UTAH DATA RESEARCH CENTER

An Analysis of Utah High School Course-Taking Patterns and Their Effects on College Readiness

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Abstract

Students who are best prepared academically coming out of high school are best positioned to do well in college. Using data from the Utah State Board of Education (USBE) and Utah Systems of Higher Education (USHE), this study focuses on Utah high school students from cohort years 2014 to 2017. The numbers of courses taken and passed in each subject in high school are combined with each student's demographic data to model college readiness and post-secondary education outcomes such as enrollment, award, intent to study science, technology, engineering, and/or math (STEM), STEM award, time to enrollment, and time to award. The results suggest that students' demographic background plays a larger role than high school coursework in students being college ready. Being college ready subsequently increases students' odds of enrolling, obtaining an award, and a shorter time to post-secondary enrollment and award. Furthermore, decision tree and random forest models illustrate that the numbers of courses taken in subjects such as social science and science were more important than the numbers of courses passed in these subjects when predicting students' post-secondary outcomes. Overall, students' post-secondary success could be better understood by examining students' environments in addition to their course-taking patterns.

Keywords

Course-taking patterns, college readiness, post-secondary outcomes, Utah System of Higher Education, State of Utah, Utah State Board of Education

1 | Introduction

1.1 | Background

In labor economics, the human capital model (Becker, 1964) views human capital as investments and wages earned as return on investment. Education is an important component of human capital, and could potentially increase productivity as well as wages earned. This study investigates the effects of high school courses on students' college readiness and post-secondary education outcome. While the Utah Data Research Center (UDRC) has conducted studies on disparities in education and wage outcomes based on social, economic, and demographic characteristics of Utahns (Utah State Board of Education, 2020; Tao & Scott, 2021; Martinez, 2019), impacts of coursework in high school is a topic yet to be examined.

Understanding the effects of high school course-taking patterns may be valuable for the students, school administrators, and policymakers. For students, awareness of how a course contributes to their future educational and career outcomes may motivate their efforts in various courses. For school administrators, knowing the benefits of courses in each subject area may assist in creating a curriculum that adequately prepares their students. For policymakers, a deep understanding of the effects of courses from each subject area could be crucial in designing and interpreting metrics that evaluate school and students' education outcomes. Comprehension of how high school courses impact future academic outcomes could incentivize individual students, empower school administrators, and assist policymakers in making informed decisions.

This study aims to analyze Utah high school course-taking patterns controlling for students' demographics to determine the effects of various courses on secondary and post-secondary educational outcomes. For each student, the numbers of courses taken and passed in each subject area according to the Comprehensive Administration of Credentials for Teachers in Utah Schools (CACTUS) are modeled to predict the student's college readiness. CACTUS provide the coding of various courses to the subject they are taught in. For example, algebra and calculus are different courses, but they are both in the subject of mathematics. In addition, high school course data, demographic data, and college readiness are combined to further model students' post-secondary outcomes. Post-secondary outcomes include enrollment at a post-secondary institution, obtaining an award from a post-secondary institution, intent to study STEM, obtaining a STEM award, and the time between high school completion and post-secondary enrollment and award.

At the beginning of 2019, a new school grading system was implemented by the USBE. The updated performance metrics include academic achievement, academic growth, progress in English language proficiency, and post-secondary readiness (USBE, 2020). Students' academic growth and achievement can be evaluated using their high school coursework and graduation; therefore, coursework and high school graduation are chosen as estimates of students' college readiness. For this study, college readiness is defined using two conditions: high school graduation and advanced coursework. If a student did not graduate from high school and did not complete any advanced coursework, the student is coded to be "not college ready." A student who either graduated high school or completed advanced coursework, but not both, is coded as "partially college ready." A student who graduated high school and completed advanced coursework is coded as "college ready." Advanced coursework is defined as receiving a grade of C or higher on at least one Advanced Placement (AP), International Baccalaureate (IB), or Concurrent Enrollment (CE) course. Students who completed a Career and Technical Education (CTE) pathway are also considered to have met the advanced coursework condition. College readiness is an ordinal variable for each student. Any Honors classes that are AP, IB, CE, or CTE courses would be coded as advanced coursework. This study will first model college readiness using the number of high school courses taken and passed in each subject area along with students' demographic data. The college readiness variable is then used as an independent variable along with course and demographic data to model post-secondary outcomes. Table 1 below summarizes the description and definition of college readiness in this study.

