may benefit from early exposure to the demands of college courses (Karp et al, 2007). This is a purpose that is not explicitly mentioned in the five above, but it is related and extremely important.

While researchers and states have well defined purposes for the implementation of dual-credit programs, there must be ways to understand if these programs are meeting their intended purposes and are truly successful.

2.4 Who takes dual-credit courses?

With many different types of dual-credit options available and a push to get more students into these programs, one might expect all different types of students to be accessing dual-credit. However, based on a review of the literature, this is often not the case. The National

Center for Education Statistics (NCES) released a report in 2019 showing dual-credit enrollment by race and parental education level. They found that White and Asian students participated at a higher rate than Black and Hispanic students, by a difference of as much as 11% (NCES, 2019). They also found that students were more likely to participate in dual-credit as their parents' level of education increased. In phase two of their analysis of dual-credit programs in Texas, Miller et al. (2018) found that while there had been gains in dual-credit participation by underserved groups, they still stood a lower chance of participating compared to White students. A newspaper article about Running Start in Washington showed that students in the program are disproportionately White and Asian and less than 5% are from low-income families (Seattle Times, March 15, 2018).

This prior descriptive work affirms the need for a comprehensive analysis of dual-credit programs in Washington. As dual-credit continues to become a prominent option in increasing college readiness and potentially impacting postsecondary enrollment, it is important to know who is currently taking advantage of these programs. If participants are skewed towards more White and Asian students, can we expect the same outcomes for all students who participate in dual-credit courses? The predictive part of my study will help to address that question. Participation may also vary by the type of dual-credit program and my descriptive work will investigate these areas.

2.5 Definition of dual-credit success and effects at the organizational and student level

While little research exists on the broad benefits that come as a result of states' dual enrollment policies, there has been research that shows pockets of success (Chait & Venezia, 2009; Karp et al., 2007). Many researchers are looking at the effectiveness of dual-credit in promoting postsecondary enrollment and persistence, but there are a few reasons why this has been challenging. At the state level, it is often only basic statistics around program enrollment that are reported and more rigorous statistical methods have not been used. In addition, longitudinal data systems that easily and accurately link high school and postsecondary data are lacking (Karp et al., 2007). Longitudinal data systems are now more common, especially across K-12 systems, but the link from high school to college can still be an issue. With these limitations in mind, the following studies and research questions provide examples of how dual-credit success is currently defined and the results of these studies.

Dual-credit course taking and its strength as a predictor of high school graduation and college readiness are both areas of interest. Karp et al. (2007) examined the effects of dual-credit participation on high school graduation. They found a positive relationship between dual enrollment and high school graduation with students that participated in dual enrollment being 4.3 times more likely to earn a diploma than their peers (Karp et al., 2007). In another study, An (2013) examined whether student participation in dual enrollment improved their college readiness and defined college readiness, defined as not having to take remedial courses in college. He found a 13 percentage-point difference in the likelihood of taking a remedial course between those who participated in dual enrollment and those that did not, with dual enrollment participants having a lower likelihood (An, 2013). Nash (2015) also studied the relationship between concurrent enrollment course taking and the need for remediation in the first year of college. Looking at remediation is an important way to measure success as we would expect students to enter non-remedial courses if they had already taken courses for college credit while in high school.

Another measure of success is increased enrollment in postsecondary institutions. Beyond just an increase, researchers have looked at the rates of postsecondary enrollment for those who took dual-credit courses compared to those that did not. In 2015, Cowan and Goldhaber concluded that Washington students in Running Start "are more likely to attend any college immediately after high school graduation, but are no more likely to attend college full-time and are less likely to attend a four-year university" (p. 25). In 2000, Kentucky deregulated its policy on dual-credit which allowed colleges and universities to have more flexibility and provided the effective transfer of dual-credit courses to all public institutions (Welsh, Brake & Choi, 2005). This deregulation did lead to some changes in dual-credit access as there was a statistically significant increase in enrollments for black students and students of low socioeconomic status (Welsh at al., 2005).

Beyond college enrollment and readiness, many studies look at college performance, persistence and matriculation. Eimers and Mullen (2003) asked if there was a difference in first-year college GPAs and retention to a second year for students who took AP or dual-credit and those who did not. They found that "holding ability indicators constant, students entering college with AP tend to get higher first-year GPAs than those students entering college with dual-credit only or than those students entering college with no college credit" (Eimers and Mullen, 2003, p. 2). Both AP and dual-credit students returned for a second year at a higher rate than those without any college credit upon entry. A study by Ganzert (2014) around dual enrollment credit and college readiness also looked at the outcome of first-year college GPA and in addition used persistence to graduation as an outcome measure. He found that dual enrolled students had higher first-year GPAs than those not in the program and the difference was statistically significant (Ganzert, 2014). Adelman (2006) ran numerous logistic models and found that college students who had earned less than 20 credits by the end of their first year were less likely to complete their degree and suggests expansion of dual enrollment programs so students can enter higher education with at least six credits to help them reach the 20-credit line.

While the success criteria mentioned above look at dual-credit students as a single group of students and compare their outcomes to students who did not participate in dual-credit, additional measures of success disaggregate the dual-credit group and look at their access and achievement. A 2016 WSAC report showed participation rates for each of Washington's dual-credit programs and noted that enrollment was strong but also stated that it was "important to look closely at who is being served to ensure that students have equitable access to educational opportunities" (WSAC, 2016, p. 10). They went on to show that many of the programs had gaps in participation equity based on students' race. So, while Washington is meeting the goal of increasing dual-credit enrolment, there appear to be issues of disproportionality in participation rates by race.

Karp et al. (2007) also studied whether the effects of dual-credit programs varied by race/ethnicity, gender and SES. Given the data they had available, they were only able to look at some outcomes by these specific groups. In one case there was no difference by gender and in another male and low-income students benefitted more from dual enrollment participation (Karp et al., 2007). An (2013) wanted to understand if dual-credit outcomes differed by socioeconomic status and Nash (2015) was looking specifically at underrepresented students and how their participation in concurrent enrollment programs impacted several postsecondary outcomes. Acknowledging the importance of who is accessing these programs and not just the number of students accessing them is key because research shows that different student groups have vastly different postsecondary outcomes. If dual-credit programs are serving students who would have already been successful in college without them, is this the best investment for states to make?

Much of the dual-credit literature speaks to success and effects on students, but it is also important to look at the impacts on high schools and colleges. There is less information available on this topic, but Kinnick (2012) offers some insight into how these institutions think about dual-credit. College administrators saw dual-credit as a way to increase the diversity of their student body, but college faculty saw dual-credit as having a negative impact on revenue as students do not pay the same amount as a college student (Kinnick, 2012). There seem to be competing agendas at play as states push for more dual-credit participation and both high schools and colleges worry about how to allocate their limited funding. In most cases, dual enrollment causes high schools to lose FTE funds for each student that enrolls and the colleges receive less funding from the state than they would for a college student. From this standpoint, we can say that dual-credit has a negative financial effect on the organizations involved and success must be measured in a different way. At Kennesaw State in Georgia, they wanted to make the case that dual enrollment added to the quality of their institution by recruiting high-achieving students, enhancing the classroom environment and through positive impact on the school's image as a school of choice (Kinnick, 2012). Institutional quality is difficult to measure and understanding dual-credit's effects at different organizational levels is a topic that needs more exploration. With the funding of education continuing to be an issue in many states, it is vital to understand whether dual-credit programs provide the most positive outcomes for students and institutions based both on financial impact and an increased number of postsecondary certificates and degrees earned.

2.6 Popular research designs

After reviewing the literature around dual-credit, most of the research fell into three general categories. There were state reports that provided basic statistics around participation, quantitative research that used regression and ANOVA models to answer research questions, and mixed methods research. The nature of the data available lends itself to quantitative research, but it does not come without some concerns. Karp et al. (2007) speak to the lack of research with rigorous statistical methods that control for preexisting student characteristics. Another concern is that without a randomized design, positive findings may be due in part to unmeasured factors that are not accounted for in the models rather than to dual enrollment participation (Bragg & Kim, 2006; Karp et al., 2007; Kim, 2008). Additionally, variables such as college readiness and success can have several definitions and proxies that are measurable are used in quantitative models. Is remedial course taking the best proxy for college readiness or first-year college GPA as a measure of success?

Karp et al. (2007) and Eimers and Mullen (2003) both used linear and logistic regression in their research while Ganzert (2014) used "inferential statistical methods including comparisons of sample means and analysis of descriptive statistics" (p. 785). In his literature review, Allen (2010) also references several studies which use linear, logistic and multiple regression. There is an abundance of quantitative research available, but qualitative research with student voice and experience is clearly missing. Dual-credit research focuses on characteristics of students, and there is a need to incorporate survey or interview data to better understand a student's thoughts and experiences regarding dual-credit programs.

Nash (2015) used a mixed methods research design to study the relationship between students' concurrent enrollment participation and college transition, readiness and success. He initially completed qualitative research by interviewing students who participated in dual-credit programs. He was able to ask them questions about their experiences that would not be available in a quantitative dataset. From there he went on to the quantitative part of his research and used propensity score matching. A mixed methods research design is a promising way to study dual-credit programs as we can't fully understand how the programs function without "each method (qualitative and quantitative) serving as a complement to one another (Nash, 2015, p. 55).

2.7 Knowledge Gaps

Allen (2010) identifies four areas regarding dual-credit that warrant further research and I will use three of them to address the knowledge gaps I have found in the literature. The first pertains to how many and what types of students participate in dual enrollment. After reading through the literature I agree that this information is lacking, especially the latter piece on the types of students participating. In addition to who is participating, it is also important to study how their outcomes differ and there is little research available on this topic. This could include participation and outcomes by race, gender and SES or by academic achievement (test scores, GPA, course taking patterns).

Allen's second area of focus is around whether dual-credit efforts support the transition and persistence of students in postsecondary education. There are many studies that look at the relationship between dual-credit participation and these outcomes, but they do not establish a causal link. While there have been some research studies that used an experimental design, more research of this type is needed to understand if it is the dual-credit program or some other variables that haven't been controlled for that may be contributing to postsecondary success. Qualitative research also has the potential to help fill in some gaps and obtain student voice to better understand why dual-credit programs can be helpful on their path to high school graduation and beyond.

The last area of focus is on how state policies influence program structures and practices. In Washington, how might the wording of the dual-credit policy be influencing the actions taken by school districts? If the dual-credit policy was to change and AP was no longer considered to be a dual-credit program in Washington, how would school districts respond?

2.8 Significance

As a result of my research I will learn more about the dual-credit options students have available across the state and if participation in those programs predict high school graduation and college enrollment. These results will inform several knowledge gaps based on my review of the literature. The first gap is that only basic statistics at the state level have been produced for dual-credit programs in Washington. My research would provide a more nuanced picture of dual-credit access in the state and would also add a predictive model that includes each dual-credit program. This is a significant contribution given both the state's policy to increase dual-credit offerings and their findings that there are differences in student's participation based on student demographics such as ethnicity, ELL and Special Education status.

In November 2017, The College Board released a working group report about college credit in high school. This report identified four factors that are essential to strong dual-credit programs. One of the factors was around equity and access and they asked the question "Do all students have access to programs, and are efforts made to help a diverse population of students succeed?" (College Board, 2017, p. 3). Additionally, as referenced in the literature review, Allen (2010) identifies a knowledge gap around how many and what types of students participate in dual enrollment. My research will help answer these questions for the state of Washington.

Lastly, research and analysis similar to mine has already taken place in Illinois and Texas (Lichtenberger, Witt, Blankenberger & Franklin, 2014; Miller et al., 2017). My research would add to the body of state level dual-credit research available and allow us to understand if our state dual-credit access and outcomes are the same or different from other states. This could lead additional states to undertake similar research and allow for a more complete picture of dual-credit across the country as it continues to gain popularity.

Chapter 3: Research Design and Methodology

3.1 Conceptual Framework

Based on a review of the dual-credit program literature, a theory of action for investing in dual-credit programs can be defined as follows: If students take dual-credit courses, they will be more likely to attend and finish college because they have had exposure to the expectation of college courses and may start postsecondary education having already accrued college credits.

This general theory of action leaves out important details around dual-credit, such as how the various programs differ and who is accessing the programs. Many of the programs have a cost associated with them, which can create barriers for low-income students. In addition, many of the programs have placement test requirements to be eligible. Increased academic rigor in high school is considered a central policy tool to increase college preparation (Chait & Venezia, 2009). If a student isn't prepared for the rigor of college courses in their early high school years, current dual-credit programs are unlikely to be a worthwhile endeavor for many students. These are important details to keep in mind as we think about how outcomes may differ for students accessing dual-credit programs.

The conceptual framework I have developed to guide my study draws from Charles Hirschman's College Pathways Model (2016). A visual of the model is provided in Figure 1 below:

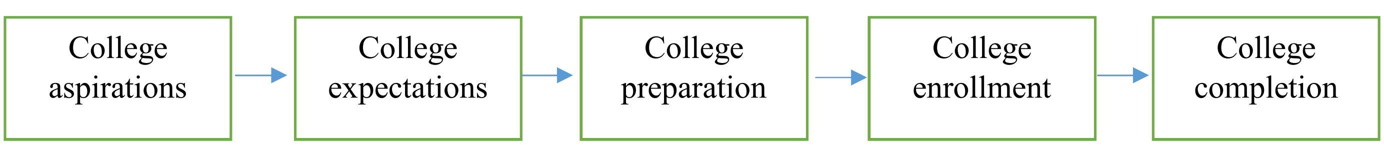


Figure 1. College Pathways Model

This model identifies the five key steps that lead to college enrollment and completion and the simplified version of the model assumes that students move sequentially through the five steps leading to college graduation (Hirschman, 2016). Dual-credit programs can fall into the college preparation step in the model, but it is also important to understand students' aspirations and expectations that lead them to enroll in dual-credit programs. Research shows that students from underrepresented groups aspire to attend college at the same levels as their white peers, but there are discrepancies between their aspirations and their expectations to attend college (Nash, 2015). I use Hirschman's model to conceptualize the outcomes in my conceptual framework and I drew upon my review of the literature on dual-credit programs to identify the key factors that influence college success. Figure 2 offers a visual representation of my conceptual framework around dual-credit programs.

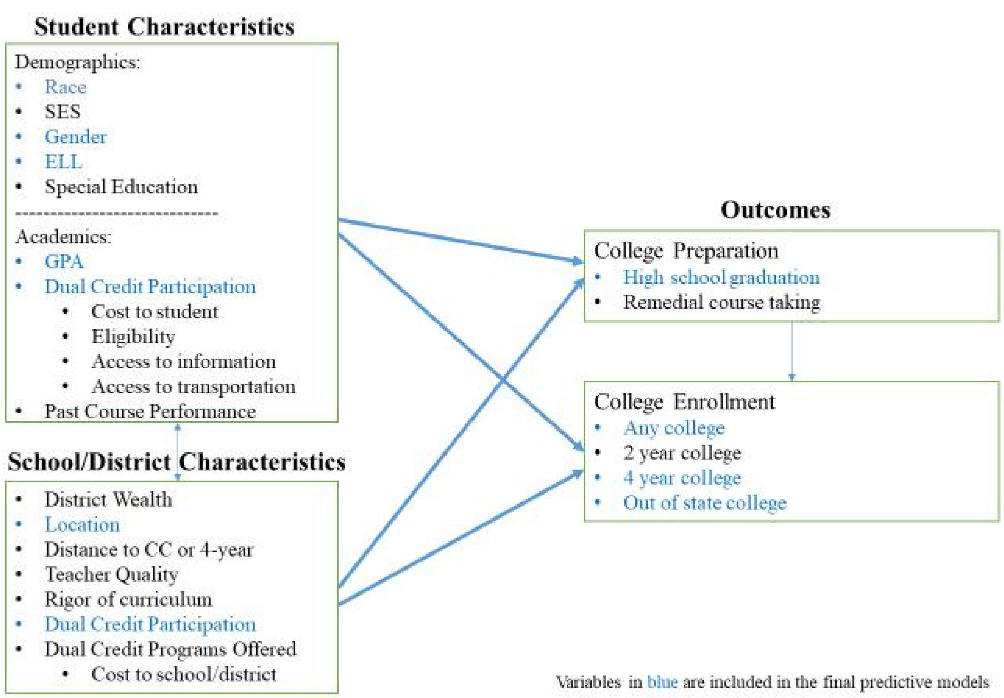


Figure 2. Factors That Influence College Outcomes

This framework includes many of the factors that play a role in whether or not a student will enroll in a dual-credit course. Some of these are discussed above and cost can be a factor for both the student and/or the district, depending on the funding strategy for the program. Some families are more aware of the different dual-credit options based on their social networks and school involvement and are able to advocate for their student's participation in the program. Other students may have a counselor or other member of the school staff that recommends enrollment in a dual-credit program. Certain dual-credit programs require students to travel to a college campus to take a course. In this case, not all students have the monetary resources to commute, and public transportation may not be readily available. Other students may live in rural areas where proximity to a postsecondary institution is an issue. Some students may not aspire to go to college and think that dual-credit programs are not something they stand to benefit from. All of these factors can influence who participates in dual-credit and what programs they participate in.

In addition to enrollment in a dual-credit program, there are other factors that may impact whether students are successful and go on to enroll in and complete college. There are demographic variables such as race, SES, ELL status and Special Education status that can influence a student's high school and college outcomes. There are also variables around how well-prepared students were for the challenge of dual-credit courses based on prior course performance and the quality of the dual-credit course taken. While it is possible to determine that students who take dual-credit have higher rates of college enrollment and completion, I can't say that dual-credit participation that causes those outcomes, as I will not be using a causal model.

The factors that enable groups of students to access and participate in dual-credit programs must be investigated before looking at their success and impact on college enrollment and completion. In my study, I will focus on school/district demographics, dual-credit offerings, student demographics, and dual-credit participation to investigate if these variables predict high school graduation and college enrollment. It is important to note that this approach does not include variables related to teacher and curriculum quality, student supports, and college completion. These are examples of areas for future research.

3.2 Methods

In order to answer my research questions, I conducted a quantitative study using state databases for the high school graduating class of 2015 which includes data from the 2012-2013 to 2014-2015 school years. The data for the 2012-2013 and 2013-2014 school years allow for a nearly complete dual-credit course history for each student as most dual-credit options begin in a student's junior year. I begin with a descriptive analysis to understand the differences that exist in dual-credit options and the factors that contribute to these differences by district, school, and student characteristics. I then conduct predictive statistical analyses using Hierarchical Linear Modeling (HLM) to discover if different types of dual-credit course enrollment predict high school graduation and college enrollment.

3.3 Sample

All data was obtained from the Education Research & Data Center (ERDC), based in Olympia, Washington. ERDC compiles data about students as they move through school and into the workforce in order to maintain a longitudinal data system. The source of high school data for this study is OSPI's Comprehensive Education Data and Research System (CEDARS) and postsecondary data comes from several sources which include: Public Centralized Higher Education Enrollment System (PCHEES), State Board for Community and Technical Colleges (SBCTC), and National Student Clearinghouse. ERDC has a formal data request process that allows researchers to obtain the data they need to answer their research questions. A formal request was submitted to ERDC in December 2017 for the data to be used in this study. As part of the data request process, this study was determined to be exempt by the Washington State Institutional Review Board. In March 2018, permission was given for ERDC to provide student level de-identified data files.

For this study, data is from the state of Washington, which has 295 districts and 1.1 million students. The sample consists of students from high schools across the state who graduated in the 2014-2015 school year. The statewide 4-year graduation rate for the class of 2015 was 78.1% and 60% of the graduates went on to enroll in a postsecondary institution (OSPI, 2019). The graduation rates for White and Asian students in the class of 2015 were 81% and 88%, respectively, while graduations rates for Hispanic and Black students were 68% and 70%, respectively.

Across the state, there are six types of dual-credit courses: AP, Cambridge, College in the High School, IB, Running Start and Tech Prep. Using state-level data allows for an analysis of specific program access and effectiveness, as well as comparisons in access to programs at regional, district, and school levels.

3.4 Data Analysis Strategy

To answer the first question regarding potential differences that exist in dual-credit options for students across the state of Washington, a descriptive approach was taken. SPSS was used to calculate basic statistics. Through this analysis, I can understand which types of students have access to one or more dual-credit options, and which can inform questions of equity of opportunity. This is important given the variation in dual-credit options across the state. While students in Running Start have the potential to earn an Associates Degree, students in AP and IB must pass a test to earn college credit and depending on which college they attend, the amount of credit earned can look different. Tech Prep leads to college credit that is more aligned to professional-technical careers. While we might see equity of opportunity to participate in dual-credit courses in general, different students may be accessing different courses and experiencing different high school and college outcomes.

The second research question has two outcomes. The first is college enrollment, defined as: did a student enroll in college the first year after graduating high school? The second is high school graduation, defined as: did a student graduate from high school during the 2014-15 school year? These outcomes will be predicted by district and student-level variables. Multilevel modeling will be used for testing the second research question. Compared with traditional unilevel models (eg., multiple logistic regression), this more complex analysis method accounts for dependencies among students within schools (Raudenbush & Bryk, 2002). For these analyses, three-level models will be used where students comprise the level 1 units, schools are the level 2 units and districts are the level 3 units. HLM will be employed to estimate the models.

3.5 Measures

In the discussion of my conceptual framework I referenced variables related to school and district characteristics, dual-credit offerings, student demographics, dual-credit participation, high school graduation, and college enrollment. Based on the data from ERDC, the list below contains variables which will be used in my descriptive analyses and predictive models.

High School Graduation is a variable that indicates if a student graduated from high school in the 2014-15 school year. Graduates are coded as a 1 and non-graduates are coded as 0.

Students who were confirmed transfers or deceased are not included in this variable. This variable includes late graduates in addition to on-time graduates (4 years to graduate).

College Enrollment indicates high school graduates that enrolled in any postsecondary institution within the first year of graduating high school. This binary variable codes graduates as a 1 if they enrolled in any college and 0 if they did not.

Four-Year College Enrollment indicates college students that enrolled in any four-year postsecondary institution within the first year of graduating high school. This binary variable codes a student as 1 if they enrolled in any four-year college and 0 if they did not.

Four-Year Out-of-State College Enrollment indicates four-year college students that enrolled in an out-of-state postsecondary institution within the first year of graduating high school. This binary variable codes a student as 1 if they enrolled in an out of state college and 0 if they did not.

Gender is a binary variable where males are coded as 1 and females are coded as 0.

Underrepresented Minority (URM) original data consisted of seven race categories (American Indian, Asian, Black, Hispanic, Pacific Islander, Two or more races and White). For the predictive analysis this has been converted to a binary variable with American Indian, Black, Hispanic, Pacific Islander and Two or more races comprising the URM group (coded as 1) and Asian and White students comprising the non-minority group (coded as 0). The decision was made to create a single binary variable as opposed to multiple dummy-coded variables to limit the number of predictors entered into the model. These two categories were chosen based on prior research that shows Asian students are more similar to White students on measures of academic performance.

Poverty Status (FRL) uses free or reduced lunch status as a proxy for poverty. This is a binary variable where students who received free or reduced lunch are coded as 1 and those that did not are coded as 0.

English Language Learner (ELL) is a binary variable where students who were a part of the ELL program in the 2014-2015 school year are coded as 1 and those not in the program are coded as 0.

Special Education (SPED) is a binary variable where students who receive Special Education services are coded as 1 and those not receiving services are coded as 0.

GPA is calculated using students' grades across their entire high school experience. This is a continuous variable that ranges from 0 to 4.0.

Took Running Start is a binary variable with students who take at least one Running Start course coded as 1 and those that did not coded as 0.

Took AP is a binary variable with students who take at least one AP course coded as 1 and those that did not coded as 0.

Took IB is a binary variable with students who take at least one IB course coded as 1 and those that did not coded as 0.

Took College in the High School is a binary variable with students who take at least one College in the High School course coded as 1 and those that did not coded as 0.

Took Cambridge is a binary variable with students who take at least one Cambridge course coded as 1 and those that did not coded as 0.

Took Tech Prep is a binary variable with students who take at least one Tech Prep course coded as 1 and those that did not coded as 0.

The dual-credit program variables described above are used in the predictive analysis. Additional dual-credit variables were included in the descriptive analysis. These variables included credits attempted and earned for each dual-credit program as well as an any dual-credit variable to understand how many students were participating in dual-credit in any capacity. A variable was also created to analyze how many dual-credit programs a student participated in.

School Poverty is a continuous school-level variable representing the percentage of students eligible for free or reduced lunch at a given school. This variable can range from 0% to 100%.

School Dual-Credit Participation is a continuous school-level variable representing the percent of students who took at least one dual-credit course in a given school year. This variable includes students in grades 9-12 and can range from 0% to100%.

District Wealth is a continuous district-level variable representing the district's fiscal capacity to raise local revenue from the local property tax. The metric used in Washington state is known as the 14% levy rate. It is computational tax rate that is used to compare the wealth capacity of the district to the state average. It is also the measure used to determine if a district will receive additional state funding to compensate for their relatively lower property values.

District Region is a district-level categorical variable. Districts will be coded by their Educational Service District (ESD). There are nine ESDs in the state of Washington and for the predictive analysis there will be eight dummy coded variables with the largest ESD serving as the reference group.

District Size is a district-level categorical variable. Districts have been coded by size from less than 100 students to more than 20000 students. This variable has eight categories.

3.6 Data Cleaning

The 2014-15 student file from ERDC contained all students enrolled in a public Washington high school that year. As a first step, this file was filtered to only include grade 12 students. This file also contained duplicates if a student was enrolled in more than one school in the 2014-15 school year. Duplicates were removed by only keeping the record for the last school a student was enrolled in.

The decision was also made to remove Tribal schools and Lake Washington Tech from the sample. These schools have different reporting structures and function differently than the other schools in our sample. After removing duplicates and these schools, the remaining sample has 91,361 12th grade students.

Chapter 4: Descriptive Analysis Results

4.1 Overall Sample

The total sample for this study represents 249 of the 296 Washington state school districts with students enrolled in the 2014-15 school year. Districts not represented include tribal districts, K-8 districts and elementary only districts. Out of the 249 districts in the sample, 116 have only one high school and the largest school district has 18 high schools. The ethnic breakdown of the sample of students is 60% White, 19% Hispanic/Latino, 7% Asian, 6% Two or More Races, 5% Black/African American, 2% American Indian and 1% Native Hawaiian/Pacific Islander. There are five students in the sample whose ethnicity information is not provided. The sample is 52% male and 43% qualify for free or reduced-price lunch. Program data is also available for the students in our sample and 11% receive Special Education services while 4% qualify as English Language Learners (ELLs). Lastly, the average GPA for the sample is 2.64. However, there is missing data for this variable, with 3,388 students having no GPA information provided. This data and corresponding sample sizes can be found in Table 1 below.

Table 1. *Demographics for Overall Sample*

Characteristic	Overall Sample n = 91361	
	N	%
Male	47191	52%
ELL	3250	4%
SPED	10414	11%
FRL	39507	43%
American Indian	1467	2%
Asian	6799	7%
Black	4698	5%
Hispanic	17288	19%
Pacific Islander	866	1%
Two or More Races	5288	6%
White	54950	60%
Average GPA	87973	2.64

All nine Educational Service Districts (ESDs) are represented in the sample and district sizes range from less than 100 students to over 20,000 students. A state map with the nine ESDs is available in Figure 3.

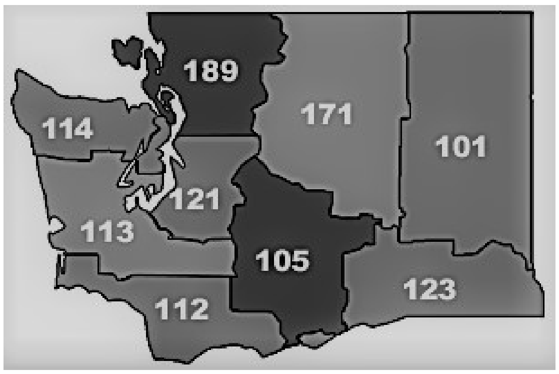


Figure 3. ESD Map

The smallest ESD is 171 and it accounts for 4% of the sample, while the largest ESD is 121 and makes up 36% of the sample. In addition to varying in size, the ESDs also vary in their demographic composition. The percentage of students eligible for free or reduced lunch ranges from 37% to 67%. ESD 105 is 61% Hispanic and ESD 101 is 79% White. And while 10% of students in ESD 121 are Black, only 1% to 3% of students in the other eight ESDs are Black. A full breakdown of demographics by ESD can be found in Table 2.

Table 2. *Demographics by ESD*

Characteristic	ESD 101		ESD 105		ESD 112		ESD 113		ESD 114		ESD 121		ESD 123		ESD 171		ESD 189	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
	7877	9%	5115	6%	8899	10%	6220	7%	5168	6%	33102	36%	6103	7%	3603	4%	15274	17%
Male	4106	52%	2582	51%	4557	51%	3248	52%	2558	50%	17202	52%	3171	52%	1853	51%	7914	52%
ELL	104	1%	483	9%	182	2%	99	2%	54	1%	1324	4%	382	6%	189	5%	433	3%
SPED	886	11%	476	9%	897	10%	835	13%	698	14%	3752	11%	745	12%	298	8%	1827	12%
FRL	3534	45%	3424	67%	3828	43%	2849	46%	2323	45%	12705	38%	3181	52%	1995	55%	5668	37%
American Indian	172	2%	185	4%	100	1%	144	2%	97	2%	384	1%	36	1%	114	3%	235	2%
Asian	147	2%	43	1%	337	4%	254	4%	204	4%	4594	14%	109	2%	31	1%	1080	7%
Black	137	2%	29	1%	220	3%	191	3%	159	3%	3308	10%	118	2%	30	1%	506	3%
Hispanic	569	7%	3112	61%	1238	14%	832	13%	542	11%	4699	14%	2352	39%	1494	42%	2450	16%
Pacific Islander	41	1%	5	0.1%	90	1%	41	1%	54	1%	514	2%	10	0.2%	4	0.1%	107	1%
Two or More Races	568	7%	92	2%	501	6%	430	7%	586	11%	2149	7%	126	2%	68	2%	768	5%
White	6243	79%	1649	32%	6413	72%	4327	70%	3525	68%	17454	53%	3352	55%	1862	52%	10125	66%

Given the varying sizes of the ESDs, a variable was created to collapse the nine ESDs into three regions in order to have a higher-level understanding of where the sample is located across the state. These three regions are Puget Sound ESD (PSESD), Western Washington (all districts other than PSESD that are located west of the Cascade Mountains) and Eastern Washington (all districts located east of the Cascade Mountains). Using this variable, 36% of the sample of students are from PSESD, 39% are from Western Washington and the remaining 25% are from Eastern Washington. While Eastern Washington only has 25% of the sample, they represent 113 school districts, which is 45% of the districts in my sample. And PSESD with 36% of the sample only serves 33 districts. Additional information can be found in Table 3.

Table 3. *Sample by Region*

Characteristic	Overall Sample n = 91361		
	N	*%*	*# School Districts*
Eastern Washington	22698	25%	113
PSESD	33102	36%	33
Western Washington	35561	39%	103

4.2 Dual-Credit Overall

Across the total sample, 76% of students participated in at least one dual-credit program. This means that nearly a quarter of students who were seniors in the 2014-15 school year did not participate in any dual-credit courses during their time in high school. Of the 76% of students participating, 42% participated in only one dual-credit program and 26% participated in two programs. Additional information is available in Table 4. For the students that participated in two dual-credit programs, 77% of them had Tech Prep as one of their programs.

Table 4. *Dual-Credit Participation*

Characteristic	Overall Sample n = 91361	
	N	%
No DC	21535	24%
1 DC Program	38656	42%
2 DC Programs	23974	26%
3 DC Programs	6576	7%
4 DC Programs	619	1%
5 DC Programs	1	0%

Note. DC is an abbreviation for dual-credit

In the sections that follow, each dual-credit program will be analyzed in detail. This analysis includes results based on student demographics as well as regional results.

4.3 Tech Prep Analysis

Of the total sample, 54% of students took at least one Tech Prep course[1]. These students represent 205 districts, with the remaining 44 districts having no students taking a Tech Prep course. Figure 4 provides a visual representation of where these 205 districts are located. Of all students in the sample, 27% took only Tech Prep dual-credit courses, which was the largest percentage for students taking a single dual-credit type. Most students attempted anywhere between 0.5 and 12.5 credits, while 1.1% of the sample attempted fewer than 0.5 credits. Students earned between 0 and 12.5 high school credits from Tech Prep courses. There are 2476 students, 5% of the sample, who attempted a Tech Prep course and did not earn any credits.

[1] Students in Washington must complete one credit in Career and Technical Education (CTE) to graduate high school and many of these CTE courses are also flagged as Tech Prep courses.

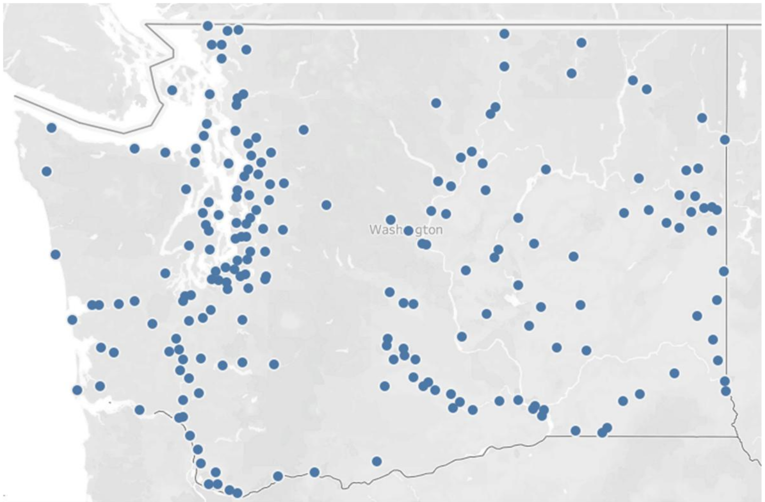


Figure 4. Map of Districts With Students Participating in Tech Prep

The ethnic breakdown of the Tech Prep sample compared to the overall sample can be found in Table 5. The ethnic breakdown is similar to the overall sample and no group is over or underrepresented by more than 1%.

Table 5. *Demographics for Overall Sample and Tech Prep*

Characteristic	Overall Sample n = 91361		TechPrep n = 49278 54%	
	N	*%*	*N*	*%*
Male	47191	52%	26238	53%
ELL	3250	4%	1815	4%
SPED	10414	11%	5403	11%
FRL	39507	43%	21435	43%
American Indian	1467	2%	648	1%
Asian	6799	7%	4063	8%
Black	4698	5%	2817	6%
Hispanic	17288	19%	9197	19%
Pacific Islander	866	1%	521	1%
Two or More Races	5288	6%	3027	6%
White	54950	60%	29003	59%
Average GPA	87973	2.64	48740	2.63

The sample is 53% male which is almost the same as the overall sample of 52% male. Of those that participate in Tech Prep, 43% qualify for free or reduced-price lunch, which is the same as the overall sample. Students who qualify for Special Education or ELL services are also represented at the same percentages as the overall sample. The average GPA for this group of students is 2.63, and it is 2.64 for the overall sample. In terms of demographics, students taking Tech Prep courses are almost identical to all students in the sample.

All nine of the ESDs are represented in the Tech Prep sample and just over 90% of these students are from districts with 3000 or more students. Of this sample, 45% of students are from PSESD, which is higher than the 36% of students in the total sample from PSESD. The smallest percentage of Tech Prep students come from ESD 105, with the next lowest number of students coming from ESD 171. While the Eastern Washington region was the smallest in the total sample at 25%, the region comprises an even smaller percentage of Tech Prep students, making up 21% of the sample. When the data is analyzed by the percentage of students from each ESD that participate in Tech Prep, results on the high-end show that 66% of students from PSESD participate in Tech Prep with ESDs 123 and 114 close behind at 63% and 61% respectively. However, only 34% of students from ESD 105 participate in Tech Prep[2].

4.4 Advanced Placement Analysis

Of the total sample, 32% of students took at least one Advanced Placement (AP) course. These students represent 196 districts, with the remaining 53 districts having no students taking an AP course. Figure 5 below shows where the 196 districts are located across the state. Of all students in the sample, 8% took only AP dual-credit courses. Almost all students attempted

[2] Summary descriptive statistics for participation rates in all dual-credit programs by ESD are provided in Table 14, which appears later in this section.

anywhere between 0.5 and 19 credits, while 0.2% of the sample attempted fewer than 0.5 credits. To break this down further, 37% of students attempted one credit or less, 34% attempted one to three credits, 16% attempted three to five credits and 13% attempted more than five credits. Students earned between 0 and 19 high school credits from AP courses. There are 1056 students, 3.6% of the sample, who attempted AP credit and did not earn any credits.

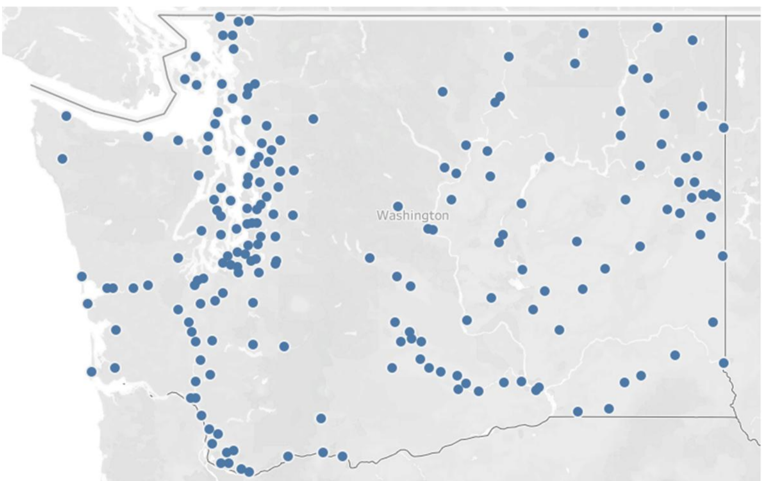


Figure 5. Map of Districts With Students Participating in AP

The ethnic breakdown of the AP sample can be found in Table 6. White and Asian students are overrepresented compared to the overall sample and Black and Hispanic students are underrepresented. The sample is 54% female which differs from our overall sample which is 48% female. Of those that participate in AP, 30% qualify for free or reduced-price lunch, which is much lower than the overall sample at 43%. Students who qualify for Special Education or ELL services are largely underrepresented at 2% and 1% respectively. The average GPA for this group of students is 3.17, which is the highest of all the dual-credit types in this analysis.

Table 6. *Demographics for Overall Sample and AP*

Characteristic	Overall Sample n = 91361		AP n = 29529	32%
	N	*%*	*N*	*%*
Male	47191	52%	13496	46%
ELL	3250	4%	351	1%
SPED	10414	11%	551	2%
FRL	39507	43%	8799	30%
American Indian	1467	2%	219	1%
Asian	6799	7%	3680	13%
Black	4698	5%	1251	4%
Hispanic	17288	19%	3789	13%
Pacific Islander	866	1%	253	1%
Two or More Races	5288	6%	1859	6%
White	54950	60%	18478	63%
Average GPA	87973	2.64	29433	3.17

All nine of the ESDs are represented in the AP sample and over 80% of these students are from districts with 5000 or more students. Of this sample, 46% of students are from PSESD, which is higher than the 36% of students in the total sample from PSESD. The smallest percentage of AP students come from ESD 171, with the next lowest number of students coming from ESD 105. While the Eastern Washington region was the smallest in the total sample at 25%, the region comprises an even smaller percentage of AP students, making up 19% of the sample. When the data is analyzed by the percentage of students from each ESD that participate in AP, results on the high-end show that 41% of students from PSESD participate in AP while on the low-end 15% of students from ESD 105 participate.

4.5 Running Start Analysis

Of the total sample, 18% of students took at least one Running Start course. These students represent 232 districts, which means there were only 17 districts where no students participated in Running Start. These 17 districts were split almost equally across Eastern and

Western Washington, with 8 belonging to Western Washington ESDs and 9 from Eastern Washington ESDs. All PSESD districts in the total sample are represented in the Running Start sample. Figure 6 provides a map with the locations of the 232 districts with students participating in Running Start. Students took anywhere between 1 and 33 courses and earned between 0 and 146 college credits. Of the 16,766 students that participated in Running Start, there are669 students who took at least one Running Start course and did not earn any credits. This subset of students will be discussed in greater detail later in this section.

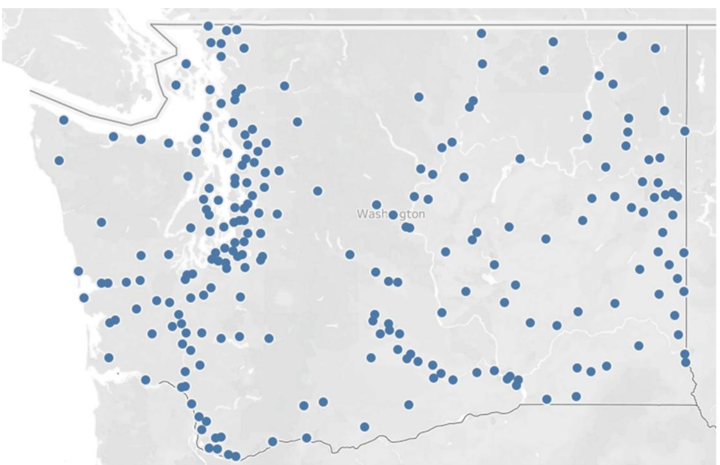


Figure 6. Map of Districts With Students Participating in Running Start

Each of the nine ESDs is represented in the Running Start sample and students come from districts with less than 100 students to over 20,000 students. Of this sample, 33% of students are from PSESD, which is comparable to the 36% of students in the total sample from PSESD. The smallest percentage of Running Start students come from ESD 114, but they are not the smallest percentage of students in the overall sample which means that ESD 114 is underrepresented in Running Start. While the Eastern Washington region was the smallest in the total sample at 25%, the region comprises 32% of the Running Start sample. When the data is analyzed by the percentage of students from each ESD that participate in Running Start, results show that 28% of students from ESD 101 participate in Running Start while 17% of students from PSESD participate. This could be related to the number of dual-credit options available and will be explored further.

The ethnic breakdown of the Running Start sample is 69% White, 14% Hispanic/Latino, 8% Asian, 5% Two or More Races, 3% Black/African American, 1% American Indian and 0.3% Native Hawaiian/Pacific Islander. Compared to the total sample, White students are overrepresented. Furthermore, the sample is 59% female which differs from our total sample which is 48% female. Of those that participate in Running Start, 31% qualify for free or reduced-price lunch, which is lower than the total sample of 43%. Students who qualify for Special Education or ELL services each comprise 1% of the sample and are largely underrepresented. Lastly, the average GPA for this group of students is 3.08. These demographics can also be found in Table 7 below.

Table 7. *Demographics for Overall Sample and Running Start*

Characteristic	Overall Sample n = 91361		RS n = 16766	18%
	N	*%*	*N*	*%*
Male	47191	52%	6905	41%
ELL	3250	4%	90	1%
SPED	10414	11%	215	1%
FRL	39507	43%	5244	31%
American Indian	1467	2%	141	1%
Asian	6799	7%	1344	8%
Black	4698	5%	465	3%
Hispanic	17288	19%	2266	14%
Pacific Islander	866	1%	52	0%
Two or More Races	5288	6%	872	5%
White	54950	60%	11626	69%
Average GPA	87973	2.64	16097	3.08

While examining the number of courses Running Start students took, there were two numbers of interest. There were spikes at 9 courses, accounting for 6% of the sample and 18 courses, accounting for 7% of the sample. These were the most frequent number of courses taken after one and two courses, which make up 20% of the Running Start students. We can roughly infer that these students are participating in Running Start full time for one or two years if on average they took 3 courses a quarter. This group of students, who are heavy consumers of Running Start were analyzed in further detail to understand if they differ from the overall group of students who participate in Running Start. Of the students taking 9 or more courses, the sample is 61% female and 72% White. They have an GPA of 3.16 and 28% qualify for free or reduced-price lunch. The students taking 18 or more courses looks very similar to the group of students taking 9 or more courses. These students are 61% female, 74% White, have an average GPA of 3.31 and 26% qualify for free or reduced-price lunch. For both groups, the largest number of students are from PSESD, but the next largest ESD differs. For those taking 9 or more courses, ESD 189 in Northwest Washington has the second largest number of students while ESD 112 in Southwest Washington has the second largest number for those taking 18 or more courses. Heavy consumers of Running Start are more likely to live in Western Washington as they make up over half the sample for both the 9 and 18 course groups. This could be due to proximity to a postsecondary institution and will be further explored.

As indicated earlier, there is a group of 669 students who took at least one Running Start course and did not earn any credit. This group of students is more diverse than the overall Running Start sample with an ethnic breakdown of 61% White, 23% Hispanic/Latino, 5% Asian, 5% Two or More Races, 4% Black/African American, 2% American Indian and 0.3% Native Hawaiian/Pacific Islander. This group is 54% female and 46% qualify for free or reduced-price meals, which is slightly higher than the total sample. The average GPA for this group of students is 2.21 which is much lower than the overall Running Start sample. When looking at this sample by district, the highest number of students came from Seattle, Bellingham and Pasco, making up for 14.6% of students earning no credit. This sample of students looks much different from all students taking Running Start and implications for participating in the program but not earning credit will be discussed later on.

4.6 College in the High School Analysis

Of the total sample, 10% of students took at least one College in the High School (CHS) course. These students represent 138 districts, with the remaining 111 districts having no students taking a CHS course. Figure 7 shows the 138 districts with students participating in CHS. There are many districts in the Puget Sound region with CHS while the program appears to be sparser across the rest of the state. Of all students in the sample, only 1% took only CHS dual-credit courses. Most students attempted anywhere between 0.5 and 8 credits, while 37 students attempted fewer than 0.5 credits. Students earned between 0 and 8 high school credits from CHS courses and 4% of the sample did not earn any credits.