While enrollment in post-secondary education, award attainment, and length of time to award are common indicators of student success (Venezia, 2005), areas of study such as engineering and mathematics appear to affect long-term earnings (Carnevale, 2011). The UDRC enjoys the unique advantage of combining data from USBE and follows students into technical colleges and degree-granting institutions to closely examine their post-secondary outcomes such as enrollment, award, studying STEM, and time to enrollment and award.

With high school courses data and student demographic data from USBE and enrollment and awards data from USHE, this study investigates the following research questions:

1) What are the effects of various high school

Table 1: Description and definition of college readiness

College-Readiness Ranking	College-Readiness Description	Definition
0	Not college ready	Student did not graduate from high school and did not complete any advanced coursework
1	Partially ready	Student either graduated high school or completed advanced coursework, but not both.
2	College ready	Student graduated high school and completed advanced coursework

courses on students' college readiness?

2) How do high school courses impact whether students enroll at and obtain an award from a post-secondary institution?

3) Which, if any, courses play a role in students declaring an intent to study STEM and obtaining an award from a STEM-related field?

4) What roles do high school courses play in the amount of time between high school completion to post-secondary enrollment and post-secondary award?

1.2 | Literature Review

Previous research consistently provide evidence that no single factor can fully account for the complex interactions of students' demographic background and their academic achievements. For example, family education background and socioeconomic status are strongly related to students' post-secondary aspirations and success (Strayhorn, 2018; Choy, 2001; Perna & Titus, 2005). For this study, previous research focused on high school courses is highlighted (Adelman, 1999; Gamoran & Hannigan, 2000; Horn, Kojaku, & Carroll, 2001; Long, Conger, & Iatarola, 2012; Warne, 2015).

Following a national cohort of students from 10th grade in 1980 to 1993 when the students were about age 30, Adelman (1999) uses high school and college transcripts, test scores, and surveys to demonstrate that the highest level of mathematics a student studies in high school has the strongest continuing influence on a bachelor's degree completion. Completing a course higher than Algebra 2, such as trigonometry or pre-calculus, more than doubles the odds for a student who enrolls at a post-secondary institution to complete a bachelor's degree. Using regression analysis with over 12,500 students, Gamoran & Hannigan (2000) find that all students, regardless of prior mathematics skills, could benefit from taking algebra in high school, and proceed to argue that all students should enroll in algebra to maximize their educational achievement.

Horn, Kojaku, & Carroll (2001) provides evidence that students who complete a rigorous curriculum in high school, especially advanced courses, were more likely to stay on track to obtaining a bachelor's degree. The authors examined the results of students' college admission exams and grades in the first year of college to establish the association between high school coursework and college preparedness. Additionally, the authors suggest that completing courses above core requirements in high school may help students overcome socioeconomic disadvantages.

Using propensity score matching, Long, Conger, & Iatarola (2012) estimate the effects of rigorous high school course-taking on various educational outcomes. Researchers observe a strong association between high school coursework and college enrollment. The relationships between course-taking and later outcomes are the same across various demographic groups. Results suggest all students, regardless of race, poverty status, gender, and academic ability, could benefit from taking rigorous courses.

With a large sample size including a control group, Warne et al. (2015) present empirical evidence that participation in AP English and AP calculus courses is not advantageous to students who enroll in the course without taking the AP exam. Students who take and pass the AP exam experience the benefits of increased ACT scores even after controlling for other academic, socioeconomic, and demographic variables. AP courses play a role in students' college admissions test scores, which directly affects students' enrollment at post-secondary institutions.