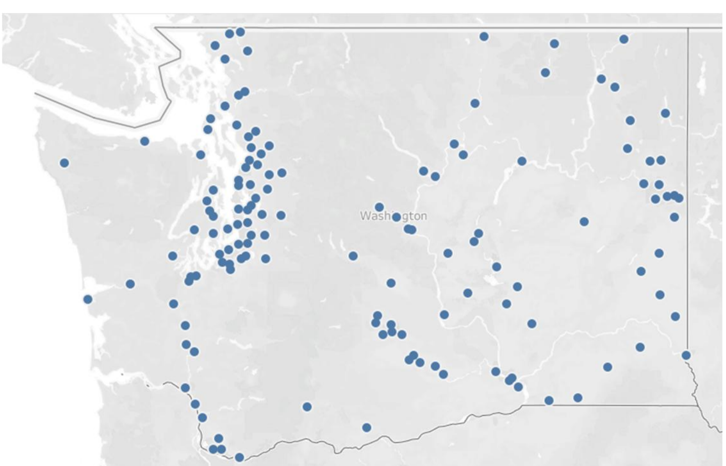


Figure 7. Map of Districts With Students Participating in College in the High School

The ethnic breakdown of the CHS sample can be found in Table 8. Similar to the AP sample, White and Asian students are overrepresented and Hispanic students are underrepresented. The sample is 54% female which differs from our total sample which is 48% female. Of those that participate in CHS, 26% qualify for free or reduced-price lunch, which is the lowest of any of the dual-credit samples. Students who qualify for Special Education or ELL services are largely underrepresented at 2% and 1% respectively. The average GPA for this group of students is 3.15, which is higher than the overall sample GPA of 2.64.

Table 8. *Demographics for Overall Sample and CHS*

Characteristic	Overall Sample n = 91361		CHS n = 9202	10%
	N	*%*	*N*	*%*
Male	47191	52%	4220	46%
ELL	3250	4%	98	1%
SPED	10414	11%	191	2%
FRL	39507	43%	2404	26%
American Indian	1467	2%	79	1%
Asian	6799	7%	1037	11%
Black	4698	5%	229	3%
Hispanic	17288	19%	1281	14%
Pacific Islander	866	1%	56	1%
Two or More Races	5288	6%	467	5%
White	54950	60%	6053	66%
Average GPA	87973	2.64	8985	3.15

All nine of the ESDs are represented in the CHS sample and 85% of these students are from districts with 3000 or more students. Of this sample, 42% of students are from Western Washington, which is higher than the 39% of students in the total sample from Western Washington. The smallest percentage of CHS students come from ESD 112, with the next lowest number of students coming from ESD 113. While the Eastern Washington region was the smallest in the total sample at 25%, the region comprises an even smaller percentage of CHS students, making up 21% of the sample. When the data is analyzed by the percentage of students from each ESD that participate in CHS, results on the high-end show that 22% of students from ESD 189 participate in CHS. On the low-end 1% of students from ESD 112 participate and PSESD falls in the middle at 10%.

4.7 International Baccalaureate Analysis

Of the total sample, 4% of students took at least one International Baccalaureate (IB) course. These students represent 33 of the 249 districts in the overall sample. Figure 8 provides a visual representation of these 33 districts, which are concentrated in the Puget Sound region. Of all students in the sample, 1% took only IB dual-credit courses. Students attempted anywhere between 0.5 and 21.5 credits and earned between 0 and 21.5 high school credits from IB courses. There are 140 students, 4% of the sample, that did not earn any credits.

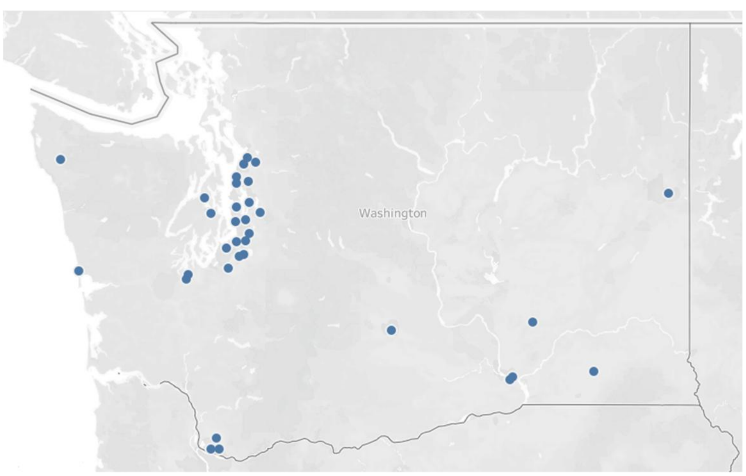


Figure 8. Map of Districts With Students Participating in IB

The ethnic breakdown of the IB sample can be found in Table 9. Different from any of the other samples, Asian and Black students are overrepresented and White students are underrepresented. This could be due to the locations of IB programs and a list of programs in

Washington can be found in Appendix A. The sample is 51% female which differs slightly from our total sample which is 48% female. Of those that participate in IB, 35% qualify for free or reduced-price lunch, which is lower than the overall sample. Students who qualify for Special Education services are largely underrepresented and students who receive ELL services are represented at a similar percentage to the overall sample. The average GPA for this group of students is 3.06, which is higher than the overall sample GPA of 2.64.

Table 9. *Demographics for Overall Sample and IB*

Characteristic	Overall Sample n = 91361		IB n = 3699	4%
	N	*%*	*N*	*%*
Male	47191	52%	1822	49%
ELL	3250	4%	97	3%
SPED	10414	11%	94	3%
FRL	39507	43%	1311	35%
American Indian	1467	2%	19	1%
Asian	6799	7%	729	20%
Black	4698	5%	300	8%
Hispanic	17288	19%	625	17%
Pacific Islander	866	1%	44	1%
Two or More Races	5288	6%	238	6%
White	54950	60%	1744	47%
Average GPA	87973	2.64	3696	3.06

Six of the nine of the ESDs are represented in the IB sample and while there are two ESDs that have a few students with IB credit, this is due to transfer credit and not earned in those ESDs. Of the IB sample, 89% of students are from districts with 10000 or more students. As indicated earlier, there is significant cost associated with IB and this could be a reason we see the program in larger districts. PSESD makes up 76% of this sample, which is more than twice as high as the 36% of students in the total sample from PSESD. The smallest percentage of IB students come from ESD 105, with the next lowest number of students coming from ESD 123.

While the Eastern Washington region was the smallest in the total sample at 25%, the region comprises an even smaller percentage of IB students, making up 7% of the sample. When the data is analyzed by the percentage of students from each ESD that participate in IB, results on the high-end show that 8% of students from PSESD participate in IB. On the low-end 1% of students from ESD 189 participate and ESDs 105, 112 and 123 all have participation rates of 2%.

4.8 Cambridge Analysis

Of the total sample, less than 1% of students took at least one Cambridge course. These students represent 7 of the 249 districts in the overall sample and 0.1% took only Cambridge dual-credit courses. Figure 9 offers a visual representation on these 7 districts which are all located in the greater Puget Sound region, Students attempted anywhere between 0.25 and 16 credits and earned between 0 and 16 high school credits from Cambridge courses. There are 26 students, 8% of the sample, that did not earn any credits.

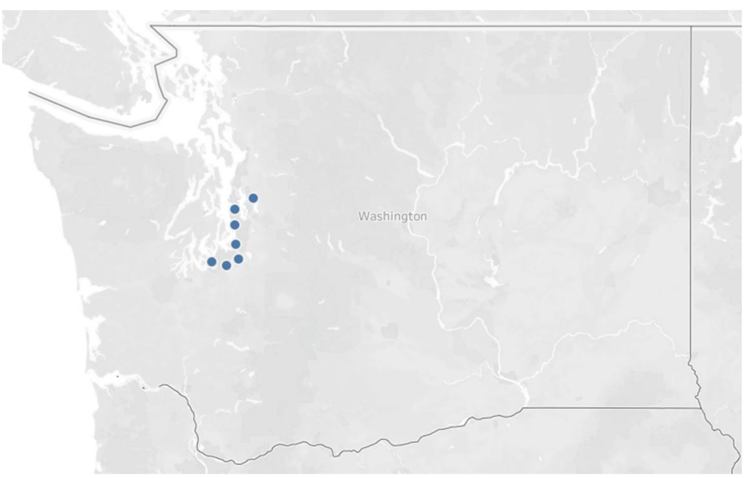


Figure 9. Map of Districts With Students Participating in Cambridge

The ethnic breakdown of the Cambridge sample can be found in Table 10. White students are underrepresented as they make up 32% of the sample and all races aside from

American Indian are overrepresented. This could be due to the locations of these programs as well as the small sample size. The sample is 52% female which differs from our overall sample which is 48% female. Of those that participate in Cambridge, 56% qualify for free or reduced-price lunch, which is much higher than the overall sample. Students who qualify for Special Education services are largely underrepresented and students who receive ELL services are represented at a similar percentage to the overall sample. The average GPA for this group of students is 2.90, which is lowest of the dual-credit programs after Tech Prep.

Table 10. *Demographics for Overall Sample and Cambridge*

Characteristic	Overall Sample n = 91361		Cambridge n = 339	0.4%
	N	*%*	*N*	*%*
Male	47191	52%	164	48%
ELL	3250	4%	10	3%
SPED	10414	11%	9	3%
FRL	39507	43%	190	56%
American Indian	1467	2%	1	0%
Asian	6799	7%	51	15%
Black	4698	5%	55	16%
Hispanic	17288	19%	69	20%
Pacific Islander	866	1%	29	9%
Two or More Races	5288	6%	26	8%
White	54950	60%	108	32%
Average GPA	87973	2.64	339	2.90

Only PSESD is represented in the Cambridge sample and 99% of students are from districts with 20000 or more students. When the data is analyzed by the percentage of students from each ESD that participate in Cambridge, results show that 1% of students from PSESD participate.

4.9 Any Dual-Credit Analysis

As stated earlier, 76% of students took at least one dual-credit course. These students participated in one to four dual-credit types and 26% of students participated in at least two different dual-credit programs. There are 243 districts with students participating in dual-credit and the demographic breakdown is similar to the overall sample. A complete breakdown of demographics is available in Table 11. There are six districts with no students participating in dual-credit and they represent small districts in Eastern and Western Washington. The average GPA for dual-credit students is 2.78, which is higher than the overall sample GPA of 2.64.

Table 11. *Demographics for Overall Sample and Any DC*

Characteristic	Overall Sample n = 91361		Any DC n = 69826	76%
	N	*%*	*N*	*%*
Male	47191	52%	35251	51%
ELL	3250	4%	2022	3%
SPED	10414	11%	5807	8%
FRL	39507	43%	27558	39%
American Indian	1467	2%	848	1%
Asian	6799	7%	6009	9%
Black	4698	5%	341	5%
Hispanic	17288	19%	11873	17%
Pacific Islander	866	1%	634	1%
Two or More Races	5288	6%	4176	6%
White	54950	60%	42853	61%
Average GPA	87973	2.64	68680	2.78

Over half of the total sample took at least one Tech Prep course. Because of the large sample and the fact that the program has a different purpose than the other dual-credit types, I also present an analysis which excludes students who only participated in Tech Prep courses. Using this criterion, 50% of students took at least one dual-credit course other than Tech Prep. Similar to the AP and CHS samples, White and Asian students are overrepresented and

Hispanic students are underrepresented when removing Tech Prep from the analysis. This group is 54% female which differs from our total sample which is 48% female. Of those that participate in dual-credit other than Tech Prep, 31% qualify for free or reduced-price lunch and students who qualify for Special Education or ELL services are largely underrepresented at 2% and 1% respectively. The average GPA for this group of students is 3.08, which is higher than the overall sample GPA of 2.64. When Tech Prep is excluded, the sample is similar to what is observed for the other single dual-credit types with an academic focus. Additional details can be found in Table 12 below.

Table 12. *Demographics for Overall Sample, Any DC and Any DC No TP*

Characteristic	Overall Sample n = 91361		Any DC n = 69826	76%	Any DC no TP 45611	50%
	N	*%*	*N*	*%*	*N*	*%*
Male	47191	52%	35251	51%	20837	46%
ELL	3250	4%	2022	3%	599	1%
SPED	10414	11%	5807	8%	964	2%
FRL	39507	43%	27558	39%	14359	31%
American Indian	1467	2%	848	1%	389	1%
Asian	6799	7%	6009	9%	4949	11%
Black	4698	5%	341	5%	1886	4%
Hispanic	17288	19%	11873	17%	6322	14%
Pacific Islander	866	1%	634	1%	352	1%
Two or More Races	5288	6%	4176	6%	2714	6%
White	54950	60%	42853	61%	28999	64%
Average GPA	87973	2.64	68680	2.78	44855	3.08

Note. TP is an abbreviation for Tech Prep

Another way to understand any dual-credit participation is to look at the overlap in program participation. Table 13 provides an overview of participation rates within each dual-credit program. The data in the column for Tech Prep indicates the percent of students participating in Tech Prep that also participated in another dual-credit type. For example, 36% of students that participated in Tech Prep also participated in AP. The data in the row for Tech Prep indicates the percent of students participating in other programs but also participating in Tech Prep. For example, 60% of students who participated in AP also took at least one Tech Prep course. Running Start students have lower percentages of students participating in other dual-credit programs, with 41% of students participating in Tech Prep and 36% participating in AP.

Table 13.
Comparison of Dual-Credit Participation Rates Within Program

Characteristic	TechPrep n = 49278		AP n = 29529		RS n = 16766		CHS n = 9202		IB n = 3699		Camb. n = 339	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Tech Prep	--	--	17576	60%	6891	41%	5358	58%	2116	57%	238	70%
AP	17576	36%	--	--	6101	36%	5152	56%	650	18%	88	26%
RS	6891	14%	6101	21%	--	--	2362	26%	669	18%	40	12%
CHS	5358	11%	5152	17%	2362	14%	--	--	133	4%	47	14%
IB	2116	4%	650	2%	669	4%	133	1%	--	--	5	2%
Camb.	238	0.5%	88	0.3%	40	0.2%	47	0.5%	5	0.1%	--	--

4.10 Dual-Credit by ESD and District Size

Dual-credit offerings by ESD ranged from 4 to all 6 of the programs available in Washington. There are three ESDs offering four programs, five offering five programs and PSESD offered all six programs. More details can be found in Table 14. All of the ESDs have Tech Prep, AP, Running Start and College in the High school programs available to students. IB programs are available in six of the ESDs and as previously mentioned, the Cambridge program is only available in PSESD.

Table 14. *Dual-Credit by ESD*

Characteristic	ESD 101		ESD 105		ESD 112		ESD 113		ESD 114		ESD 121		ESD 123		ESD 171		ESD 189	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
	7877	9%	5115	6%	8899	10%	6220	7%	5168	6%	33102	36%	6103	7%	3603	4%	15274	17%
Taking Tech Prep	2939	37%	1737	34%	3594	40%	3023	49%	3158	61%	21915	66%	3873	63%	1998	55%	7041	46%
Taking AP	2749	35%	787	15%	2699	30%	1689	27%	1538	30%	13636	41%	1454	24%	586	16%	4391	29%
Taking Running Start	2213	28%	886	17%	1612	18%	981	16%	772	15%	5506	17%	1342	22%	876	24%	2578	17%
Taking College in HS	413	5%	593	12%	126	1%	173	3%	241	5%	3411	10%	366	6%	529	15%	3350	22%
Taking IB	1	0%	110	2%	220	2%	184	3%	3	0%	2813	8%	140	2%	0	0%	228	1%
Taking Cambridge	0	0%	0	0%	0	0%	0	0%	0	0%	339	1%	0	0%	0	0%	0	0%
Any Dual Credit	5450	69%	2844	56%	6163	69%	4437	71%	3963	77%	28394	86%	4684	77%	2633	73%	11258	74%
Any Dual Credit no TP	3870	49%	1629	32%	4014	45%	2529	41%	2082	40%	19743	60%	2498	41%	1400	39%	7846	51%

The average number of dual-credit programs students take is 1.2, and by ESD this number ranged from 0.8 in ESD 105 to 1.4 in PSESD. When Tech Prep is removed from the analysis, this average changes to 0.7. When broken out by ESD, the average low of 0.5 is in ESD 105 and the average high of 0.8 is once again in PSESD. As mentioned earlier, one of the ESSA indicators of success is participating in at least 1 dual-credit program and if Tech Prep was not included, this indicator would provide very different results.

Analyzing dual-credit offerings by district size is another way to understand who has access to the different dual-credit programs. Depending on the size of the district they were from, students could access four to six different dual-credit types. Similar to the analysis by ESD, districts of all sizes had students taking Tech Prep, AP, Running Start and CHS courses. However, the sample sizes for students at districts with less than 100 students are very small and further investigation would be needed to know if the schools actually offered Tech Prep, AP and CHS as in-person options or if students could access these courses online or through some other means. Districts with 5000 or more students all offered IB courses in addition to the four discussed previously and only districts with 20,000 or more students offered Cambridge.

This analysis by district size surfaces new findings and potential policy implications. Out of the 85 students from districts with less than 100 students, 25 of them (29%) participate in Running Start. Aside from Tech Prep, Running Start is the largest program for districts under 3000 students. Small districts are dependent on staff who play multiple roles and may not have the personnel or financial resources to implement dual-credit courses in their buildings. Running Start creates an opportunity that can happen outside of the high school and may be the best of the six options for smaller districts. As district size increases, there are more offerings available for students to experience dual-credit and participation rates also increase. Figure 10 shows the dual-credit participation trend by district size.

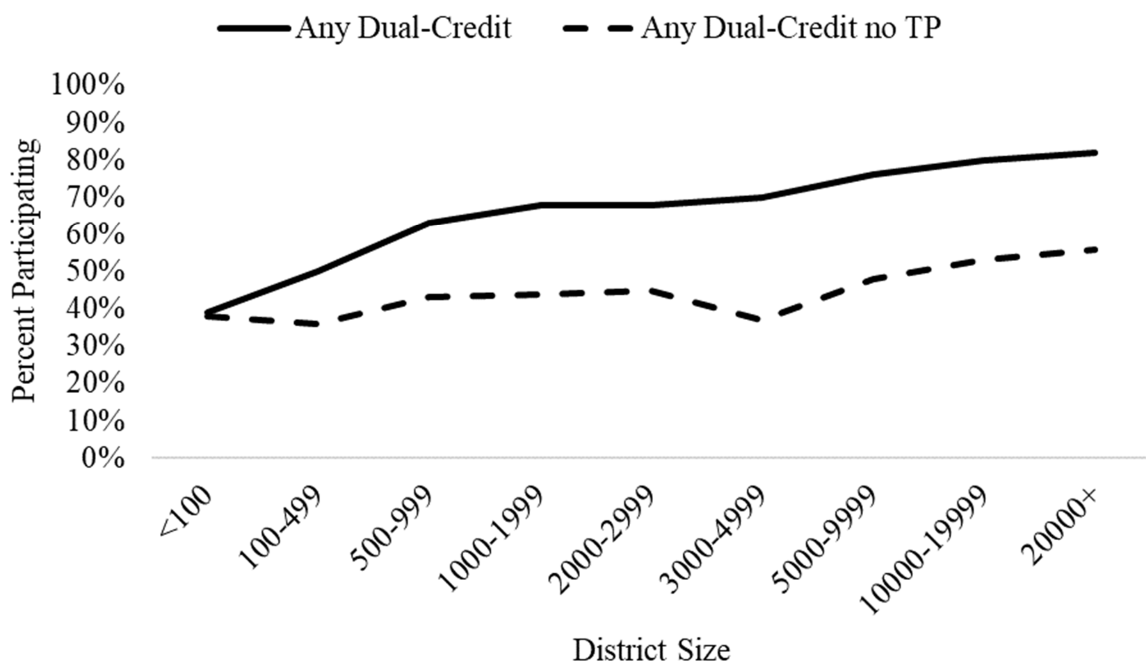


Figure 10. Dual-Credit Participation by District Size

The larger districts have a lower percentage of students participating in Running Start, but have more students accessing AP. Figure 11 shows how AP and Running Start participation rates vary by district size. A program that is more consistently offered across all districts is College in the High School. Overall, 10% of the sample of students participated in this program and the participation rate ranges from 6 to 13% depending on district size. This is one of the newer dual-credit options and could potentially fill some of the gaps that exist. Students are still able to take the courses on their high school campus and there is no exam to pass in order to obtain college credit. Depending on where a student lives in the state as well as the size of the school they attend, they will have different dual-credit options available that may or may not capture their interest and meet their needs. A comprehensive table of dual-credit participation by district size can be found in Appendix B.

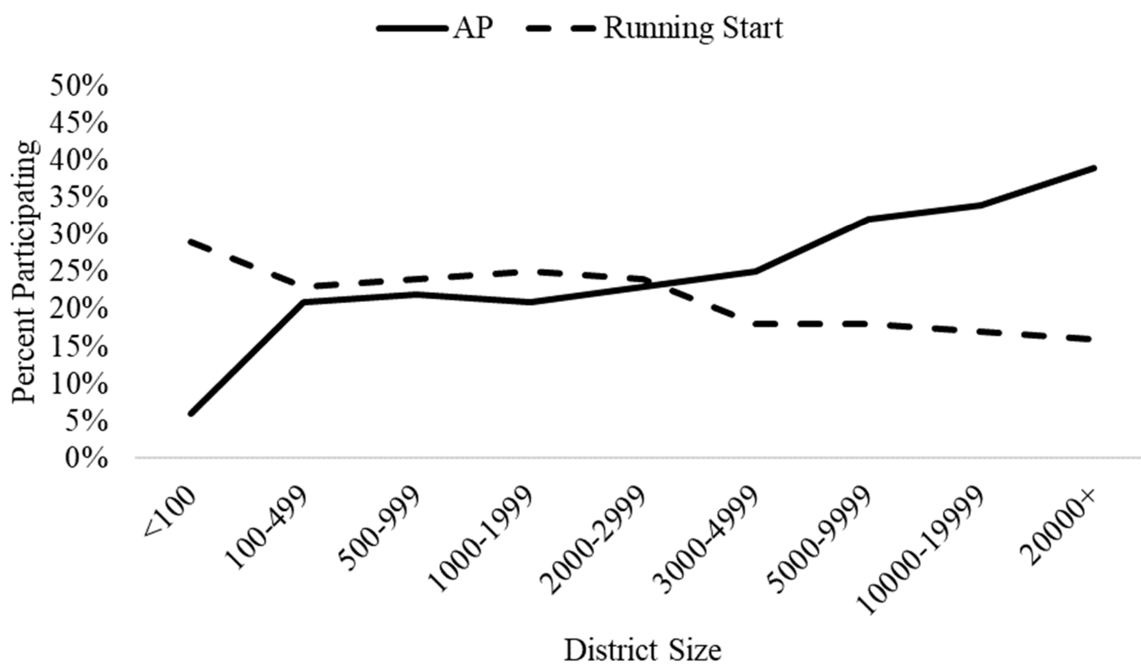


Figure 11. AP and Running Start Participation by District Size

4.11 Dual-Credit by District and School Wealth

In addition to analyzing dual-credit participation by district size and ESD, I also analyzed participation by district and school wealth. The district wealth measure is the 14% levy rate and a higher number on this measure indicates the district can qualify for additional state monies to help compensate for the district's lower assessed valuation of property. In general, the 14% levy rate can serve as a measure of district property wealth. Wealth measures are only available at the district level and a proxy must be used to understand wealth/poverty at a school level. In this case, school free and reduced lunch rates were used and compared to schools' dual-credit participation rates.

When correlating district wealth with the percentage of students taking dual-credit in a given district, the result is a negative correlation, $r = -0.25$, $p < 0.001$. The negative correlation indicates that wealthier districts have higher rates of students participating in dual-credit. In addition to this finding at the district level, there are also similar results at the school level. When correlating school FRL rates with the percentage of students taking dual-credit in a given school, the result is a negative correlation, $r = -0.35$, $p < 0.001$. This means that the higher a schools' FRL rate, the lower the percentage of students participating in dual-credit courses. In order to make this easier to see, FRL rate was split into quintiles and the average dual-credit participation rate was calculated for each quintile. A visual representation of these results can be found in Figure 12. For schools with a FRL rate of 0-20%, an average of 64% of students took at least one dual-credit course while schools with an FRL rate of over 80% had an average participation rate of just 36%.