In addition to course-taking patterns, other influences on high school students were widely explored. Pascarella and Terenzini (2005) studied the long-term effects of attending colleges, such as influences on occupations and earnings and various indices of quality of life. College graduates tend to choose environments with similarly educated people, including spouses, close friends, and colleagues who share their social and political points of view. These benefits are then transmitted to their children, favorably shaping their academic preparation, college choices, and college performance. For students whose parents had no education beyond high school, a rigorous high school curriculum can play a role in students remaining on track to receive a bachelor's degree (Warburton, Bugarin, & Nunez, 2001).

2 | Methods

2.1 | Software

Regression models and visualizations for this study were performed in Python (v 3.7) with libraries including pandas (v0.25.1), seaborn (v0.9.0), matplotlib (v3.1.1), and sklearn (v0.21.3). The R software environment 4.1.0 (R Core Team, 2017) was also utilized, along with the following libraries: dplyr (v1.0.7, Wickham, François, Henry, & Müller, 2018), and mass (v7.3.54, Venables & Ripley, 2002).

2.2 | Data

To study the effects of high school course-taking patterns on post-secondary educational outcomes, course data from USBE cohorts from 2014 to 2017 are joined with enrollment and graduation data from USHE. For each USBE student, the number of courses taken and passed in each subject area is calculated. Passing a course is defined as passing with a grade of C or higher. For example, when a student fails a science class, the number of science class taken would increase by one while the number of science class passed would remain the same. If the student repeats this science class, the number of science class taken would again increase by one, while the number science class passed would change depending on if the student passes the class. With 28 subject areas from CACTUS, each student has 56 numeric continuous variables from course data representing the number of courses taken and the number of courses passed in each subject area. If a student did not take a course in a given subject area, the course variables, taken and passed, of that subject area for that student are zeroes. If a student took one class in a subject area but failed, the student would receive one in the number of courses taken in that subject area and zero in the number of courses passed in that subject area. At initial analysis, some high school courses were removed prior to modeling as no high school students took or passed these courses during the time frame studied. These subject areas included library media, administration, elementary early childhood, and support services courses providing a final 24 subject areas. With these courses eliminated, course data for each student contained 48 continuous variables. See Appendix Figures A and B for distributions of courses taken and passed in each subject area.

In addition to course data, demographic data are collected for USBE students. Demographic variables include race, gender, low-income status (based on free- and reduced-lunch eligibility), immigration status, refugee status, English language learning (ELL) status, and special education status. From USBE data, demographic data and course data are compiled for each student as independent variables for modeling.

In the race category, the main subgroups are: Asian, Black, White, Hispanic, Native American, Multiracial, and Pacific Islander. These subgroups are then transformed into eight binary dummy variables with 1 representing a student in a certain racial subgroup, and 0 representing a student not in the subgroup. For each student, only one of the eight binary racial variables is one, with the rest of the binary racial variables zero. Low-income status, immigration status, refugee status, and special education status are binary variables indicating whether a student was identified in these groups. Students' most recent ELL status in USBE data is transformed to a binary variable, with 1 representing those who were English learners (Y) or eligible but opted out (O), and 0 representing those who reclassified as fluent (F), were monitored (M), or English language learning not needed (N).

For each student, an ordinal categorical variable representing college readiness outcome is calculated. A student who graduated high school and received a passing score on advanced coursework is coded as "college ready." A student who either graduated high school or received a passing score on advanced coursework is coded as "partially college ready." For example, students who failed advanced coursework but graduated high school are partially college ready for this study. A student who did not graduate or receive a passing score on advanced coursework is coded as "not college ready." Advanced coursework is defined as AP, IB, or CE courses. Passing is defined as receiving a grade of C or higher. A student who completed a CTE pathway is also considered as having a passing score on advanced coursework.

Next, enrollment and graduation data from USHE are joined with USBE data. For each student, binary variables were created to denote whether the individual enrolled at a degree-granting institution or technical college, whether the individual obtained at least one post-secondary award, whether the individual indicated intent to study a STEM-related area, and whether the individual obtained an award from a STEM-related field. Finally, numeric continuous variables are calculated to represent the time between high school completion and the first post-secondary enrollment, as well as the time between high school completion and the first post-secondary award. For this study, data from degree-granting institutions and technical colleges are combined to investigate whether a student continued to pursue post-secondary education. Completion of programs from degree-granting institutions or technical colleges prior to high school graduation are not considered for this study as the aim is to investigate academic performance after high school. For separate models of students attending degree-granting institutions as opposed to students attending technical colleges, please see Appendix Tables A-D.

For this study, STEM-related degrees are defined using the U.S. Department of Homeland Security's "STEM Designated Degree Program List (U.S. Immigration and Customs Enforcement, 2012)." This list contains Classification of Instructional Program (CIP) codes that are considered STEM. If a student has ever indicated intent to study or obtained an award from one of these CIP codes in a post-secondary institution, the individual was coded as having the intent to study STEM or obtaining an award in STEM respectively.

2.3 | Feature Selection

Decision tree and random forest models were built to examine feature importance of the various high school courses taken or passed. Decision tree and random forest models are tree-based models that calculate feature importance scores which are indicative of the best predictive features of the outcome. High feature importance scores from these models indicate courses that played an important role in students' college readiness and post-secondary outcomes. In other words, high importance scores represent courses taken or passed that were most predictive for students' college readiness or post-secondary outcomes. To limit the importance scores to course data, only students' coursework variables were examined with these models without using demographic data. Once the important course features were selected, demographic data were then combined with course data for the final modeling process. See Appendix Table E and F for detailed feature importance scores from the decision tree and random forest models for each of the following regression models built.

2.4 | Regression Models

The reference levels for each demographic variable was the modal student in the data: a white male student, not from a low-income family, not an immigrant or refugee, did not receive special education, and not an English learner. Top courses are each course variable from the feature selection method described in section 2.3 with the highest importance scores. The model structure for college readiness is as follows:

College Readiness ~ Top Courses + Immigrant + Low income + Refugee + Special Education + Gender + English Learner + Hispanic + Asian + Black + Native American + Pacific Islander+ Multiracial

The post-secondary outcomes are modeled using a similar structure, with the additional independent variable of College Readiness. Models were built for post-secondary enrollment, post-secondary award, intent to study STEM in post-secondary education, post-secondary STEM award, time to enroll at a degree-granting institution, time to enroll at a technical college, time to award at a degree-granting institution, and time to award at a technical college. The basic model structure for post-secondary outcomes is as follows:

Post-secondary outcome ~ Top Courses + College Readiness + Immigrant + Low income + Refugee + Special Education + Gender + English Learner + Hispanic + Asian + Black + Native American + Pacific Islander + Multiracial

2.5 | Limitations

The data used in this study are limited in a few ways. First, USHE data only include public technical colleges and degree-granting institutions in Utah. Data from private post-secondary institutions such as Brigham Young University and Westminster College were not available for this study. In addition, enrollment and awards data were not available for students who continued their academic careers outside of Utah. Furthermore, with the religious practice of serving an LDS mission after high school, the time to award at a Utah degree-granting institution could be longer than the typical four years. As the USBE cohorts studied include 2014 to 2017, some of these students could still be on track to obtain an award. Figures 3 and 4 demonstrate that the time to awards data skew towards students who completed their awards in six years or shorter.

Students' ACT scores were available but were not chosen as a measure for college readiness. Not all students had taken the ACT, and the missing data would require an estimate of the college readiness ranking. ACT scores do not reflect students' course-taking patterns; however, they could serve as summary statistics of students' preparedness for college-level courses.

The model does not establish causal relations between courses taken or demographic data and post-secondary outcomes. Furthermore, due to the linear nature, incremental effects were not examined. Previous research (Adelman, 1999) argued a mathematics course beyond Algebra 2 more than doubles the odds of a student's obtaining a bachelor's degree for those who enrolled. Students' demographic background may affect their course selections. They may be influenced by friends from a similar background and end up taking the same courses. The role of student engagement, in high school and post-secondary institutions, is not investigated in this study. Finally, data are not available to indicate whether a student is a first-generation student. A complete representation of students' social capital such as economic, social, cultural, and parental involvement was not within the scope of this research.