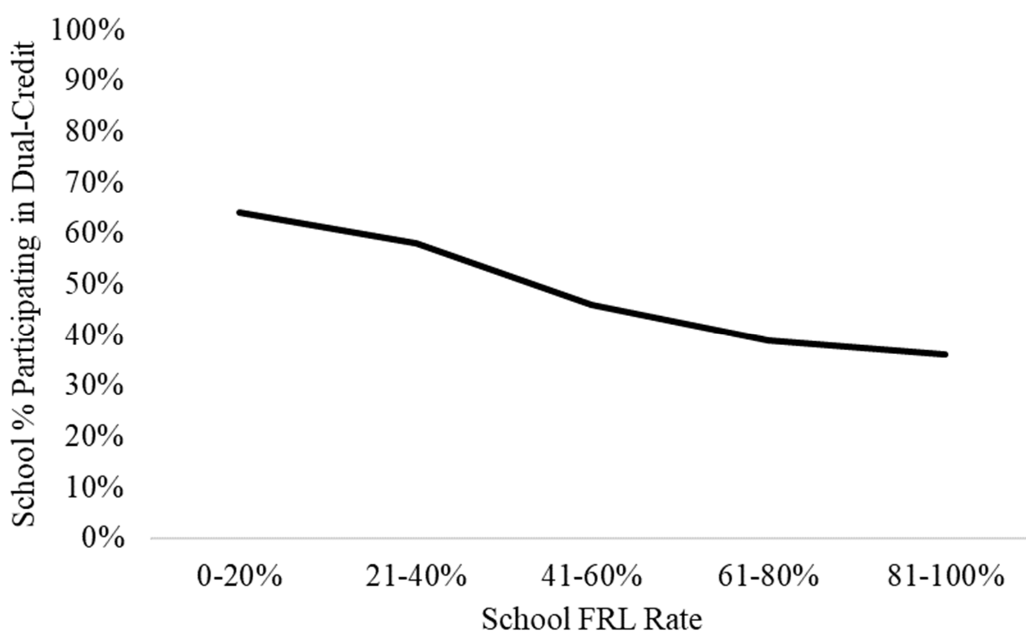


Figure 12. School Dual-Credit Participation by Level of School Poverty

The results above add to the earlier analysis of dual-credit by program and the finding that FRL students were underrepresented in many of the programs. As the push to expand dual-credit participation continues, these results have policy implications that will be discussed in a later section.

4.12 Descriptive Analysis Discussion

The descriptive results in this study answer my research question around differences in dual-credit access across the state and the factors that may contribute to those differences. From the analysis, I found that the patterns of student access to dual-credit programs differ based on where a student lives as well as the size of the district they attend. Hispanic and Black students are often underrepresented in these programs compared to their representation in the overall sample and students eligible for free or reduced lunch are underrepresented as well.

Given all the results of the descriptive analyses, I find that dual-credit access is not equitable across the state. Students in more heavily populated areas, especially the greater Puget Sound region, have access to more dual-credit options than students in other parts of the state. Results from the predictive analysis will show if different dual-credit programs are predictive of various postsecondary outcomes. If that is the case, students in districts with fewer options may be at a disadvantage. Inequitable access also has implications for policy, especially given that dual-credit participation is an ESSA indicator in Washington. Student interest and participation in dual-credit programs may be influenced by both the number and the types of options available to them.

There are also policy implications in regard to representation by race in dual-credit programs. There has been a recent push to increase the number of students taking AP courses, yet in 2015 Hispanic students were largely underrepresented. In one striking example, ESD 105 is 61% Hispanic but only 15% of students from that ESD took at least one AP course. We can assume that different dual-credit programs require different levels and types of resources, and that what works for one school may not be the best fit for another. Results from the predictive analyses may be able to help inform a more differentiated approach to dual-credit offerings.

Results from the descriptive analysis also show that dual-credit participation varies by district property wealth and school poverty status. Once again, there are implications for ESSA if it is known that districts with less fiscal capacity and schools with higher poverty rates have lower dual-credit participation rates. This result also has policy implications around program cost and subsidy availability for students accessing the different programs. Based on results from the descriptive analysis, Running Start may be one of the most viable options for students from smaller districts. How can the state help ensure any student who wants to access Running Start has the opportunity to do so?

Chapter 5: Predictive Analysis Results

5.1 HLM Overview

HLM 7.03 was used to run all HLM models. The HLM models used in this study test whether the dual-credit courses taken are significant predictors of high school graduation, any college enrollment, any four-year college enrollment and four-year out of state college enrollment. Each of these outcomes tested have a different sample size as students must be high school graduates to be included in the any college analysis, be enrolled in any college to be included in the any four-year college analysis and enrolled in any four-year college to be included in the four-year out-of-state analysis. Table 15 provides the percentage of students by outcome.

Table 15.
Sample by Outcome

Characteristic	Total Sample n = 91361	
	N	*%*
HS Graduates	67155	74%
Any College Enrollment	40538	44%
Any Four-Year College Enrollment	22296	24%
Four-Year Out-of-State College Enrollment	6444	7%

Dual-credit variables are those of interest while the other variables serve as controls. The control variables in this analysis were first informed by the results of my pilot study as well as previous research on variables that are shown to have great predictive power in studies related to postsecondary education (Bettinger & Long, 2009; Porchea, Allen, Robbins, & Phelps, 2010; Thompson, Gorin, Obeidat, & Chen, 2006). They were then refined based on the descriptive analysis which showed differences in dual-credit participation by race, ELL status, FRL status, special education status, gender and GPA. These variables were all included as predictors in the initial HLM models that included dual-credit and control variables. Binary variables were effect-coded and continuous variables were standardized in all models for ease of interpretation. Correlations and results from the initial HLM models informed the final selection of control variables to be included in the predictive models. Correlations can be found in Appendix C.

5.2 HLM Initial Analyses

The first step in my predictive modeling was to choose the number of levels I would be including in my HLM models. I could use a 3-level model with student, school and district as the levels of interest or I could use a 4-level model which would add ESD as a level above district. Intercept only models were run for each of the four outcome variables with both 3 and 4-level models. Significant variance between ESDs was found for three of the outcome variables and those results can be found in Appendix D. When ESD was not included, there was significant variance between districts for the two four-year college outcomes. While the 4-level models for each of the four outcomes were significant, the choice was made to move forward with 3-level models. The rationale for this choice was that the HLM software did not handle the 4-level models well and there were issues getting them to run smoothly. In order to still include ESD in future models, eight ESD dummy variables were created and included as district level fixed effects.

The next step was to run 3-level models with each dual-credit program variable as well as an any dual-credit variable one at a time to understand direct effects and all together to understand unique effects. ESD variables were included in all models and all four outcomes were tested. Results from these models are available in Appendix E. Dual-credit participation was significant for all programs in both the direct and unique models for the outcomes of high school graduation, any college enrollment and four-year college enrollment. For the out of state four-year college models, only Running Start and IB were significant predictors when testing direct effects. The results of the unique effects model showed Running Start and Tech Prep to be significant predictors of out of state four-year college enrollment. These results provided a rationale to move forward with additional analyses that included demographic control variables in addition to the dual-credit participation variables.

The next round of HLM 3-level models included dual-credit program participation variables, gender, race, FRL, ELL, SPED and GPA student-level variables as well as school-level dual-credit participation and ESD and district wealth variables. These unique-effects models were run for each of the four outcome variables and results are available in Appendix F. Results from these models provided information on how to approach the final models. In order to better understand how each dual-credit program predicts the four outcomes, the decision was made to run separate models for each dual-credit type. Also, only models for Tech Prep, AP, Running Start and College in the High School would be run as they are the biggest programs in the state. Not only are IB and Cambridge not offered in many schools in Washington, they also have more start-up costs than the other programs. The decision was also made to not include SPED in the final models as it is not a focal variable of interest in this research. FRL was also excluded even though it was a significant predictor of all four outcomes. This was done to better understand how the other demographics predict the outcomes and interact with the dual-credit variables. I also chose to exclude district wealth as it was only a significant predictor of any college enrollment.

5.3 HLM Final Models

The final HLM models used in this study test whether dual-credit program participation (Tech Prep, AP, Running Start, College in the High School) is a significant predictor of high school graduation, college enrollment, four-year college enrollment and four-year out-of-state college enrollment, after controlling for demographics (gender, URM and ELL status), GPA, ESD and district dual-credit participation. Interactions terms were also included. For ease of results interpretation, dual-credit participation, gender, URM and ELL status were effect-coded and GPA and district dual-credit participation were standardized. The final model for Tech Prep and the outcome of high school graduation can all be shown as:

HSgrad = intercept + DIS_ESD + DIS_TP + GENDER + URM + ELL+ GPA
+ TOOK_TP + TOOK_TP x GENDER + TOOK_TP x URM + TOOK_TP x ELL +
TOOK_TP x GPA + TOOK_TP x DIS_TP

Models for AP, Running Start and College in the High School take the same format as the Tech Prep model shown above and the same inputs are used for each of the four outcomes. Results for each of the models can be found in Tables 16 – 19 below.

Table 16. *Tech Prep HLM Results*

	High School Graduation					Any College					Any Four-Year College					Four-Year Out-of-State College				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	1.15	0.57	2.00	(238)	**.047**	-2.14	0.26	-8.06	(238)	**<.001**	-4.53	0.33	-13.57	(238)	**<.001**	-2.03	0.36	-5.72	(238)	**<.001**
Student Predictors																				
Any TP	0.50	0.03	18.06	(81543)	**<.001**	0.01	0.03	0.42	(65211)	.673	-0.25	0.06	-4.13	(39221)	**<.001**	-0.21	0.15	-1.43	(21252)	.153
Male	-0.05	0.01	-4.14	(81543)	**<.001**	-0.05	0.01	-5.47	(65211)	**<.001**	0.08	0.01	6.10	(39221)	**<.001**	-0.06	0.02	-3.70	(21252)	**<.001**
URM	-0.01	0.01	-0.43	(81543)	.669	0.05	0.01	4.38	(65211)	**<.001**	0.07	0.02	4.32	(39221)	**<.001**	-0.10	0.02	-4.84	(21252)	**<.001**
ELL	-0.49	0.03	-18.24	(81543)	**<.001**	-0.24	0.03	-8.00	(65211)	**<.001**	-0.98	0.06	-16.43	(39221)	**<.001**	-0.30	0.14	-2.10	(21252)	**.036**
GPA	1.51	0.02	91.70	(81543)	**<.001**	1.27	0.01	88.37	(65211)	**<.001**	2.01	0.02	83.02	(39221)	**<.001**	0.06	0.03	1.75	(21252)	.080
Any TP x Male	0.04	0.01	3.46	(81543)	**.001**	0.03	0.01	3.48	(65211)	**.001**	0.02	0.01	1.38	(39221)	.167	0.01	0.02	0.50	(21252)	.619
Any TP x URM	0.01	0.01	1.14	(81543)	.255	0.02	0.01	2.07	(65211)	**.039**	0.00	0.01	-0.02	(39221)	.983	-0.03	0.02	-1.60	(21252)	.110
Any TP x ELL	-0.05	0.03	-1.97	(81543)	**.049**	0.05	0.03	1.61	(65211)	.106	-0.14	0.06	-2.36	(39221)	**.018**	-0.21	0.14	-1.45	(21252)	.148
Any TP x GPA	0.31	0.02	19.99	(81543)	**<.001**	0.06	0.01	4.18	(65211)	**<.001**	0.05	0.02	1.93	(39221)	.054	-0.03	0.03	-0.96	(21252)	.339
District Predictors																				
% Taking TP	-0.12	0.07	-1.71	(238)	.088	-0.03	0.03	-1.13	(238)	.258	0.00	0.04	-0.07	(238)	.948	-0.02	0.04	-0.47	(238)	.642
Any TP x % Taking TP	0.14	0.07	2.03	(238)	**.044**	0.01	0.03	0.42	(238)	.675	0.05	0.04	1.40	(238)	.162	-0.04	0.04	-0.99	(238)	.325
ESD 101	-0.05	0.13	-0.37	(238)	.716	-0.37	0.06	-6.27	(238)	**<.001**	-0.40	0.07	-5.47	(238)	**<.001**	-0.12	0.08	-1.60	(238)	.111
ESD 105	-0.08	0.15	-0.54	(238)	.593	-0.30	0.07	-4.30	(238)	**<.001**	-0.14	0.08	-1.66	(238)	.099	-0.45	0.09	-4.77	(238)	**<.001**
ESD 112	0.06	0.14	0.43	(238)	.669	-0.30	0.06	-4.76	(238)	**<.001**	-0.44	0.08	-5.61	(238)	**<.001**	0.17	0.08	2.27	(238)	**.024**
ESD 113	-0.01	0.13	-0.10	(238)	.920	-0.29	0.06	-4.89	(238)	**<.001**	-0.55	0.07	-7.56	(238)	**<.001**	-0.10	0.08	-1.22	(238)	.223
ESD 114	-0.17	0.15	-1.13	(238)	.258	-0.25	0.07	-3.46	(238)	**.001**	-0.34	0.09	-3.80	(238)	**<.001**	0.04	0.09	0.49	(238)	.627
ESD 123	-0.08	0.15	-0.53	(238)	.598	-0.22	0.07	-3.20	(238)	**.002**	-0.30	0.08	-3.53	(238)	**.001**	0.08	0.08	1.00	(238)	.321
ESD 171	0.25	0.15	1.73	(238)	.084	-0.31	0.07	-4.76	(238)	**<.001**	-0.44	0.08	-5.48	(238)	**<.001**	-0.23	0.09	-2.48	(238)	**.014**
ESD 189	-0.18	0.11	-1.59	(238)	.113	-0.19	0.05	-3.72	(238)	**<.001**	-0.36	0.06	-5.52	(238)	**<.001**	-0.06	0.06	-0.95	(238)	.344
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept																				
Between Schools	1.79		6694.42	(334)	**<.001**	0.21		1680.63	(299)	**<.001**	0.17		884.84	(259)	**<.001**	0.13		523.44	(190)	**<.001**
Between Districts	0.10		223.81	(234)	>.500	0.04		274.62	(233)	**.032**	0.11		402.87	(229)	**<.001**	0.09		347.89	(224)	**<.001**

Note. All predictors either standardized into z-scores or effect coded.

Table 17. *AP HLM Results*

	High School Graduation					Any College					Any Four-Year College					Four-Year Out-of-State College				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	1.88	0.56	3.37	(238)	**.001**	-1.23	0.26	-4.78	(238)	**<.001**	-3.20	0.32	-9.93	(238)	**<.001**	-1.46	0.34	-4.26	(238)	**<.001**
Student Predictors																				
AnyAP	0.80	0.05	15.01	(81543)	**<.001**	0.32	0.04	8.30	(65211)	**<.001**	0.41	0.06	6.62	(39221)	**<.001**	-0.41	0.14	-2.82	(21252)	**.005**
Male	-0.02	0.02	-0.80	(81543)	.424	-0.04	0.01	-4.54	(65211)	**<.001**	0.07	0.01	5.93	(39221)	**<.001**	-0.05	0.02	-2.91	(21252)	**.004**
URM	0.03	0.02	1.29	(81543)	.197	0.05	0.01	4.31	(65211)	**<.001**	0.06	0.02	3.78	(39221)	**<.001**	-0.12	0.02	-5.29	(21252)	**<.001**
ELL	-0.40	0.05	-7.79	(81543)	**<.001**	-0.17	0.04	-4.49	(65211)	**<.001**	-0.87	0.06	-14.35	(39221)	**<.001**	-0.32	0.14	-2.25	(21252)	**.025**
GPA	1.65	0.03	58.50	(81543)	**<.001**	1.15	0.02	74.53	(65211)	**<.001**	1.87	0.02	76.65	(39221)	**<.001**	0.00	0.03	0.04	(21252)	.965
Any AP x Male	0.02	0.02	0.82	(81543)	.415	0.00	0.01	-0.47	(65211)	.638	0.01	0.01	1.02	(39221)	.306	-0.03	0.02	-1.75	(21252)	.080
Any AP x URM	0.04	0.02	1.92	(81543)	.055	0.00	0.01	0.41	(65211)	.685	-0.02	0.01	-1.11	(39221)	.266	0.03	0.02	1.29	(21252)	.197
Any AP x ELL	-0.01	0.05	-0.14	(81543)	.890	-0.01	0.04	-0.38	(65211)	.703	0.09	0.06	1.57	(39221)	.117	-0.17	0.14	-1.16	(21252)	.247
Any AP x GPA	0.46	0.03	16.43	(81543)	**<.001**	0.02	0.02	1.53	(65211)	.126	0.14	0.02	5.72	(39221)	**<.001**	0.30	0.03	8.93	(21252)	**<.001**
District Predictors																				
% Taking AP	-0.08	0.08	-1.04	(238)	.300	0.04	0.03	1.10	(238)	.273	0.12	0.04	2.68	(238)	**.008**	0.20	0.04	4.67	(238)	**<.001**
Any AP x % Taking AP	0.06	0.07	0.81	(238)	.419	0.03	0.03	0.84	(238)	.404	0.04	0.04	1.00	(238)	.321	0.08	0.04	2.06	(238)	**.041**
ESD 101	0.01	0.11	0.06	(238)	.950	-0.27	0.05	-5.10	(238)	**<.001**	-0.23	0.07	-3.53	(238)	**<.001**	-0.05	0.07	-0.71	(238)	.481
ESD 105	-0.07	0.15	-0.44	(238)	.658	-0.18	0.07	0.01	(238)	**.007**	0.08	0.08	0.99	(238)	.321	-0.31	0.09	-3.39	(238)	**.001**
ESD 112	0.05	0.13	0.40	(238)	.692	-0.19	0.06	-3.33	(238)	**.001**	-0.28	0.07	-3.91	(238)	**<.001**	0.25	0.07	3.65	(238)	**<.001**
ESD 113	0.02	0.13	0.19	(238)	.850	-0.17	0.06	-3.07	(238)	**.002**	-0.36	0.07	-5.09	(238)	**<.001**	0.01	0.08	0.18	(238)	.857
ESD 114	-0.12	0.14	-0.80	(238)	.423	-0.19	0.07	-2.85	(238)	**.005**	-0.26	0.08	-3.16	(238)	**.002**	0.10	0.08	1.21	(238)	.228
ESD 123	-0.02	0.15	-0.16	(238)	.876	-0.12	0.06	-1.79	(238)	.074	-0.14	0.08	-1.74	(238)	.084	0.18	0.08	2.26	(238)	**.025**
ESD 171	0.29	0.15	2.01	(238)	**.046**	-0.20	0.06	-3.09	(238)	**.002**	-0.24	0.08	-2.95	(238)	**.004**	-0.12	0.09	-1.35	(238)	.178
ESD 189	-0.13	0.10	-1.24	(238)	.216	-0.11	0.05	-2.24	(238)	**.026**	-0.25	0.06	-4.27	(238)	**<.001**	-0.01	0.06	-0.11	(238)	.913
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept																				
Between Schools	1.83		6860.65	(334)	**<.001**	0.16		1342.34	(299)	**<.001**	0.18		899.66	(259)	**<.001**	0.12		495.28	(190)	**<.001**
Between Districts	0.03		232.50	(234)	>.500	0.04		292.20	(233)	**.005**	0.07		346.21	(229)	**<.001**	0.06		316.99	(224)	**<.001**

Note. All predictors either standardized into z-scores or effect coded.

Table 18. *Running Start HLM Results*

	High School Graduation					Any College					Any Four-Year College				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	1.23	0.51	2.39	(238)	**.018**	-1.66	0.26	-6.47	(238)	**<.001**	-4.25	0.33	-12.91	(238)	**<.001**
Student Predictors															
Any RS	0.11	0.09	1.25	(81543)	.210	0.40	0.08	5.35	(65211)	**<.001**	0.06	0.11	0.53	(39221)	.598
Male	-0.06	0.02	-3.25	(81543)	**.001**	-0.04	0.01	-3.62	(65211)	**<.001**	0.06	0.01	4.69	(39221)	**<.001**
URM	0.07	0.02	2.97	(81543)	**.003**	0.09	0.01	6.17	(65211)	**<.001**	0.08	0.02	4.86	(39221)	**<.001**
ELL	-0.47	0.09	-5.20	(81543)	**<.001**	-0.14	0.08	-1.92	(65211)	.055	-1.01	0.11	-9.31	(39221)	**<.001**
GPA	1.55	0.03	59.43	(81543)	**<.001**	1.10	0.02	59.37	(65211)	**<.001**	1.96	0.03	72.62	(39221)	**<.001**
Any RS x Male	-0.03	0.02	-1.59	(81543)	.111	-0.02	0.01	-1.51	(65211)	.132	-0.02	0.01	-1.36	(39221)	.175
Any RS x URM	0.09	0.02	4.07	(81543)	**<.001**	0.03	0.01	2.40	(65211)	**.016**	0.04	0.02	2.31	(39221)	**.021**
Any RS x ELL	0.00	0.09	-0.01	(81543)	.989	0.04	0.08	0.59	(65211)	.552	0.02	0.11	0.17	(39221)	.864
Any RS x GPA	0.17	0.03	6.67	(81543)	**<.001**	-0.21	0.02	-11.45	(65211)	**<.001**	-0.15	0.03	-5.77	(39221)	**<.001**
District Predictors															
% Taking RS	0.03	0.05	0.65	(238)	.519	-0.02	0.02	-0.82	(238)	.411	0.03	0.03	1.16	(238)	.247
Any RS x % Taking RS	0.01	0.05	0.24	(238)	.814	-0.04	0.02	-1.55	(238)	.123	-0.02	0.03	-0.78	(238)	.434
ESD 101	-0.03	0.11	-0.29	(238)	.771	-0.35	0.05	-6.31	(238)	**<.001**	-0.33	0.07	-4.72	(238)	**<.001**
ESD 105	-0.05	0.14	-0.33	(238)	.741	-0.28	0.07	-4.18	(238)	**<.001**	-0.07	0.08	-0.87	(238)	.383
ESD 112	0.01	0.13	0.05	(238)	.961	-0.27	0.06	-4.51	(238)	**<.001**	-0.40	0.08	-5.28	(238)	**<.001**
ESD 113	0.01	0.12	0.06	(238)	.954	-0.25	0.06	-4.45	(238)	**<.001**	-0.52	0.07	-7.27	(238)	**<.001**
ESD 114	-0.15	0.15	-1.03	(238)	.304	-0.23	0.07	-3.21	(238)	**.001**	-0.32	0.09	-3.59	(238)	**<.001**
ESD 123	-0.15	0.15	-0.39	(238)	.695	-0.22	0.07	-3.33	(238)	**.001**	-0.27	0.08	-3.22	(238)	**.001**
ESD 171	0.26	0.14	1.83	(238)	.069	-0.31	0.07	-4.77	(238)	**<.001**	-0.42	0.08	-5.14	(238)	**<.001**
ESD 189	-0.17	0.10	-1.68	(238)	.095	-0.17	0.05	-3.37	(238)	**.001**	-0.33	0.06	-5.20	(238)	**<.001**
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept															
Between Schools	1.98		7541.93	(334)	**<.001**	0.21		1617.29	(299)	**<.001**	0.16		854.71	(259)	**<.001**
Between Districts	0.02		210.46	(234)	>.500	0.05		281.58	(233)	**.016**	0.12		415.74	(229)	**<.001**

Note. All predictors either standardized into z-scores or effect coded.