3 | Results

3.1 | Objective One - Effect of High school course-taking pattern on college readiness outcomes

Data from USBE cohorts 2014 – 2017 included 157,613 students. Table 2 below is the make-up of each demographic subgroup.

Table 2: Demographic summaries for USBE cohorts studied in this research. N=157,613

Demographic group	Number of students	Percentage
Male	81,306	51.59%
Female	76,307	48.41%
Special Education	15,955	10.12%
Low-income	73,887	46.88%
Refugee	725	0.46%
Immigrant	2,537	1.61%
English Learner	5,305	3.37%
Asian	3,729	2.37%
Black	2,604	1.65%
White	121,450	77.06%
Hispanic	23,608	14.98%
Native American	2,390	1.52%
Multiracial	1,063	0.67%
Pacific Islander	2,633	1.67%
Unknown	136	0.09%

Among all students, 78.34% were college ready, 16.70% were partially ready, and 4.96% were not ready. To understand the effects of various courses taken and passed in high school on students' college readiness, separate feature selection processes were completed. The first process was to examine the courses that had an effect on college readiness from 0 to 1, moving students from not being college ready to being partially ready. A second feature selection process was completed to examine the courses that had an effect on college readiness from 1 to 2, moving students from being partially ready for college to being college ready. The top ten courses from these two selections processes were then combined to produce a set of courses that were then utilized in the final modeling process. Some of the course features were selected by both the decision tree model and the random forest model, resulting in overlapping in the top ten features from these models. For example, both the decision tree model and the random forest model selected "social studies courses passed" as one of the top ten features. When combining the top ten features from these two models, "social studies courses passed" was one unique course feature as a result of the overlapping of important features by the two models. Therefore, the final set of unique course features selected for the final model included fourteen features. The final course features include science courses taken, mathematics courses taken, mathematics courses passed, foreign language courses taken, language arts courses taken, language arts courses passed, fine arts courses taken, health movement fitness courses taken, social studies courses passed, social studies courses taken, CTE family and consumer sciences courses taken, general education courses taken, student option courses taken, and special education courses taken. Examples of the student options courses include teachers' aide, peer tutor, student government, and study skills. Examples of the education courses include introduction to education and college introduction. Examples of the general education courses include driver's education and learning strategies. The majority of the course data with high importance came from courses taken. Only two of the features were courses passed. This observation suggests students attempting courses could be as impactful as passing the course with a grade of C or higher. With college-readiness outcome being the dependent variable, an ordinal logistic regression model was built with the fourteen selected course features and demographic data. The regression coefficients for the course data and demographic data are reported in Table 3 on the next page.

3.2 | Objective Two - Effects of high school course-taking patterns on post-secondary enrollment

The demographic background of students who continued their education are examined. Among all students studied, 47.61% of the students enrolled

Table 3: Regression coefficients, 95% confidence intervals, and odds ratios for college readiness. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval	Odds Ratio
Intercept 0|1	-2.16***	(-2.16, -2.16)	0.12
Intercept 1|2	-0.25	(-0.25, -0.26)	0.78
Special education courses taken	-0.07***	(-0.07, -0.07)	0.93
Language arts courses taken	0.01*	(0.01, 0.00)	1.01
CTE family and consumer sciences courses taken	0.03***	(0.03, 0.02)	1.03
Fine arts courses taken	0.09***	(0.09, 0.08)	1.09
Mathematics courses taken	-0.03***	(-0.03, -0.04)	0.97
Language arts courses passed	0.19***	(0.19, 0.18)	1.21
Student option courses taken	0.01***	(0.01, 0.01)	1.01
Social studies courses passed	0.26***	(0.26, 0.25)	1.30
Social studies courses taken	0.05***	(0.05, 0.04)	1.05
Foreign language courses taken	0.23***	(0.23, 0.22)	1.26
Health movement fitness courses taken	0.09***	(0.09, 0.08)	1.10
Science courses taken	-0.12***	(-0.12, -0.13)	0.89
General education courses taken	-0.04***	(-0.04, -0.05)	0.96
Mathematics courses passed	0.15***	(0.15, 0.13)	1.16
Immigrant	-0.04	(-0.04, -0.13)	0.96
Low-income	-0.43***	(-0.43, -0.46)	0.65
Refugee	-0.12	(-0.12, -0.30)	0.89
Special Education	-0.13***	(-0.13, -0.17)	0.88
Female	0.06***	(0.06, 0.03)	1.06
English Learner	-0.66***	(-0.66, -0.73)	0.52
Asian	-0.46*	(-0.46, -0.90)	0.63
Black	-0.55*	(-0.55, -0.99)	0.58
Hispanic	-0.14	(-0.14, -0.57)	0.87
Native American	-0.35	(-0.35, -0.79)	0.70
Multiracial	-0.61**	(-0.61, -1.07)	0.54
Pacific Islander	0.04	(0.04, -0.40)	1.04

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$

in at least one post-secondary institution. This figure is consistent with the figure reported on the USHE feedback reports of 46.5% enrollment after one year of high school graduation (Utah System of Higher Education, 2021). Among those who enrolled, 94.96% were college ready, 4.24% were partially ready, and 0.80% were not college ready using the definitions within this research. Table 4 below is the make-up of each demographic subgroup for those who enrolled at a post-secondary institution.

Table 4: Demographic summaries for high school students who enrolled post-secondary education. N=75,037

Demographic group	Number of students	Percentage
Male	35,944	47.90%
Female	39,093	52.10%
Special Education	3,785	5.04%
Low-income	32,372	43.14%
Refugee	323	0.43%
Immigrant	896	1.19%
English Learner	1,091	1.45%
Asian	1,984	2.64%
Black	1,050	1.40%
White	61,420	81.85%
Hispanic	8,432	11.24%
Native American	700	0.93%
Multiracial	449	0.60%
Pacific Islander	925	1.23%
Unknown	77	0.10%

To study whether students continued to pursue their academic careers after completing high school, data from degree-granting institutions and technical college were combined. When a student appeared in enrollment data from either a degree-granting institution or a technical college, the student was coded to have enrolled in post-secondary education.

Using decision tree and random forest models, the top ten course features from each model were combined. Due to top features from each model overlapping, eleven most important course features were selected. For post-secondary enrollment, the eleven most important courses features included fine arts courses taken, CTE skilled technical sciences courses taken, social studies courses taken, health movement fitness courses taken, science courses taken, mathematics courses taken, language arts courses taken, CTE family and consumer sciences courses taken, social studies courses passed, foreign language courses taken, and student option courses taken. Students' demographic data were added to the course data along with college readiness ranking for the final logistic regression model of post-secondary enrollment. The results for the logistic regression model are reported on the next page in Table 5.

3.3 | Objective Three - Effects of high school course-taking patterns on post-secondary awards

Among those who enrolled in a post-secondary institution, 29.85% received a post-secondary award prior to 2021. For those who received an award, 96.79% were college ready, 2.63% were partially ready, and 0.58% were not college ready. Table 6 below breaks down the demographic make-up of those who received an award. More female students received at least one post-secondary award than male students. Given this study follows students for up to six years after high school graduation, the higher percentage of female award recipients is consistent with findings from the National Center for Education Statistics (NCES, 2021). Male students in Utah are more likely to serve an ecclesiastical mission for two years after high school, and therefore may take longer to obtain their first post-secondary award.

Table 6: Demographic summaries for high school students who received a post-secondary award. N=22,400

Demographic group	Number of students	Percentage
Male	8,043	35.91%
Female	14,357	64.09%
Special Education	773	3.45%
Low-income	8,346	37.26%
Refugee	40	0.18%
Immigrant	196	0.88%
English Learner	157	0.70%
Asian	653	2.92%
Black	176	0.79%
White	19,305	86.18%
Hispanic	1,874	8.37%
Native American	152	0.68%
Multiracial	88	0.39%
Pacific Islander	126	0.56%
Unknown	26	0.12%

Table 5: Regression coefficients, 95% confidence intervals, and odds ratios for post-secondary enrollment. Numbers in parentheses indicate 95% confidence interval ranges. .