Table 19. *College in the High School HLM Results*

	High School Graduation					Any College					Any Four-Year College					Four-Year Out-of-State College				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	1.66	0.55	3.04	(238)	**.003**	-1.56	0.25	-6.15	(238)	**<.001**	-4.01	0.32	-12.38	(238)	**<.001**	-1.80	0.35	-5.18	(238)	**<.001**
Student Predictors																				
Any CHS	0.52	0.10	5.26	(81543)	**<.001**	0.44	0.08	5.88	(65211)	**<.001**	0.42	0.11	3.88	(39221)	**<.001**	0.24	0.19	1.27	(21252)	.204
Male	0.01	0.03	0.33	(81543)	.742	-0.04	0.02	-2.63	(65211)	**.008**	0.07	0.02	4.02	(39221)	**<.001**	-0.07	0.02	-3.69	(21252)	**<.001**
URM	-0.01	0.04	-0.38	(81543)	.702	0.06	0.02	3.25	(65211)	**.001**	0.05	0.02	2.20	(39221)	**.028**	-0.12	0.03	-4.29	(21252)	**<.001**
ELL	-0.51	0.10	-5.39	(81543)	**<.001**	-0.07	0.07	-0.89	(65211)	.373	-0.87	0.10	-8.41	(39221)	**<.001**	-0.07	0.18	-0.37	(21252)	.711
GPA	1.72	0.04	38.80	(81543)	**<.001**	1.20	0.02	51.24	(65211)	**<.001**	1.98	0.03	58.47	(39221)	**<.001**	0.10	0.04	2.22	(21252)	**.026**
Any CHS x Male	0.05	0.03	1.57	(81543)	.115	0.01	0.02	0.45	(65211)	.650	-0.01	0.02	-0.59	(39221)	.557	-0.02	0.02	-1.20	(21252)	.230
Any CHS x URM	-0.01	0.04	-0.21	(81543)	.838	0.01	0.02	0.44	(65211)	.657	-0.02	0.02	-1.10	(39221)	.272	-0.02	0.03	-0.58	(21252)	.565
Any CHS x ELL	-0.05	0.10	-0.52	(81543)	.604	0.17	0.07	2.21	(65211)	**.027**	0.14	0.10	1.38	(39221)	.168	0.33	0.18	1.82	(21252)	.068
Any CHS x GPA	0.35	0.04	7.90	(81543)	**<.001**	-0.07	0.02	-2.90	(65211)	**.004**	-0.02	0.03	-0.72	(39221)	.474	0.06	0.04	1.32	(21252)	.188
District Predictors																				
% Taking CHS	-0.25	0.14	-1.82	(238)	.070	-0.02	0.06	-0.35	(238)	.729	0.13	0.07	1.79	(238)	.075	0.18	0.06	2.75	(238)	**.006**
Any CHS x % Taking CHS	-0.22	0.14	-1.58	(238)	.115	0.01	0.06	0.12	(238)	.907	0.20	0.07	2.80	(238)	**.005**	0.12	0.06	1.89	(238)	.061
ESD 101	-0.01	0.12	-0.13	(238)	.901	-0.33	0.05	-6.04	(238)	**<.001**	-0.34	0.07	-5.00	(238)	**<.001**	-0.11	0.07	-1.60	(238)	.111
ESD 105	-0.07	0.15	-0.49	(238)	.626	-0.28	0.07	-4.28	(238)	**<.001**	-0.11	0.08	-1.42	(238)	.157	-0.43	0.09	-4.84	(238)	**<.001**
ESD 112	0.03	0.13	0.26	(238)	.798	-0.25	0.06	-4.18	(238)	**<.001**	-0.37	0.08	-4.93	(238)	**<.001**	0.20	0.07	2.81	(238)	**.005**
ESD 113	0.00	0.13	0.02	(238)	.987	-0.25	0.06	-4.40	(238)	**<.001**	-0.50	0.07	-7.07	(238)	**<.001**	-0.07	0.08	-0.88	(238)	.380
ESD 114	-0.16	0.15	-1.04	(238)	.298	-0.23	0.07	-3.21	(238)	**.002**	-0.32	0.09	-3.51	(238)	**.001**	0.07	0.09	0.83	(238)	.406
ESD 123	-0.03	0.15	-0.19	(238)	.851	-0.21	0.07	-3.10	(238)	**.002**	-0.31	0.08	-3.71	(238)	**<.001**	0.08	0.08	1.01	(238)	.315
ESD 171	0.26	0.15	1.72	(238)	.086	-0.31	0.07	-4.71	(238)	**<.001**	-0.43	0.08	-5.22	(238)	**<.001**	-0.22	0.09	-2.52	(238)	**.012**
ESD 189	-0.20	0.11	-1.72	(238)	.087	-0.18	0.05	-3.57	(238)	**<.001**	-0.35	0.06	-5.35	(238)	**<.001**	-0.07	0.06	-1.09	(238)	.275
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept																				
Between Schools	1.91		7342.39	(334)	**<.001**	0.20		1568.82	(299)	**<.001**	0.17		874.37	(259)	**<.001**	0.13		523.94	(190)	**<.001**
Between Districts	0.10		223.99	(234)	>.500	0.05		288.74	(233)	**.008**	0.11		405.44	(229)	**<.001**	0.08		335.95	(224)	**<.001**

Note. All predictors either standardized into z-scores or effect coded.

5.4 Tech Prep

There are four models for Tech Prep, one for each of the outcome variables. For all models, there was significant between-schools variance and there was significant between-districts variance for all models but high school graduation. For the student-level fixed effects, Gender and ELL status were significant predictors of all four outcomes. In all models, ELL status was a negative predictor while being male was negative in all models but four-year college. GPA was a significant positive predictor of all outcomes but four-year out-of-state college and URM status was significant in all models except for high school graduation. URM status was a positive predictor of any college and four-year college, but a negative predictor of four-year out-of-state college.

In regard to Tech Prep itself, taking at least one Tech Prep course was a positive significant predictor of high school graduation. This means that holding all else constant, students taking at least one Tech Prep had a predicted high school graduation rate of 80% while the predicted high school graduation rate for students not taking Tech Prep was 59%. Tech Prep was also a negative significant predictor of four-year college enrollment which means that holding all else constant, taking at least one Tech Prep course is associated with a 6% predicted probability of enrolling in a four-year college compared to a 12% predicted probability for students not participating in Tech Prep. Tech Prep was not a significant predictor of any college or four-year out-of-state college. These finding have policy implications that will be discussed later in this study.

For the district-level fixed effects, several ESD variables were significant across the models predicting college going. All but one of the significant ESD predictors were negative which indicates that holding all else constant, belonging to that ESD was associated with a decreased probability of going to college in comparison to the reference ESD (PSESD). There was one positive ESD predictor in the four-year out-of-state model. Holding all else constant, belonging to ESD 112 was associated with an increased probability of enrolling in a four-year out-of-state college compared to the reference group. Recall from Figure 3 that ESD 112 is located in Southern Washington and shares a border with Oregon. This could be a reason for a higher number of out-of-state college enrollments.

There were four student-level interactions included in the models as well as one cross-level interaction. The cross-level interaction of a student taking Tech Prep crossed with the district's Tech Prep participation rate was a positive significant predictor of high school graduation. There were several significant student-level interactions and one of note is the interaction between gender and Tech Prep participation. This interaction was significant and positive for both high school graduation and any college. For both outcomes, male students saw a larger increase compared to females in their predicted probabilities of high school graduation and any college enrollment by taking Tech Prep courses, holding all else constant. Figure 13 shows how the predicted probabilities for any college enrollment change according to gender and Tech Prep participation.

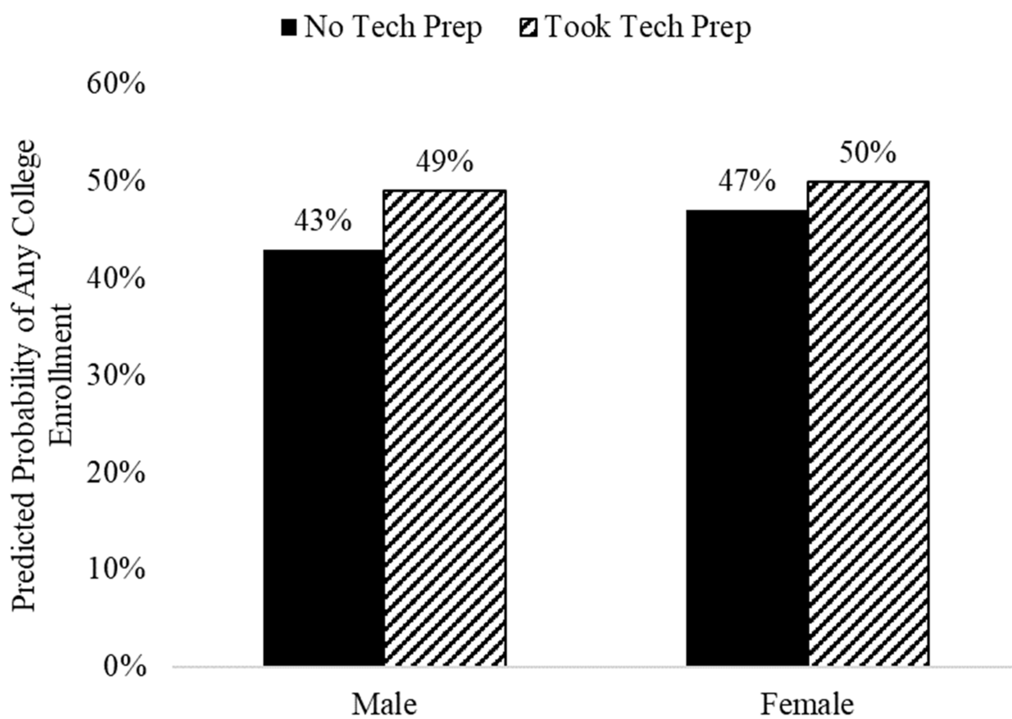


Figure 13. Predicted Probability of Any College Enrollment by Gender and Tech Prep Participation Status

While Tech Prep was a significant positive predictor of high school graduation, it was not a significant predictor of college enrollment and was a negative predictor of four-year college enrollment. These results do not align with previous research pertaining to dual-credit and college enrollment and invites the question of how Tech Prep courses should be considered among the dual-credit program options. One result with practical implications is the interaction between gender and Tech Prep being a positive significant predictor of any college enrollment. Tech Prep course participation may be a promising way for male students to increase their likelihood of attending college.

5.5 AP

As with Tech Prep, there are four models for AP. For all models, there was significant between-schools variance and there was significant between-districts variance for all models but high school graduation. For the student-level fixed effects, ELL status was a significant negative predictor of all four outcomes. GPA was a significant positive predictor of all outcomes but four-year out-of-state college and Gender and URM status were significant in all models except for high school graduation. URM status was a positive predictor of any college and four-year college, but a negative predictor of four-year out-of-state college. Being male was a positive significant predictor of four-year college but a negative significant predictor of any college and four-year out-of-state college.

When looking at AP participation, taking at least one AP course was a significant predictor of all outcomes. Taking AP was a significant positive predictor of high school graduation, any college and four-year college. This means that holding all else constant, taking at least one AP course is associated with an increased probability of graduating high school, enrolling in any college and enrolling in a four-year college. AP was a negative significant predictor of four-year out-of-state college enrollment which means that holding all else constant, taking at least one AP course is associated with a decreased probability of enrolling in a four-year out-of-state college. See Figure 14 for predicted probabilities based on AP participation. As described earlier, students taking an AP course must pass an exam in order to earn college credit. This study only looks at course participation and there could be information on AP exam results that would explain AP course participation being a negative predictor of four-year out-of-state enrollment.

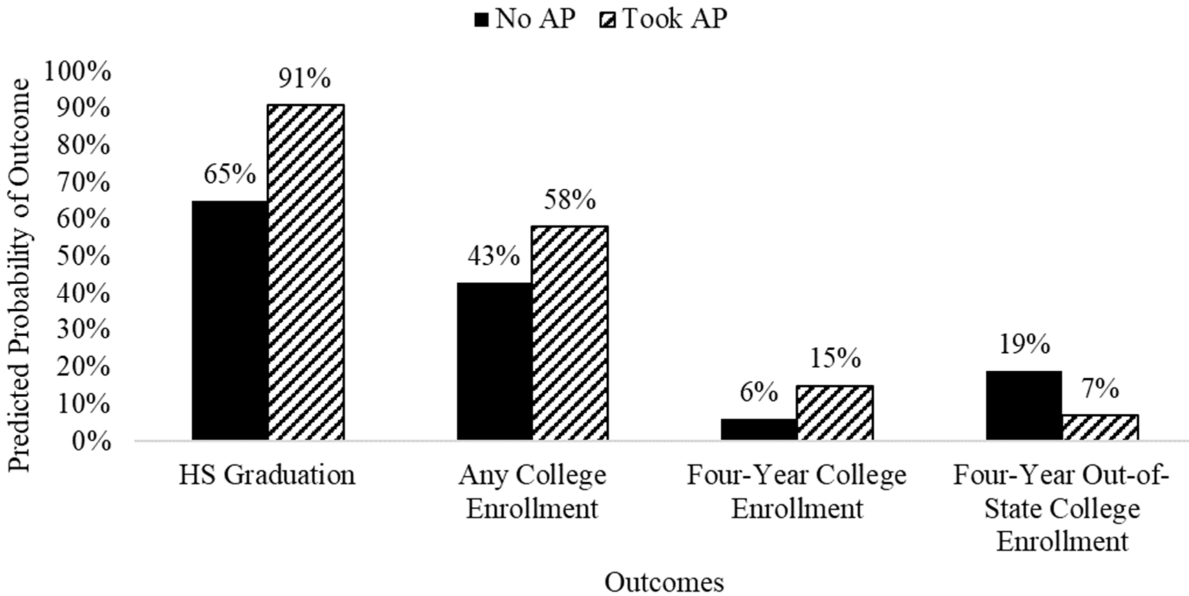


Figure 14. Predicted Probability of Each Outcome by AP Participation Status

For the district-level fixed effects, several ESD variables were significant across all of the models. All but three of the seventeen significant ESD predictors were negative. There was one positive significant ESD predictor in the high school model and two positive significant predictors in the four-year out-of-state model. Holding all else constant, belonging to ESD 171 was associated with an increased probability of graduating high school compared to the reference group. Belonging to ESD 112 and 123 was associated with an increased probability of enrolling in a four-year out-of-state college compared to the reference group, holding all else constant. Both ESD 112 and ESD 123 are located in Southern Washington and share a border with Oregon. As mentioned in the Tech Prep analysis, this could be a reason for a higher number of out-of-state college enrollments.

A district's percentage of students participating in AP was a significant positive predictor of enrolling in four-year college and four-year out-of-state college. Holding all else constant, a student attending a district having a higher percentage of students participating in AP, defined as one standard deviation above average, had predicted probabilities of 17% and 9% of enrolling in a four-year or four-year out-of-state college, respectively. This result for the four-year out-of-state model will be discussed in further detail after the results of the interaction variables.

In all models there were four student-level interactions included as well as one cross-level interaction. The cross-level interaction of student AP participation status and a district's AP participation rate was a positive significant predictor of enrolling in a four-year out-of-state college. In this case, while AP participation on its own was a negative predictor, this interaction meant that both students taking and not taking AP courses saw higher predicted probabilities of enrolling in a four-year out of state college if they belonged to a district with a high AP participation rate.

The only significant student-level interaction was for the interaction between GPA and AP participation. This interaction was significant and positive for all outcomes but any college. Holding all else constant, having a higher GPA, one standard deviation above the mean, and taking at least one AP course is associated with 56% predicted probability of enrolling in a four-year college compared to a 2% predicted probability for student with a low GPA (-1 SD) and participating in AP. As GPA increases, students participating in AP see a greater increase in predicted probability of enrolling in a four-year college compared to students who do not participate in AP. For the out-of-state model, the interaction result differs from the predictors on their own, where taking AP is a significant negative predictor and GPA is not significant. Figures 15 and 16 provide a visual interpretation of the interaction results.

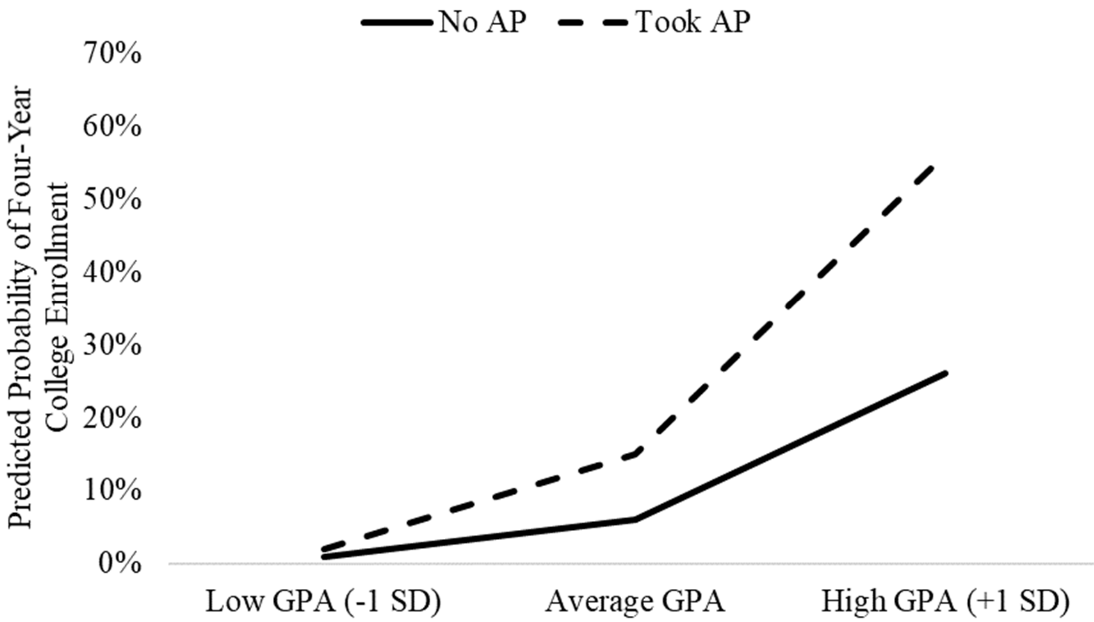


Figure 15. Predicted Probability of Four-Year College Enrollment by GPA and AP Participation Status

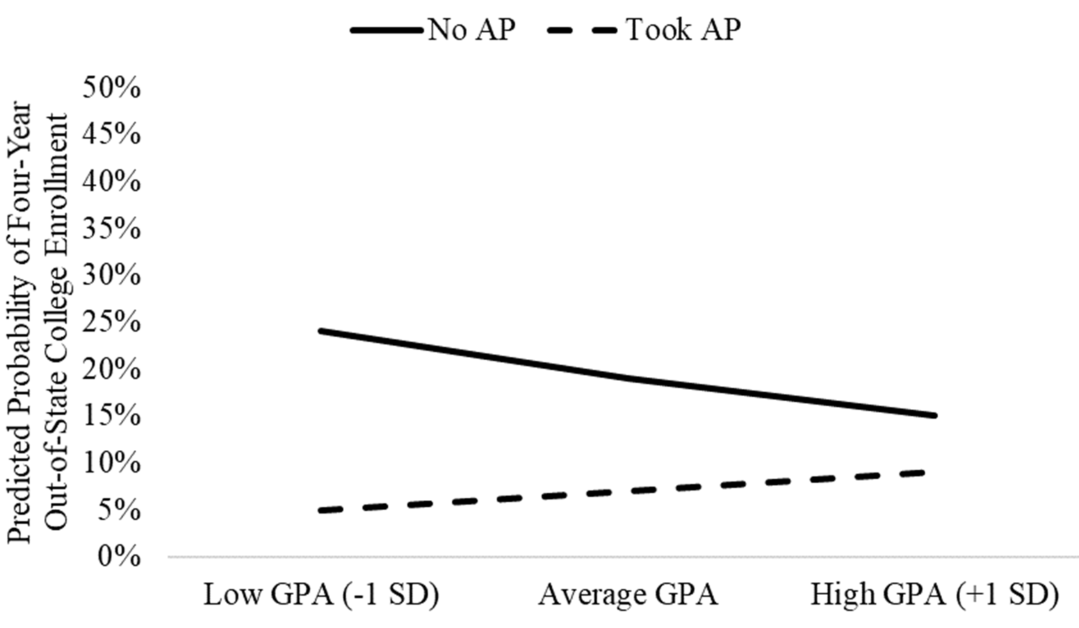


Figure 16. Predicted Probability of Four-Year Out-of-State College Enrollment by GPA and AP Participation Status

AP was a significant positive predictor of all outcomes but four-year out-of-state college enrollment, where it was a negative significant predictor. These results help solidify the use of AP as a dual-credit course as course participation is associated with an increased likelihood of enrolling in any college. This aligns with the state's rationale for increasing dual-credit participation. Looking further into the four-year out-of-state model, additional details emerge that help to explain the initial result regarding AP participation. I find that students with higher GPAs taking AP courses are more likely to enroll in a four-year out-of-state college as well as students who take AP courses and attend districts where more students take AP courses.

5.6 Running Start

Models for each of the four outcomes were run for Running Start, but the four-year out-of-state model would not converge due to issues of multicollinearity. Correlations can be found in Table 20 below and the correlations of concern are in bold. The interaction between Running Start and ELL Status and GPA was highly correlated with Running Start participation, $r = -0.99$, $p < 0.01$ and $r = 0.84$, $p < 0.01$, respectively. The two interaction terms mentioned were also highly correlated with one another, $r = -0.83$, $p < 0.01$.

Table 20. *Zero-Order Correlations Among Running Start Four-Year Out-of-State College Variables*

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Four-Year Out-of-State College Enrollment (1=yes)	--								
2. Running Start Participation (1=yes)	-.07 **	--							
3. Gender (1=Male)	-.02 **	-.08 **	--						
4. URM Status (1=URM)	-.08 **	.00	-.01	--					
5. ELL Status (1=ELL)	-.02 **	-.03 **	-.01	.06 **	--				
6. GPA	.04 **	.02 **	-.15 **	-.20 **	-.04	--			
7. Running Start x Gender	.02 **	-.16 **	-.47 **	.00	.02 **	.09	--		
8. Running Start x URM Status	.07 **	-.53 **	.04 **	-.39 **	-.02 **	.09 **	.07	--	
9. Running Start x ELL Status	.08 **	**-.99** **	.08 **	-.01	-.10 **	-.01 *	.15 **	.53	--
10. Running Start x GPA	-.08 **	**.84** **	-.02 *	.07 **	-.01	-.27 **	-.21 **	-.54 **	**-.83** **

Note. *N*=22296 students enrolling in a four-year college. All predictor variables have been effect-coded except for GPA, which has been standardized.
**p* <.05, ***p* <.01

Of the three models that could be run, there was significant between-schools variance for all three outcomes and there was significant between-districts variance for the two college outcomes. Gender, URM status and GPA were significant predictors of all three outcomes. URM status and GPA were significant positive predictors of all outcomes and being male was a significant negative predictor of high school graduation and any college enrollment, but a significant positive predictor of four-year college enrollment. ELL status was a significant negative predictor of high school graduation and four-year college enrollment.