Model Term	Parameter Estimate	95% Confidence Interval	Odds Ratio
(Intercept)	-2.65***	(-3.04, -2.26)	0.07
Fine arts courses taken	-0.01***	(-0.02, -0.01)	0.99
Student option courses taken	0.00	(-0.01, 0.00)	1.00
Language arts courses taken	-0.03***	(-0.04, -0.02)	0.97
Health movement fitness courses taken	0.01	(0.00, 0.01)	1.01
Social studies courses passed	0.10***	(0.09, 0.11)	1.11
CTE skilled technical sciences courses taken	-0.04***	(-0.05, -0.04)	0.96
Science courses taken	0.00	(-0.01, 0.01)	1.00
Social studies courses taken	-0.02***	(-0.03, -0.01)	0.98
CTE family and consumer sciences courses taken	-0.06***	(-0.07, -0.06)	0.94
Mathematics courses taken	0.01	(0.00, 0.01)	1.01
Foreign language courses taken	0.08***	(0.08, 0.09)	1.08
College Readiness	1.82***	(1.78, 1.85)	6.17
Immigrant	0.04	(-0.06, 0.14)	1.04
Low-income	-0.41***	(-0.44, -0.39)	0.66
Refugee	0.78***	(0.59, 0.98)	2.18
Special Education	-0.74***	(-0.79, -0.70)	0.48
Female	0.21***	(0.19, 0.24)	1.23
English Learner	-0.57***	(-0.65, -0.49)	0.57
Asian	-0.15	(-0.55, 0.24)	0.86
Black	-0.34	(-0.74, 0.05)	0.71
Hispanic	-0.56**	(-0.95, -0.18)	0.57
Native American	-0.69***	(-1.09, -0.30)	0.50
Multiracial	-0.70***	(-1.11, -0.29)	0.50
Pacific Islander	-0.96***	(-1.35, -0.56)	0.38

Note: *$*p<0.05$; $**p<0.01$; $***p<0.001$*

To study whether students receive at least one post-secondary award, awards data from degree-granting institutions and technical colleges were combined. When a student appeared in awards data from either a degree-granting institution or a technical college, the student is coded to have received a post-secondary award. Only students who enrolled at a post-secondary institution were included in this model.

Using decision tree and random forest models, the top ten course features from each model were combined. Due to top features from each model overlapping, eleven most important course features were selected. For post-secondary awards, the eleven most important courses features included social studies courses taken, health movement fitness courses taken, student option courses taken, language arts courses taken, fine arts courses taken, science courses taken, fine arts courses passed, mathematics courses taken, CTE family and consumer sciences courses taken, CTE skilled technical sciences courses taken, and foreign language courses taken. Students' demographic data were added to the course data along with college readiness ranking for the final logistic regression model of post-secondary awards. The results for the logistic regression model are reported below in Table 7:

Table 7: Regression coefficients, 95% confidence intervals, and odds ratios for post-secondary awards. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval	Odds Ratio
(Intercept)	-1.65***	(-2.15, -1.15)	0.19
Social studies courses taken	0.00	(-0.01, 0.01)	1.00
Health movement fitness courses taken	-0.03***	(-0.04, -0.02)	0.97
Student option courses taken	-0.02***	(-0.03, -0.02)	0.98
Language arts courses taken	-0.01	(-0.02, 0.00)	0.99
Fine arts courses taken	-0.03***	(-0.04, -0.03)	0.97
Science courses taken	0.00	(-0.02, 0.01)	1.00
Fine arts courses passed	0.00	(-0.01, 0.01)	1.00
Mathematics courses taken	0.03***	(0.02, 0.050)	1.03
CTE family and consumer sciences courses taken	-0.02***	(-0.03, -0.01)	0.98
CTE skilled technical sciences courses taken	0.00	(-0.01, 0.01)	1.00
Foreign language courses taken	0.00	(-0.01, 0.01)	1.00
College Readiness	0.46***	(0.39, 0.53)	1.58
Immigrant	0.07	(-0.11, 0.24)	1.07
Low-income	-0.25***	(-0.29, -0.22)	0.78
Refugee	-0.63***	(-0.99, -0.27)	0.53
Special Education	-0.34***	(-0.43, -0.26)	0.71
Female	0.73***	(0.69, 0.76)	2.08
English Learner	-0.50***	(-0.69, -0.32)	0.61
Asian	0.04	(-0.45, 0.53)	1.04
Black	-0.73**	(-1.24, -0.22)	0.48
Hispanic	-0.47	(-0.96, 0.01)	0.63
Native American	-0.44	(-0.95, 0.08)	0.64
Multiracial	-0.72**	(-1.26, -0.18)	0.49
Pacific Islander	-1.09***	(-1.61, -0.58)	0.34