For Running Start participation, taking at least one Running Start course was a significant positive predictor of any college enrollment. This means that holding all else constant, taking at least one Running Start course is associated with a 69% predicted probability of enrolling in any college compared to a 47% predicted probability for students not participating in the program. Running Start participation was not significant in the high school graduation or four-year college enrollment models. The finding of Running Start positively predicting any college enrollment is also what Cowan and Goldhaber found in their 2015 study of Running Start. However, my results differ in that, unlike Cowan and Goldhaber (2015), I did not find students taking Running Start to be less likely to graduate from high school or enroll in a four-year college.

For the district-level fixed effects, there were several ESD variables that were significant in both of the college going models. All of the significant ESD predictors were negative. Holding all else constant, belonging to one of these ESDs was associated with a decreased probability of going to college in comparison to the reference ESD (PSESD). The percentage of students taking Running Start at the district level was not a significant predictor in any of the models.

There were significant student-level interactions between Running Start and URM Status and Running Start and GPA for all three models. All interactions between Running Start and

URM status were significant and positive. This is an important finding in the high school graduation and four-year college models given that Running Start on its own was not a significant predictor in those models. The interpretation of the interaction is different for each outcome. For high school graduation the interaction between Running Start participation and URM Status results in slightly decreased predicted probabilities for URM and non-URM students who participated in Running Start, holding all else constant. For any college enrollment and four-year college enrollment, URM students taking a Running Start course saw increased predicted probabilities compared to URM students who did not participate but differed in how predicted probabilities on non-URM students changed. Figures 17 – 19 show results of these interaction terms.

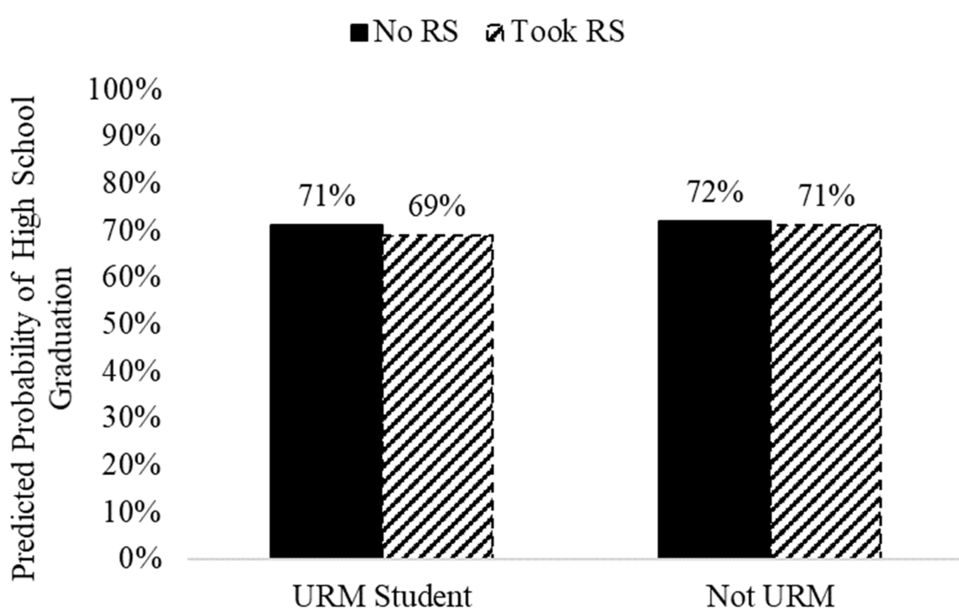


Figure 17. Predicted Probability of High School Graduation by URM Status and Running Start Participation Status

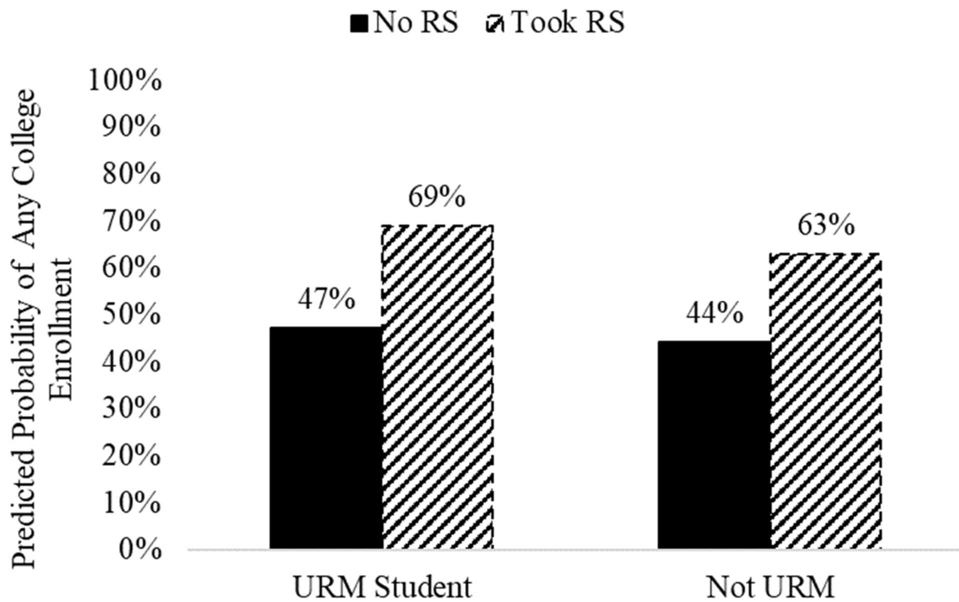


Figure 18. Predicted Probability of Any College Enrollment by URM Status and Running Start Participation Status

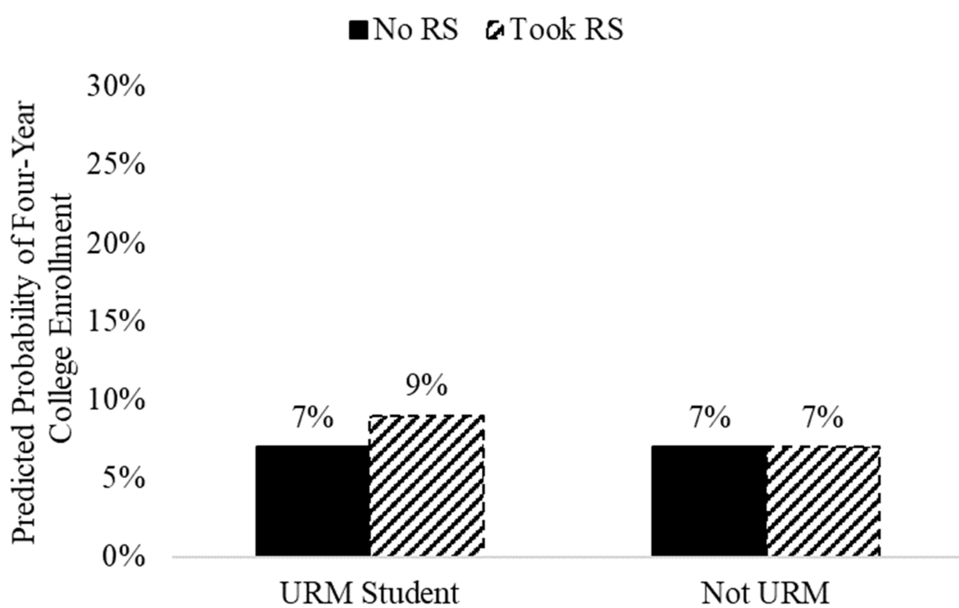


Figure 19. Predicted Probability of Four-Year College Enrollment by URM Status and Running Start Participation Status

The interaction between Running Start and GPA was positive for the high school graduation model, but negative in both the any college and four-year college models. For the models in which the interaction was negative having a high GPA (+1 SD) leads to a bigger increase in predicted probabilities for students who do not participate in Running Start, holding all else constant. In the case of the four-year college enrollment model, students with high GPAs who do not participate in Running Start have a higher predicted probability than students with high GPAs that do participate. This could be the case if more students with high GPAs taking Running Start are enrolling in two-year colleges, which we have not accounted for in any of these models. This is a result that needs more investigation in future studies. This result for four-year college enrollment can be found in Figure 20.

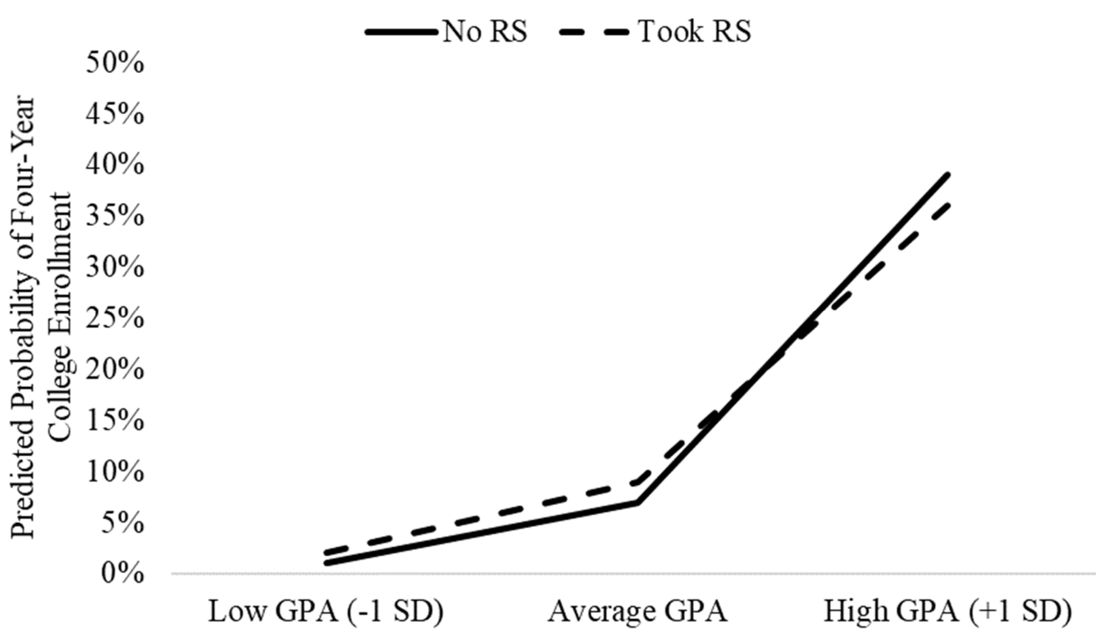


Figure 20. Predicted Probability of Four-Year College Enrollment by GPA and Running Start Participation Status

Running Start was only a significant positive predictor of any college enrollment. This is still an important finding given the states' focus on dual-credit participation as a means of increasing college enrollment. The positive significant interaction between Running Start and URM status is also a finding that has implications as districts look to increase dual-credit participation. Based on these findings, Running Start may be a better option for URM students than other dual-credit programs.

5.7 College in the High School

As with Tech Prep and AP, there are four models for CHS. For all models, there was significant between-schools variance and there was significant between-districts variance for all models but high school graduation. For the student-level fixed effects, GPA was a significant positive predictor of all four outcomes. Gender and URM status were significant predictors in all three college going models. Being male was a negative predictor of any college and four-year out-of-state college enrollment, but a positive predictor of four-year college enrollment. URM status was a positive significant predictor of any and four-year college enrollment, but a negative predictor of four-year out-of-state college enrollment. ELL status was a negative significant predictor of high school graduation and four-year college enrollment.

Taking at least one CHS course was a significant positive predictor of all outcomes but four-year out-of-state college enrollment where it was not a significant predictor. This means that holding all else constant, taking at least one CHS course is associated with an increased probability of graduating high school, enrolling in any college and enrolling in a four-year college. See Figure 21 for predicted probabilities based on CHS participation. These results are similar to what was found in the AP analysis and as indicated earlier, there is no exam associated with CHS. This program could be an alternative or addition to offering AP courses as students can take and pass the course and receive college credit.

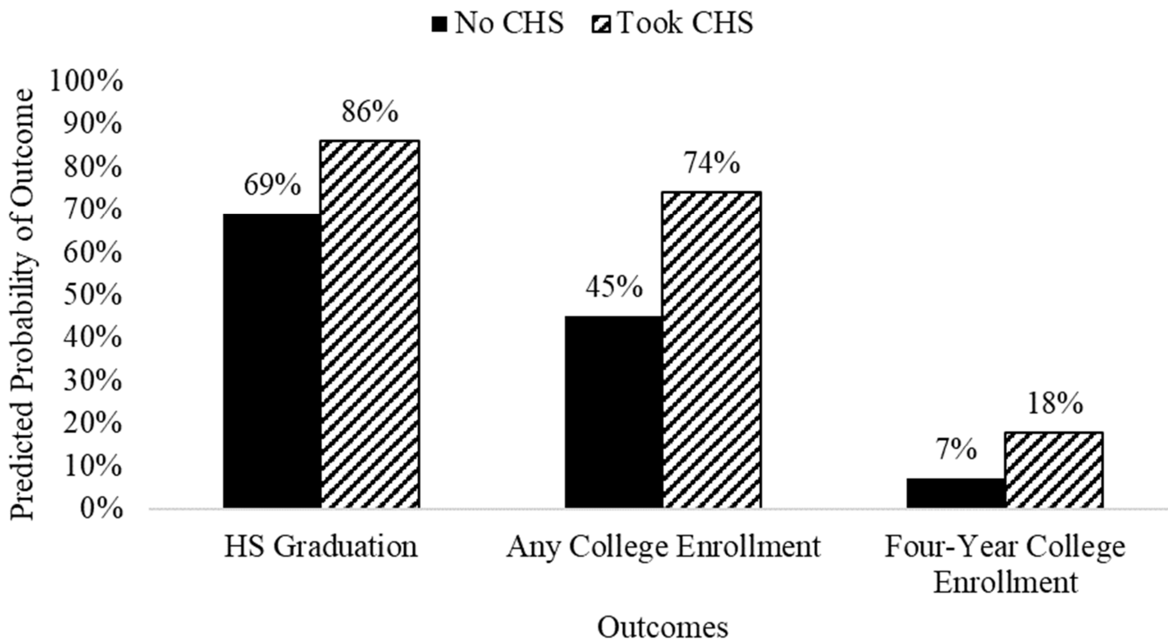


Figure 21. Predicted Probability of Outcome by CHS Participation Status

For the district-level fixed effects, several ESD variables were significant across all of the college going models. All but one of the significant ESD predictors were negative. The one positive significant ESD predictor was in the four-year out-of-state college model. Holding all else constant, belonging to ESD 112 was associated with an increased probability of enrolling in a four-year out-of-state college compared to the reference group, holding all else constant. This is a result that was also seen in the analyses of Tech Prep and AP.

A district's percentage of students participating in CHS was a significant positive predictor of four-year out-of-state college. Holding all else constant, a student attending a district having a high percentage of students participating in CHS (+1 SD), had a predicted probability of

34% of enrolling in a four-year out-of-state college. This is compared to a predicted probability of 27% for students attending a district with an average amount of students participating in CHS.

In all models there were four student-level interactions included as well as one cross-level interaction. The cross-level interaction of student CHS participation status crossed with the district's CHS participation rate was a positive significant predictor of enrolling in a four-year college. The results from this interaction indicate that students taking CHS courses saw higher predicted probabilities of enrolling in a four-year college if they belonged to a district with a high CHS participation rate, while the high CHS participation rate had no effect on students not participating in CHS.

There were only three significant student-level interactions and they were between GPA and CHS participation and ELL status and CHS participation. This interaction between GPA and CHS was a positive predictor of high school graduation and a negative predictor of any college enrollment. Holding all else constant, as GPA increases, students participating in CHS have a higher predicted probability of graduating from high school and enrolling in any college compared to students who do not participate in CHS. However, for both outcomes students not participating in CHS see a greater change in predicted probabilities from average to high GPAs than students participating in the program. Figures 22 and 23 show these outcomes below.

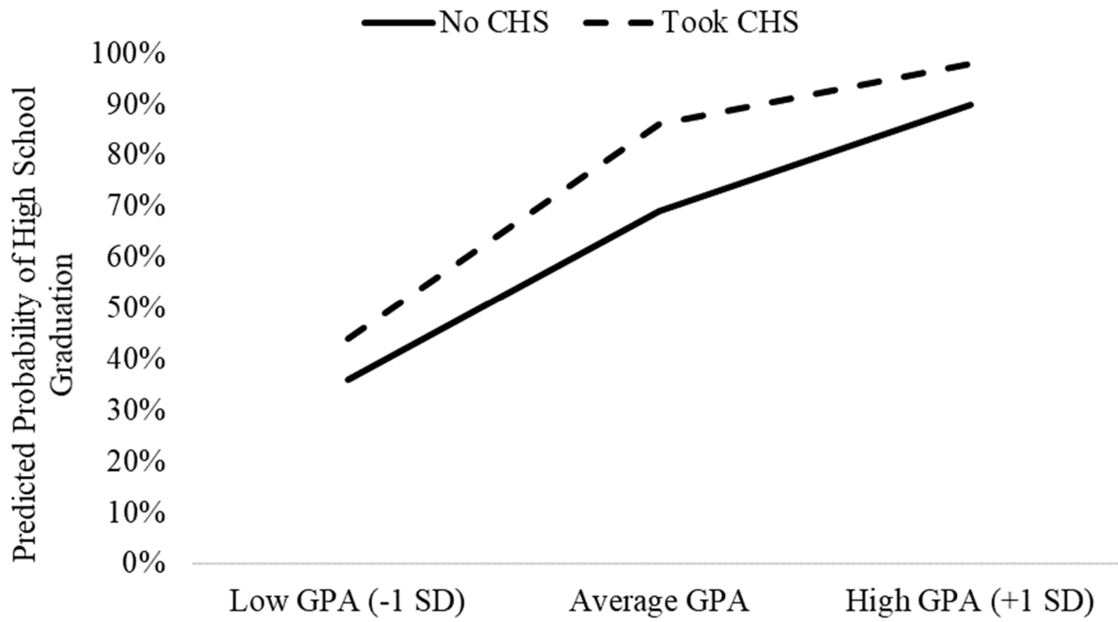


Figure 22. Predicted Probability of High School Graduation by GPA and CHS Participation Status

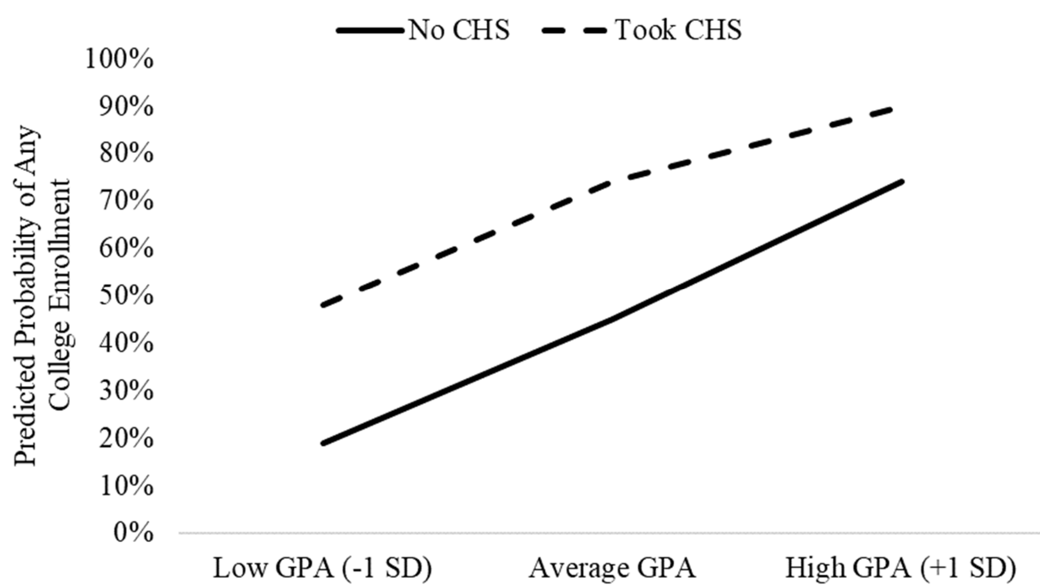


Figure 23. Predicted Probability of Any College Enrollment by GPA and CHS Participation Status

The interaction between ELL and CHS participation was a significant positive predictor of any college enrollment. Holding all else constant, ELL students participating in CHS have a higher predicted probability of enrolling in any college than non-ELL students taking CHS courses at 74% and 70% respectively. ELL students also see a larger increase in predicted probability by participating in CHS than non-ELL students, as shown in Figure 24. This is another finding that has implications for districts as ELL status on its own was a negative (although not significant) predictor of any college enrollment.

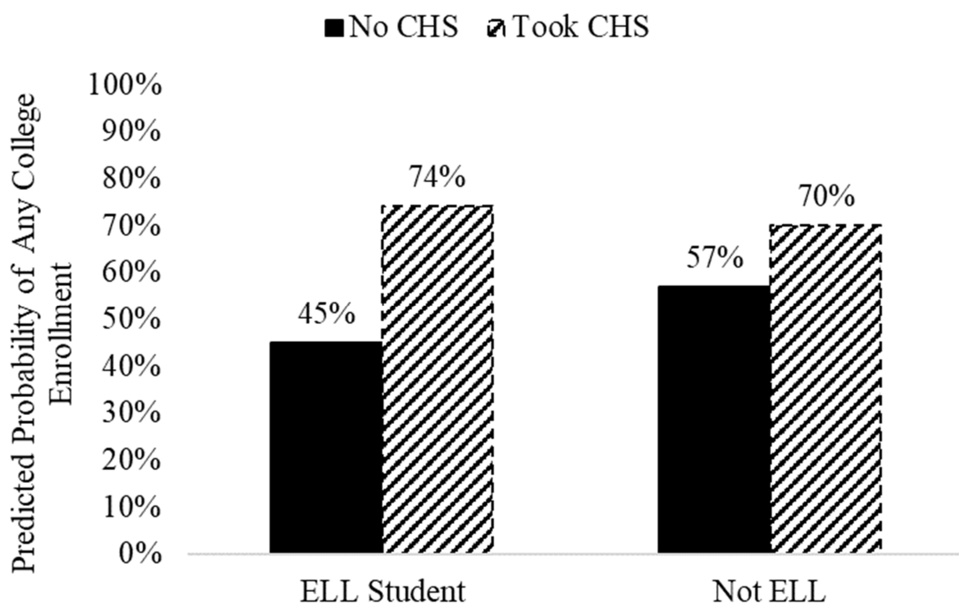


Figure 24. Predicted Probability of Any College Enrollment by ELL Status and CHS Participation Status

CHS participation was a significant positive predictor of all outcomes but four-year out-of-state college enrollment. Even though this is a newer program it is showing results similar to AP and is a significant predictor of college enrollment which aligns with the state's rationale for increasing dual-credit participation. Furthermore, CHS shows promise as a method to increase college enrollment for ELL students. This finding and its implications will be discussed in further detail along with results from the descriptive analysis of the program.

5.8 Predictive Analysis Discussion

Depending on the program and outcome, different predictors emerged as significant across the HLM models. An overview of significant predictors from all models can be found in Table 21 below. This table gives a different view of the results as it allows for a quick comparison by outcome.

Table 21. *Significant Predictors from Final Models*

	High School Graduation				Any College				Any Four-Year College				Four-Year Out-of-State College			
Fixed Effect	*TP*	*AP*	*RS*	*CHS*	*TP*	*AP*	*RS*	*CHS*	*TP*	*AP*	*RS*	*CHS*	*TP*	*AP*	*RS*	*CHS*
Student Predictors																
Male	-		-		-	-	-	-	+	+	+	+	-	-		-
URM			+		+	+	+	+	+	+	+	+	-	-		-
ELL	-	-	-	-	-	-			-	-	-	-	-	-		
GPA	+	+	+	+	+	+	+	+	+	+	+	+				+
DC	+	+		+		+	+	+	-	+		+		-		
DC x Male	+				+											
DC x URM			+		+		+				+					
DC x ELL	-							+	-							
DC x GPA	+	+	+	+	+		-	-		+	-			+		
District Predictors																
% Taking DC										+				+		+
Any DC x % Taking DC	+											+		+		
ESD 101					-	-	-	-	-	-	-	-				
ESD 105					-	-	-	-					-	-		-
ESD 112					-	-	-	-	-	-	-	-	+	+		+
ESD 113					-	-	-	-	-	-	-	-				
ESD 114					-	-	-	-	-	-	-	-				
ESD 123					-		-	-	-		-	-		+		
ESD 171		+			-	-	-	-	-	-	-	-	-			-
ESD 189					-	-	-	-	-	-	-	-				

Note: DC pertains the the specific dual-credit program being referenced

Demographic predictor variables and GPA behaved similarly by the outcome they were predicting. ELL status was a negative predictor of all outcomes for all programs and GPA was a positive predictor. Being male is a negative predictor of high school graduation, any college enrollment and four-year out-of-state enrollment, but a positive predictor of four-year college enrollment. URM status was a positive predictor of any college and four-year college, but a negative predictor of four-year out-of-state college enrollment. URM status is often found to be a negative predictor in the literature, so this was an unexpected finding.

The results of the dual-credit program predictors and their interactions with the demographics varied by outcome and provide insight and implications for dual-credit access. There was not a single outcome that was significantly predicted by all four dual-credit programs. Both Tech Prep and Running Start significantly predicted two of the outcome variables while CHS was predictive of three of the outcomes and AP predicted all four outcomes. However, as mentioned previously, AP course taking was a negative significant predictor of four-year out-of-state college.

When thinking about the different dual-credit programs and the research on dual-credit course taking being related to increased college enrollment, it is important to focus on the results of the any college models. For these models, all programs were significant positive predictors of any college enrollment, except for Tech Prep. This finding begs the question of Tech Prep being included as a dual-credit option and will be explored further in the discussion. The results of these models also provide support for considering increased AP, Running Start and CHS access and participation.

In regard to four-year college enrollment, Tech Prep and Running Start provide results that should be discussed. Tech Prep is a significant negative predictor of four-year college enrollment and Running Start is not a significant predictor. Two-year college enrollment is not included as an outcome in any of my models and may have yielded different results for these programs. Many Tech Prep students are on a path that would lend itself to a two-year degree and looking at that outcome should be explored in the future. In my initial pilot study, I found that

Running Start course taking was a significant positive predictor of two-year college enrollment, but I did not replicate that analysis in this study.

Each dual-credit program has at least one significant interaction that provides information to districts as they think about how to expand their dual-credit programming. For Tech Prep, the interaction of Tech Prep and Gender was a significant positive predictor of any college enrollment. This means that male students participating in Tech Prep have an increased likelihood of attending any college. Being male was a negative predictor of any college enrollment, so taking Tech Prep courses could be a way to get more male students on the path to college.

The interaction between AP participation and GPA was a significant positive predictor of four-year out-of-state college enrollment. Remember that AP participation on its own was a negative predictor of this outcome. Students that take AP courses and have a higher GPA have an increased probability in enrolling in a four-year out-of-state college.

The interaction between Running Start and URM status was a significant positive predictor of any college and four-year college enrollment. Running Start participation by itself was not a significant predictor of four-year college enrollment. This result shows that Running Start may be a good dual-credit option for URM students who are interested in attending a four-year college. However, there can be barriers to accessing Running Start and this will be explored further in the discussion.

Lastly, the interaction between College in the High School participation and ELL status was a positive significant predictor of any college enrollment. Out of all the models in this analysis, this was the only ELL variable that was a positive significant predictor. Schools and districts with large populations of ELL students might consider providing increased access to College in the High School courses.

Chapter 6: Discussion and Implications

6.1 Summary of Key Findings

As previously discussed in the descriptive analysis, not all students have access to the same dual-credit options. Dual-credit programs offerings differ by region of the state as well as school district size. Students in the greater Puget Sound region have access to more dual-credit options than students elsewhere in the state. Larger districts also have more dual-credit options available to students and have a larger proportion of students participating in dual-credit than smaller districts. Students outside of Puget Sound that attend smaller districts are at a disadvantage in having choice of dual-credit programs as well as participating in any type of dual-credit.

The demographics of students participating in Tech Prep were almost identical to the overall sample, but this was not the case for the other dual-credit programs. In all five of the other programs, male students, ELL students and SPED students were underrepresented. Students that were eligible for free or reduced lunch were underrepresented in AP, Running Start, College in the High School and IB programs. White students were overrepresented in AP, Running Start and College in the High School programs. Lastly, students participating in all programs except for Tech Prep had higher GPAs than the overall sample. Through the predictive analyses we know that GPA is often a strong positive predictor of college enrollment. However, it is not known if taking dual-credit courses leads to higher GPAs or if students with higher GPAs are more likely to participate in dual-credit. Additionally, being a male or ELL student often leads to a decreased probability of graduating high school or enrolling in college, but dual-credit participation can lead to an increased probability of those outcomes. This leads to a discussion of key findings from the predictive analysis.

Participation in Tech Prep, AP, Running Start or College in the High School was a significant positive predictor of at least one of the outcomes tested in the predictive models. Tech Prep participation is associated with an increased probability of graduating from high school, while AP, Running Start and College in the High School participation are all associated with an increased probability of enrolling in any college. Additionally, the interaction between participating in Running Start and being an URM student is associated with an increased probability of enrolling in a four-year college. The interaction between being an ELL student and participating in College in the High School was a significant positive predictor of any college enrollment. These findings have implications for districts and policymakers as these results are analyzed in the context of who is participating in each of the programs.

6.2 Challenge of Inequitable Access

Results from the descriptive and predictive analyses have been discussed separately, but it is also important to understand how those results fit together. Starting with region, dual-credit participation varies by 30 percentage points from the lowest participating ESD (105) to the highest participating ESD (PSESD). Across the predictive models for college enrollment, most significant ESD variables were negative, which indicates that students from ESDs other than PSESD were less likely to enroll in college. Not only do students from outside the Puget Sound region participate in dual-credit at lower rates, they are also less likely to go to college. Figure 25 shows the locations of two and four-year colleges in Washington and Northern Oregon. Students outside the Puget Sound region have convenient access to far fewer postsecondary options and this could help explain the lower college enrollment rates outside of PSESD. Students have little say about where they live and go to school, but we know that participating in certain dual-credit programs predicts college enrollment so working to increase access and participation in all regions across the state is a solution worth pursuing.

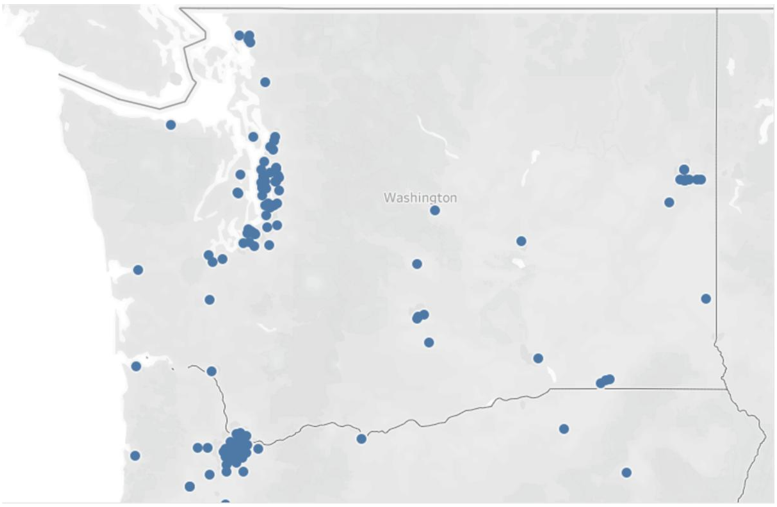


Figure 25. Two and Four-Year Colleges in Washington and Northern Oregon

Most students that participate in dual-credit are participating in Tech Prep. When Tech Prep is removed as a dual-credit option, participation decreases from 76% to 50%. Across the state, all ESDs offer Tech Prep and it is the program with the highest participation rates in all ESDs. And while Tech Prep participation is a significant positive predictor of high school graduation, it does not predict any college enrollment and is a significant negative predictor of four-year college enrollment. These are important findings to present together because while Tech Prep participation does align with prior research related to high school graduation, it does not align with prior research that shows dual-credit participation as a significant positive predictor of postsecondary enrollment. It could be that participating in Tech Prep leads to the attainment of more technical credentials or a two-year degree, but further research is needed to know if that is the case. Districts, schools and students must be aware of how Tech Prep differs from the other dual-credit programs and make decisions on program offerings and participation with this information in mind.

Results from the descriptive analysis showed that ELL and URM students were often underrepresented in dual-credit programs. While participation in AP, Running Start and College in the High School were all positive predictors of any college enrollment, ELL, Black and Hispanic students were underrepresented in all these programs compared to their representation in the overall sample. The ESDs with the largest numbers of ELL sand Hispanic students (ESDs 105, 123 and 171) had the lowest AP participation rates in the state (see Table 13). One finding from the predictive models was that the interaction between URM status and Running Start participation was a significant positive predictor of four-year college enrollment. As mentioned above, Black and Hispanic students across the state are underrepresented in this program, but ESDs with the most URM students have Running Start participation rates similar or higher to the state participation rate of 18%. Thus, Running Start seems to be a more popular dual-credit choice for URM students than other options. Another program specific result of importance was the interaction between ELL status and College in the High School participation being a significant positive predictor of any college enrollment. While there were only 98 ELL students participating in College in the High School, this is a promising finding that furthers the conversation around ELL students in dual-credit programs. These results all indicate that the different dual-credit programs produce different outcomes for different groups of students. This suggests a need for a more nuanced and differentiated approach to how districts choose their dual-credit offerings.

While measures of poverty were not included in the predictive analysis, these measures and their descriptive results warrant further discussion. As mentioned previously, students that were eligible for free or reduced lunch were underrepresented in four of the dual-credit programs. Schools with higher FRL percentages also had lower dual-credit participation rates. There was a 30 percentage point gap between the top and bottom FRL percentage quintiles. This is an important finding as there are costs associated with all dual-credit programs and that could be one of the barriers that leads to lower participation rates. The program that is the least expensive to implement and participate in may not be the best choice for a school given the other findings that have been presented. All schools should be able to offer the variety of dual-credit programs tailored to the specific needs of students.

6.3 Implications

The results of this study have policy implications for district, ESD and state-level policymakers. One of the first implications is about cost and who pays for the various costs and fees associated with the different dual-credit program. Cost becomes an important consideration for two reasons. First, results from this study show that having a greater variety of dual-credit offerings is associated with higher levels of dual-credit participation. Expanding dual-credit program offerings will require additional financial resources. Another reason to consider cost and funding for dual-credit is related to the finding that high poverty schools have lower dual-credit participation rates. This suggests that additional financial resources are needed for both students and schools.

There are currently fee waivers available in Washington for students who qualify for free or reduced lunch to take the AP, IB and Cambridge exams at no cost (OSPI, 2019). However, there are still students who do not qualify for these waivers that do not have the financial means to take the exams. There is a need to provide more fee waivers or fee reductions to these students and that is something that could be accomplished at the state or district-level. There are also costs associated with implementing those programs at a district and/or school level and that is a potential area for the state to support as well. There have been increased subsidies for College in the High School to reduce the cost of the college credits (WSAC, 2016) and this has potential to be expanded upon given the results of this study.

The results of this study have implications for ESSA as this policy treats participation in all dual-credit programs as equal, yet the results presented here shows that these programs are not the same on a variety of factors. There needs to be a better understanding of why dual-credit is included as a metric and if the current measure is really serving the intended purpose. Along with different programs having different outcomes, access and participation vary across the state. If a district or school offers fewer dual-credit programs because of fewer resources or being in a remote area and thus has fewer students participating in dual-credit courses, should that district or school receive a lower accountability score under ESSA? Are there ways in which the ESSA accountability score can provide an incentive for districts to increase the variety of dual-credit options available to students? State policymakers could revisit the dual-credit metric of ESSA and determine if any adjustments are needed to adequately address the differing circumstances and needs of districts. Combining increased supports and improved accountability metrics could potentially result in a more equitable distribution of the variety of dual-credit options available to all students across the state.

After looking at both the descriptive and predictive results for Tech Prep, it is clear that this program does not look like the other five offerings. While most students have access to this program, it does not produce outcomes similar to the other programs. Additional research is needed to understand the purpose and impacts of this program. There also needs to be a way to measure if students are career ready, if that is the intent of Tech Prep. Once this information is available, policymakers can revisit whether Tech Prep should be included as a dual-credit program, a separate career readiness option or something else.

Given the heightened stakes around dual-credit in Washington, state-level policymakers and researchers need to take a holistic approach to understanding dual-credit participation and outcomes. The current approach of presenting results of each program separately misses how these programs interact with one another and the variety of what is available to a student. While it is not expected that each student participates in all types of dual-credit programs, this study shows support for students having access to a variety of programs and being able to make choices.

6.4 Limitations and Suggestions for Further Research

One limitation to this study is that it is purely quantitative. It does not allow me to answer questions about why dual-credit courses are being taken or how they are producing certain outcomes. Given that the results of the OSPI Dual-Credit Survey (2017) showed the primary purpose of dual-credit as depending on the student's post-high school plan, it would be valuable to interview students taking dual-credit and ask them why they participate. Also, in using HLM models, I was able to see how well dual-credit program participation predicts outcomes but I was not able to infer causation. My results do not tell me if taking certain dual-credit courses cause student to graduate high school or enroll in college at higher rates. Results from this quantitative study can be used to inform qualitative or mixed-methods work on this topic as an area for future research. There also need to be more experimental studies around dual-credit to understand if there is a causal link.

Another limitation of this study is the recency of the data being used. Data for graduates of the class of 2015 was readily available via state sources and used for this study. It is understood that patterns in dual-credit offerings and participation may change over time and results only pertain to the class of 2015 in Washington. New policies pertaining to dual-credit have been implemented since 2015, the most notable being ESSA. One area of future research would be to replicate the descriptive analyses presented here with more recent graduating classes. This would help policymakers understand if the patterns of program participation for the class of 2015 are similar to more recent years or if there have been changes to program availability and participation.

There are several variables referenced in the conceptual framework that were not included in this study. Future studies could include predictors around poverty and past student performance, such as grades and test scores. It would also be helpful for future studies to examine the interaction between region/ESD and each dual-credit program to provide additional insight into which programs may be the best fit for which students. Distance to a postsecondary institution was not included in the analysis and is also an area for future research. One outcome that was not analyzed in the predictive models was two-year college enrollment. There may be some differences in how the different dual-credit programs predict two-year college enrollment compared to four-year enrollment. It would also be beneficial to look at additional outcomes such as remedial course taking, college persistence and matriculation to understand if dual-credit participation is a predictor beyond initial college enrollment.

This study provides the first comprehensive overview of dual-credit programs in Washington and provides both descriptive and predictive results. Past state reports have shown each dual-credit program in isolation while this study takes a holistic approach to access and participation across the state. I find that not all students have access to the same variety of dual-credit programs and that different programs may be more beneficial for different groups of students. As previously discussed this has policy implications as increased dual-credit participation continues to be a focus in Washington. The results presented here add to the body of state-level studies analyzing dual-credit participation and postsecondary outcomes as well as the larger body of dual-credit research.

References

Adelman, C. (2006). *The Toolbox Revisited: Paths to Degree Completion from High School Through College*. Washington, D.C.: U.S. Department of Education.

Allen, D. (2010). *Dual Enrollment: A Comprehensive Literature Review and Bibliography*. New York: City University of New York.

An, B.P. (2013). The influence of dual enrollment on academic performance and college readiness: Differences by socioeconomic status. *Research in Higher Education, 54,* 407-432.

Bailey, T. R., Hughes, K. L., & Karp, M. M. (2002). *What role can dual enrollment play in easing the transition from high school to postsecondary education?* Washington, DC: U.S. Department of Education.

Bettinger, E.P., & Long, B.T. (2009). Addressing the needs of underprepared students in higher education: Does college remediation work? *The Journal of Human Resources, 44*(3), 732-771.

Blume, G.H., & Zumeta, W.M. (2014). The state of state college readiness policies. *American Behavioral Scientist, 58*(8), 1071-1092.

Bragg, D. & Kim, E. (2006). *Dual credit and dual enrollment.* Champaign, IL: Office of Community College Research and Leadership, University of Illinois at Urbana-Champaign.

Cambridge Assessment International Education (2019). Facts and figures. Retrieved from https://www.cambridgeinternational.org/about-us/what-we-do/facts-and-figures/

Chait, R., & Venezia, A. (2009). Improving academic preparation for college: What we know and how state and federal policy can help. Center for American Progress. Washington, DC.

College Board (2017). College Credit in High School: Working Group Report. *College Board.* Retrieved May 6, 2018, from https://secure-media.collegeboard.org/pdf/research/college-credit-high-school-working-group-report.pdf

College Now (2017). About College Now. *College Now.* Retrieved May 18, 2017, from http://collegenow.cuny.edu/about-college-now/

Complete College America (2012). *Remediation: Higher education's bridge to nowhere.* Washington, DC.

Conley, D.T. (2007). The challenge of college readiness. *Educational Leadership, 64*(7), 23-29.

Cowan, J., & Goldhaber, D. (2015). How much of a "Running Start" do dual enrollment programs provide students? *The Review of Higher Education, 38*(3), 425-460.

Education Research & Data Center

Eimers, M. & Mullen, R. (2003). *Dual credit and advanced placement: Do they help prepare students for success in college?* Paper presented at the 43rd Annual Association of Institutional Research (AIR) Conference, Tampa, FL.

Ganzert, B. (2014). Dual enrollment credit and college readiness. *Community College Journal of Research and Practice, 38*(9), 783-793.

Hirschman, C. (2016). *From high school to college: Gender, immigrant generation, and race-ethnicity.* New York, NY: Russell Sage Foundation.

Hofmann, E. (2012). Why dual enrollment? In E. Hofmann & D. Voloch (Eds.), *Dual enrollment: Strategies, outcomes, and lessons for school-college partnerships* (pp. 1-8). Wiley.

Karp, M. M., Calcagno, J. C., Hughes, K. L., Jeong, D. W., & Bailey, T. R. (2007). *The postsecondary achievement of participants in dual enrollment: An analysis of student outcomes in two states*. St. Paul, MN: University of Minnesota, National Research Center for Career and Technical Education.

Kim, J. (2008). *The impact of dual and articulated credit on college readiness and total credit hours in four selected community colleges*. Champaign, IL: Office of Community College Research and Leadership, University of Illinois at Urbana-Champaign.

Kinnick, K.N. (2012). The impact of dual enrollment on the institution. In E. Hofmann & D. Voloch (Eds.), *Dual enrollment: Strategies, outcomes, and lessons for school-college partnerships* (pp. 1-8). Wiley.

Lichtenberger, E., Witt, M.A., Blankenberger, B, & Franklin, D. (2014). Dual credit/dual enrollment and data driven policy implementation. *Community College Journal of Research and Practice, 38*(11), 959-979.

Long, K. (2018, March 15). At 25, Running Start is a success. Now it must attract students who need it the most. *The Seattle Times*. Retrieved from https://www.seattletimes.com/

Miller, T., Kosiewicz, H., Wang, E.L., Marwah, E.V., Delhommer, S., & Daugherty, L. (2017). *Dual credit education in Texas.* Santa Monica, CA: RAND Corporation.

Miller, T., Kosiewicz, H., Tanenbaum, C., Atchison, D., Knight, D., Ratway, B., Delhommer, S., & Levin, J. (2018). *Dual credit education programs in Texas: Phase II.* Washington, DC: American Institutes for Research.

Nash, C.J. (2015). *Spheres of educational opportunity: A mixed methods study examining the relationship between concurrent enrollment participation and students' college* *transition, readiness, and success* (Doctoral dissertation). Retrieved from ProQuest (UMI 3704779)

National Center for Education Statistics (2019). *Dual enrollment: Participation and characteristics.* U.S Department of Education.

Office of Superintendent of Public Instruction (2019). AP/IB Test Fee Program. Retrieved from http://www.k12.wa.us/AdvancedPlacement/testfee.aspx

Office of Superintendent of Public Instruction (2019). K-12 Data and Reports. Retrieved from http://www.k12.wa.us/DataAdmin/PerformanceIndicators/DataAnalytics.aspx

Porchea, S.F., Allen, J., Robbins, S., & Phelps, R.P. (2010). Predictors of long-term enrollment and degree outcomes for community college students: Integrating academic, psychosocial, socio-demographic, and situational factors. *The Journal of Higher Education, 81*(6), 750-778.

Raudenbush, S.W. & Bryk, A.S. (2002) *Hierarchical linear models: Applications and data analysis methods, second edition.* Thousand Oaks, CA: Sage Publications, Inc.

Thompson, M.S., Gorin, J.S., Obeidat, K., & Chen, Y. (2006). Understanding differences in postsecondary educational attainment: A comparison of predictive measures for black and white students. *The Journal of Negro Education, 75*(3), 546-562.

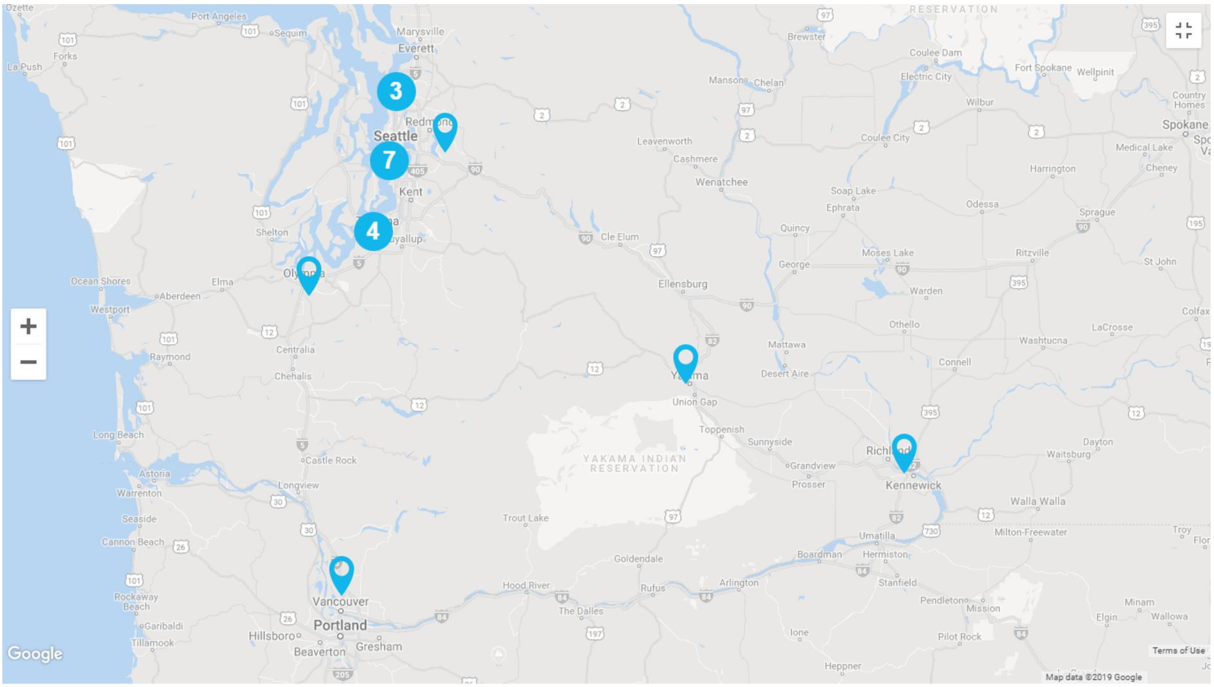
Washington Student Achievement Council (2016). *Dual credit report.* Olympia: The Council.

Washington State STEM Education Innovation Alliance (2017). Vision 2021: Investing in a future ready Washington. *STEM Alliance.* Retrieved May 6, 2018, from https://www.wsac.wa.gov/sites/default/files/2017.01.03.STEM.Vision.2021.pdf

Welsh, J.F., Brake, N., & Choi, N. (2005). Student participation and performance in dual-credit courses in a reform environment. *Community College Journal of Research and Practice, 29*(3), 199-213.

Appendix A

IB Program Locations and Schools



School Names:

A.C. Davis Senior High School

Capital High School

Chief Sealth International High School

Columbia River High School

Edmonds-Woodway High School

Henry Foss High School

Inglemoor High School

Ingraham High School

Interlake High School

Kennewick High School

Kent-Meridian High School

Lt. General William H. Harrison Preparatory School

Mt. Rainier High School

Rainier Beach High School

Renton High School

Skyline High School

South Kitsap High School

Sumner High School

Thomas Jefferson High School

Source: https://www.ibo.org/programmes/find-an-ib-school/

Appendix B

Table B. *Dual-Credit by District Size*

Characteristic	<100		100-499		500-999		1000-1999		2000-2999		3000-4999		5000-9999		10000-19999		20000+	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
	85	0.1%	1220	1%	2630	3%	4356	5%	4480	5%	10934	12%	17450	19%	25025	27%	25181	28%
Taking Tech Prep	5	6%	262	21%	896	34%	1806	41%	1833	41%	5738	52%	9158	52%	14714	59%	14866	59%
Taking AP	5	6%	262	21%	566	22%	920	21%	1052	23%	2695	25%	5598	32%	8608	34%	9823	39%
Taking Running Start	25	29%	282	23%	638	24%	1069	25%	1073	24%	1970	18%	3224	18%	4352	17%	4133	16%
Taking College in HS	6	7%	73	6%	332	13%	423	10%	550	12%	766	7%	1810	10%	3035	12%	2207	9%
Taking IB	0	0%	6	0%	1	0%	0	0%	1	0%	2	0%	411	2%	1308	5%	1970	8%
Taking Cambridge	0	0%	0	0%	0	0%	0	0%	0	0%	1	0%	1	0%	1	0%	336	1%
Any Dual Credit	33	39%	614	50%	1644	63%	2945	68%	3057	68%	7696	70%	13198	76%	20038	80%	20601	82%
Any Dual Credit no TP	32	38%	444	36%	1134	43%	1901	44%	2007	45%	4094	37%	8443	48%	13366	53%	14190	56%

Appendix C

Table C. *Zero-Order Correlations Among Variables*

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1. HS Graduation (1=yes)	--															
2. Any College Enrollment (1=yes)	a.	--														
3. Four-Year College Enrollment (1=yes)	a.	a.	--													
4. Four-Year Out-of-State College Enrollment (1=yes)	a.	a.	a.	--												
5. GPA	.51 **	.44 **	.51 **	.04 **	--											
6. FRL Status (1=FRL)	-.18 **	-.19 **	-.18 **	-.16 **	-.30 **	--										
7. SPED Status (1=SPED)	-.17 **	-.20 **	-.14 **	.02 **	-.13 **	.13 **	--									
8. ELL Status (1=ELL)	-.09 **	-.06 **	-.11 **	-.02 **	-.09 **	.16 **	.04 **	--								
9. Gender (1=Male)	-.08 **	-.09 **	-.05 **	-.02 **	-.18 **	-.01	.09 **	.00	--							
10. URM Status (1=URM)	-.13 **	-.09 **	-.11 **	-.08 **	-.23 **	.31 **	.04 **	.17 **	.00	--						
11. Running Start Participation (1=yes)	.14 **	.16 **	.01 **	-.07 **	.23 **	-.12 **	-.15 **	-.08 **	-.10 **	-.10 **	--					
12. AP Participation (1=yes)	.30 **	.30 **	.30 **	.02 **	.42 **	-.19 **	-.21 **	-.09 **	-.08 **	-.11 **	.04 **	--				
13. Cambridge Participation (1=yes)	.01	.01 *	.02 **	-.01	.02 **	.02 **	-.02 **	.00	.00	.03 **	-.01 **	-.01 *	--			
14. College in the High School Participation (1=yes)	.14 **	.13 **	.12 **	.00	.19 **	-.12 **	-.10 **	-.05 **	-.04 **	-.07 **	.06 **	.17 **	.01 *	--		
15. IB Participation (1=yes)	.07 **	.08 **	.09 **	.02 **	.10 **	-.03 **	-.06 **	-.01 **	-.01 **	.00	.00	-.07 **	-.01 *	-.04 **	--	
16. Tech Prep Participation (1=yes)	.14 **	-.02 **	-.05 **	.00	-.01 *	.01	-.02 **	.01 *	.03 **	.01 **	-.12 **	.08 **	.02 **	.03 **	.01 **	--
17. Any Dual-Credit Participation (1=yes)	.34 **	.22 **	.17 **	.00	.30 **	-.14 **	-.18 **	-.06 **	-.04 **	-.09 **	.26 **	.38 **	.03 **	.19 **	.11 **	.60 **

Note. All variables dummy-coded except for GPA.

*p<.05, **p<.01

a. Cannot be computed because at least one of the variables is constant.

Appendix D

Table D1. *HS Graduation 3 and 4-Level Intercept Only Models*

	3 Level Intercept Only					4 Level Intercept Only				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept 3L	1.21	0.08	15.19	(248)	**<.001**					
Intercept 4L						0.71	0.02	45.43	(8)	**<.001**
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept										
Between Schools	3.16		16293.55	(341)	**<.001**	0.08		30354.69	(331)	**<.001**
Between Districts	0.04		202.56	(247)	>.500	0.00		170.31	(238)	>.500
Between ESDs						0.00		10.02	(8)	.262

Note. *N* =85068 students from 248 districts and 9 ESDs in Washington state.

Table D2. *Any College (of those who graduated) 3 and 4-Level Intercept Only Models*

	3 Level Intercept Only					4 Level Intercept Only				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept 3L	0.02	0.04	0.36	(248)	.716					
Intercept 4L						0.50	0.02	30.99	(8)	**<.001**
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept										
Between Schools	0.62		5677.12	(303)	**<.001**	0.03		5565.34	(293)	**<.001**
Between Districts	0.07		234.87	(246)	>.500	0.00		193.14	(237)	>.500
Between ESDs						0.00		28.09	(8)	**.001**

Note. *N* =67155 students from 247 districts and 9 ESDs in Washington state.

Table D3. *Any Four-Year College (for those with Any College) 3 and 4-Level Intercept Only Models*

	3 Level Intercept Only					4 Level Intercept Only				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept 3L	-0.15	0.05	-3.24	(248)	**.001**					
Intercept 4L						0.46	0.02	24.07	(8)	**<.001**
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept										
Between Schools	0.51		2702.42	(265)	**<.001**	0.02		2338.33	(255)	**<.001**
Between Districts	0.07		307.87	(243)	**.003**	0.00		254.09	(234)	.175
Between ESDs						0.00		37.19	(8)	**<.001**

Note. *N* =40538 students from 244 districts and 9 ESDs in Washington state.

Table D4. *Four-Year Out-of-State College (for those attending Any Four-Year) 3 and 4-Level Intercept Only Models*

	3 Level Intercept Only					4 Level Intercept Only				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept 3L	-1.11	0.05	-23.83	(248)	**<.001**					
Intercept 4L						0.26	0.02	12.05	(8)	**<.001**
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept										
Between Schools	0.16		550.54	(198)	**<.001**	0.00		491.36	(188)	**<.001**
Between Districts	0.17		423.96	(238)	**<.001**	0.00		341.11	(229)	**<.001**
Between ESDs						0.00		53.26	(8)	**<.001**

Note. *N* =22296 students from 239 districts and 9 ESDs in Washington state.

Appendix E

Table E1. *HS Graduation Direct and Unique Effects of Focal Predictors*

	Direct					Unique				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	--	--	--	--	--	4.97	0.61	8.13	(240)	**<.001**
Student Predictors										
Any RS	0.41	0.02	24.80	(84225)	**<.001**	0.28	0.02	13.56	(84219)	**<.001**
AnyAP	1.05	0.02	57.19	(84225)	**<.001**	0.88	0.02	44.33	(84219)	**<.001**
Any Cambridge	0.77	0.11	7.10	(84225)	**<.001**	0.59	0.11	5.31	(84219)	**<.001**
Any CHS	0.86	0.03	27.26	(84225)	**<.001**	0.50	0.03	15.11	(84219)	**<.001**
Any IB	1.00	0.05	21.80	(84225)	**<.001**	0.83	0.05	17.76	(84219)	**<.001**
Any TP	0.26	0.01	21.93	(84225)	**<.001**	0.05	0.02	2.13	(84219)	**.033**
Any Dual Credit	0.74	0.01	58.62	(84225)	**<.001**	0.35	0.02	14.34	(84219)	**<.001**
District Predictors										
ESD 101	--	--	--	--	--	0.35	0.13	2.75	(240)	**.006**
ESD 105	--	--	--	--	--	0.09	0.16	0.55	(240)	.587
ESD 112	--	--	--	--	--	0.31	0.15	2.10	(240)	**.037**
ESD 113	--	--	--	--	--	0.30	0.14	2.14	(240)	**.034**
ESD 114	--	--	--	--	--	-0.05	0.17	-0.27	(240)	.785
ESD 123	--	--	--	--	--	0.09	0.17	0.56	(240)	.575
ESD 171	--	--	--	--	--	0.39	0.16	2.46	(240)	**.015**
ESD 189	--	--	--	--	--	-0.11	0.12	-0.89	(240)	.377
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept										
Between Schools	--		--	--	--	2.34		10305.86	(341)	**<.001**
Between Districts	--		--	--	--	0.15		249.25	(239)	.311

Note. *N*=85068 students from 248 districts in Washington state.

Table E2. *Any College (for those who Graduated) Direct and Unique Effects of Focal Predictors*

	Direct					Unique				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	--	--	--	--	--	0.49	0.28	1.77	(240)	.079
Student Predictors										
Any RS	0.49	0.01	41.85	(66312)	**<.001**	0.40	0.01	30.47	(66306)	**<.001**
AnyAP	0.64	0.01	63.67	(66312)	**<.001**	0.56	0.01	50.09	(66306)	**<.001**
Any Cambridge	0.55	0.12	4.56	(66312)	**<.001**	0.44	0.12	3.68	(66306)	**<.001**
Any CHS	0.54	0.02	30.11	(66312)	**<.001**	0.29	0.02	15.59	(66306)	**<.001**
Any IB	0.52	0.03	15.31	(66312)	**<.001**	0.47	0.03	13.74	(66306)	**<.001**
Any TP	-0.15	0.01	-15.16	(66312)	**<.001**	-0.17	0.01	-13.22	(66306)	**<.001**
Any Dual Credit	0.56	0.01	42.49	(66312)	**<.001**	0.26	0.02	14.65	(66306)	**<.001**
District Predictors										
ESD 101	--	--	--	--	--	-0.21	0.05	-3.90	(240)	**<.001**
ESD 105	--	--	--	--	--	-0.20	0.07	-2.92	(240)	**.004**
ESD 112	--	--	--	--	--	-0.16	0.06	-2.60	(240)	**.010**
ESD 113	--	--	--	--	--	-0.10	0.06	-1.78	(240)	.076
ESD 114	--	--	--	--	--	-0.19	0.07	-2.62	(240)	**.009**
ESD 123	--	--	--	--	--	-0.14	0.07	-2.11	(240)	**.036**
ESD 171	--	--	--	--	--	-0.16	0.07	-2.41	(240)	**.017**
ESD 189	--	--	--	--	--	-0.12	0.05	-2.31	(240)	**.022**
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept										
Between Schools	--		--	--	--	0.33		2562.54	(303)	**<.001**
Between Districts	--		--	--	--	0.01		255.66	(238)	.206

Note. N=67155 students from 247 districts in Washington state.

Table E3. *Any Four-Year College (for those with Any College) Direct and Unique Effects of Focal Predictors*

	Direct					Unique				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	--	--	--	--	--	0.44	0.37	1.18	(240)	.239
Student Predictors										
Any RS	0.09	0.01	7.66	(39695)	**<.001**	0.11	0.01	7.82	(39689)	**<.001**
AnyAP	0.72	0.01	57.41	(39695)	**<.001**	0.66	0.01	48.22	(39689)	**<.001**
Any Cambridge	0.71	0.19	3.82	(39695)	**<.001**	0.68	0.19	3.67	(39689)	**<.001**
Any CHS	0.53	0.02	26.31	(39695)	**<.001**	0.35	0.02	16.55	(39689)	**<.001**
Any IB	0.68	0.04	16.43	(39695)	**<.001**	0.66	0.04	16.02	(39689)	**<.001**
Any TP	-0.20	0.01	-16.29	(39695)	**<.001**	-0.23	0.01	-16.23	(39689)	**<.001**
Any Dual Credit	0.62	0.02	27.78	(39695)	**<.001**	0.28	0.03	10.40	(39689)	**<.001**
District Predictors										
ESD 101	--	--	--	--	--	-0.10	0.07	-1.51	(240)	.132
ESD 105	--	--	--	--	--	-0.01	0.08	-0.11	(240)	.915
ESD 112	--	--	--	--	--	-0.16	0.08	-2.09	(240)	**.037**
ESD 113	--	--	--	--	--	-0.26	0.07	-3.57	(240)	**<.001**
ESD 114	--	--	--	--	--	-0.16	0.09	-1.76	(240)	.080
ESD 123	--	--	--	--	--	-0.13	0.09	-1.54	(240)	.125
ESD 171	--	--	--	--	--	-0.16	0.08	-1.95	(240)	.052
ESD 189	--	--	--	--	--	-0.23	0.06	-3.47	(240)	**.001**
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept										
Between Schools	--		--	--	--	0.28		1349.36	(265)	**<.001**
Between Districts	--		--	--	--	0.09		350.22	(235)	**<.001**

Note. *N*=40538 students from 244 districts in Washington state.

E4. *Four-Year Out-of-State College (for those attending Any Four-Year) Direct and Unique Effects of Focal Predictors*

	Direct					Unique				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	--	--	--	--	--	-1.38	0.37	-3.76	(240)	**<.001**
Student Predictors										
Any RS	-0.14	0.02	-7.32	(21453)	**<.001**	-0.15	0.02	-7.35	(21447)	**<.001**
AnyAP	0.00	0.02	0.26	(21453)	.797	-0.03	0.02	-1.27	(21447)	.205
Any Cambridge	0.14	0.16	0.84	(21453)	.400	0.12	0.16	0.75	(21447)	.455
Any CHS	-0.01	0.02	-0.35	(21453)	.727	-0.01	0.02	-0.54	(21447)	.590
Any IB	0.12	0.05	2.32	(21453)	**.020**	0.08	0.05	1.47	(21447)	.142
Any TP	-0.02	0.02	-1.03	(21453)	.304	-0.04	0.02	-2.29	(21447)	**.022**
Any Dual Credit	-0.06	0.04	-1.44	(21453)	.150	0.03	0.05	0.62	(21447)	.538
District Predictors										
ESD 101	--	--	--	--	--	-0.07	0.07	-0.90	(240)	.369
ESD 105	--	--	--	--	--	-0.47	0.09	-5.14	(240)	**<.001**
ESD 112	--	--	--	--	--	0.20	0.08	2.62	(240)	**.009**
ESD 113	--	--	--	--	--	-0.08	0.08	-0.99	(240)	.324
ESD 114	--	--	--	--	--	0.10	0.09	1.10	(240)	.271
ESD 123	--	--	--	--	--	0.11	0.09	1.32	(240)	.189
ESD 171	--	--	--	--	--	-0.23	0.09	-2.49	(240)	**.013**
ESD 189	--	--	--	--	--	-0.04	0.06	-0.65	(240)	.518
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept										
Between Schools	--		--	--	--	0.15		562.63	(198)	**<.001**
Between Districts	--		--	--	--	0.10		350.51	(230)	**<.001**

Note. *N*=22296 students from 239 districts in Washington state.

Appendix F

Table F. *HLM First Version Full Models*

	HS Graduation					Any College					Any Four-Year College					Four-Year Out-of-State College				
Fixed Effect	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*	*Coeff*	*SE*	*t*	*(df)*	*p*
Intercept (Mean)	4.74	0.61	7.80	(239)	**<.001**	-0.36	0.27	-1.31	(239)	.191	-2.57	0.37	-6.91	(239)	**<.001**	-1.37	0.38	-3.63	(239)	**<.001**
Student Predictors																				
Any RS	-0.11	0.02	-4.81	(81539)	**<.001**	0.19	0.01	13.85	(65207)	**<.001**	-0.07	0.02	-4.47	(39217)	**<.001**	-0.16	0.02	-7.82	(21248)	**<.001**
AnyAP	0.45	0.02	20.42	(81539)	**<.001**	0.25	0.01	21.05	(65207)	**<.001**	0.34	0.02	22.40	(39217)	**<.001**	-0.04	0.02	-1.91	(21248)	.056
Any Cambridge	0.16	0.12	1.34	(81539)	.181	0.19	0.11	1.67	(65207)	.095	0.53	0.17	3.11	(39217)	**.002**	0.09	0.15	0.63	(21248)	.531
Any CHS	0.21	0.04	5.94	(81539)	**<.001**	0.11	0.02	5.84	(65207)	**<.001**	0.17	0.02	7.53	(39217)	**<.001**	-0.02	0.02	-0.89	(21248)	.372
Any IB	.528	0.05	10.15	(81539)	**<.001**	0.19	0.03	5.60	(65207)	**<.001**	0.39	0.04	9.13	(39217)	**<.001**	0.06	0.05	1.18	(21248)	.238
Any TP	0.19	0.02	7.95	(81539)	**<.001**	-0.09	0.01	-6.73	(65207)	**<.001**	-0.15	0.02	-9.72	(39217)	**<.001**	-0.03	0.02	-1.65	(21248)	.099
Any Dual Credit	0.25	0.03	9.14	(81539)	**<.001**	0.18	0.02	9.76	(65207)	**<.001**	0.17	0.03	5.78	(39217)	**<.001**	0.01	0.05	0.21	(21248)	.834
Gender	-0.03	0.01	-2.10	(81539)	**.035**	-0.03	0.01	-2.90	(65207)	**.004**	0.08	0.01	6.04	(39217)	**<.001**	-0.08	0.02	-5.20	(21248)	**<.001**
Race	0.03	0.01	1.92	(81539)	.055	0.09	0.01	7.85	(65207)	**<.001**	0.08	0.02	4.85	(39217)	**<.001**	-0.04	0.02	-2.00	(21248)	**.046**
FRL	-0.15	0.01	-11.46	(81539)	**<.001**	-0.11	0.01	-10.25	(65207)	**<.001**	-0.09	0.01	-5.77	(39217)	**<.001**	-0.39	0.02	-16.90	(21248)	**<.001**
SPED	-0.50	0.02	-31.14	(81539)	**<.001**	-0.42	0.02	-23.36	(65207)	**<.001**	-0.46	0.04	-11.71	(39217)	**<.001**	0.19	0.07	2.80	(21248)	**.005**
ELL	-0.34	0.03	-12.77	(81539)	**<.001**	-0.05	0.03	-1.78	(65207)	.074	-0.83	0.06	-13.99	(39217)	**<.001**	-0.23	0.14	-1.66	(21248)	.098
GPA	1.28	0.02	76.06	(81539)	**<.001**	1.02	0.02	66.75	(65207)	**<.001**	1.79	0.02	72.02	(39217)	**<.001**	0.00	0.03	0.09	(21248)	.931
School Predictors																				
% Taking DC	0.42	0.06	7.60	(343)	**<.001**	0.18	0.02	7.69	(343)	**<.001**	0.13	0.04	3.69	(343)	**<.001**	-0.01	0.04	-0.13	(343)	.893
District Predictors																				
ESD 101	0.43	0.13	3.42	(239)	**.001**	-0.15	0.05	2.90	(239)	**.004**	-0.17	0.07	-2.51	(239)	**.013**	-0.04	0.07	-0.62	(239)	.538
ESD 105	0.39	0.15	2.56	(239)	**.011**	-0.07	0.06	-1.13	(239)	.262	0.09	0.08	1.07	(239)	.287	-0.29	0.09	-3.23	(239)	**.001**
ESD 112	0.46	0.14	3.36	(239)	**.001**	-0.10	0.06	-1.83	(239)	.069	-0.27	0.07	-3.66	(239)	**<.001**	0.21	0.07	3.11	(239)	**.002**
ESD 113	0.43	0.13	3.34	(239)	**.001**	-0.02	0.05	-0.47	(239)	.636	-0.34	0.07	-4.92	(239)	**<.001**	-0.05	0.07	-0.77	(239)	.442
ESD 114	0.14	0.16	0.89	(239)	.377	-0.09	0.07	-1.46	(239)	.146	-0.21	0.08	-2.44	(239)	**.015**	0.09	0.08	1.10	(239)	.275
ESD 123	0.25	0.15	1.64	(239)	.102	-0.05	0.06	-0.84	(239)	.400	-0.11	0.08	-1.36	(239)	.175	0.18	0.08	2.35	(239)	**.019**
ESD 171	0.60	0.15	4.02	(239)	**<.001**	-0.15	0.06	-2.57	(239)	**.011**	-0.25	0.08	-3.15	(239)	**.002**	-0.12	0.08	-1.45	(239)	.148
ESD 189	0.09	0.12	0.80	(239)	.425	-0.07	0.05	-1.49	(239)	.138	-0.28	0.06	-4.60	(239)	**<.001**	-0.06	0.05	-1.04	(239)	.297
District Wealth	-0.04	0.05	-0.78	(239)	.438	-0.06	0.03	-2.09	(239)	**.038**	-0.04	0.04	-1.13	(239)	.261	-0.07	0.05	-1.30	(239)	.194
Random Effect	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*	*Var*		*Chi*	*(df)*	*p*
Intercept																				
Between Schools	1.54		4470.46	(333)	**<.001**	0.10		883.46	(298)	**<.001**	0.12		677.11	(258)	**<.001**	0.09		458.02	(189)	**<.001**
Between Districts	0.22		320.25	(235)	**<.001**	0.06		405.35	(234)	**<.001**	0.11		430.64	(230)	**<.001**	0.05		319.61	(225)	**<.001**

Note. For HS Graduation *N*=85068 students from 248 districts. For Any College N=67155 students from 247 districts. For Any Four-Year College N=40538 students from 244 districts. For Four-Year Out-of-State College N=22296 students from 239 districts.