3.4 | Objective Four - Effect of high school course-taking pattern on STEM intent and awards

To examine students' intent to study STEM and completion of a STEM award, the data were narrowed down to the 75,037 students who enrolled at a post-secondary institution. For those who declared intent to study STEM, 94.85% were college ready, 4.35% were partially ready, and 0.80% were not college ready. Table 8 below breaks down the demographic make-up of those who intended to study STEM.

Table 8: Demographic summaries for high school students who declared intent to study STEM. N=18,282

Demographic group	Number of students	Percentage
Male	12,441	68.05%
Female	5,841	31.95%
Special Education	781	4.27%
Low-income	7,130	39.00%
Refugee	97	0.53%
Immigrant	223	1.22%
English Learner	192	1.05%
Asian	751	4.11%
Black	195	1.07%
White	15,146	82.85%
Hispanic	1,780	9.74%
Native American	138	0.75%
Multiracial	118	0.65%
Pacific Islander	130	0.71%
Unknown	24	0.13%

For students who enrolled in post-secondary education, a binary variable was created to indicate whether the student declared intent at least once to study a STEM-related area at either a degree-granting institution or a technical college. The STEM intent variable is the dependent variable for the next logistic regression model. The course features selection process is similar to the previous models, using the top ten course features from decision tree and random forest models. Due to top features overlapping, eleven most important course features were selected. For the STEM intent model, the eleven most important courses features included health movement fitness courses taken, fine arts courses passed, social studies courses taken, student option courses taken, foreign language courses taken, language arts courses taken, mathematics courses taken, science courses taken, CTE skilled technical sciences courses taken, fine arts courses taken, and health movement fitness courses passed. Students' demographic data were added to the course data along with college readiness ranking for the final logistic regression model of STEM intent. Only students who enrolled at a post-secondary institution were included in this model. The results for the logistic regression model are reported on the next page in Table 9.

Furthermore, data were narrowed down to the students who received an award from a post-secondary institution, regardless if they had declared intent to study STEM. For those who received a STEM award, 95.44% were college ready, 3.77% were partially ready, and 0.78% were not college ready. Table 10 below breaks down the demographic make-up of those who received a STEM award.

Table 10: Demographic summaries for high school students who received a STEM award and percentage of students with STEM intent who received a STEM award. N=2,808.

Demographic group	Number of students	Percentage of all recipients of STEM awards	Percentage of students who declared STEM intent
Male	1,770	63.03%	14.23%
Female	1,038	36.97%	17.77%
Special Education	148	5.27%	18.95%
Low-income	987	35.15%	13.84%
Refugee	--	--	--
Immigrant	33	1.18%	14.80%
English Learner	--	--	--
Asian	188	6.70%	25.03%
Black	--	--	--
White	2,346	83.55%	15.49%
Hispanic	208	7.41%	11.69%
Native American	--	--	--
Multiracial	--	--	--
Pacific Islander	--	--	--
Unknown	--	--	--

Note: -- insufficient sample size

Table 9: : Regression coefficients, 95% confidence intervals, and odds ratios for intent to study STEM. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval	Odds Ratio
(Intercept)	-0.13***	(-0.66, 0.40)	0.88
Health movement fitness courses taken	-0.10***	(-0.12, -0.09)	0.91
Fine arts courses passed	0.02*	(0.01, 0.04)	1.02
Social studies courses taken	-0.04***	(-0.05, -0.03)	0.96
Student option courses taken	-0.03***	(-0.04, -0.03)	0.97
Foreign language courses taken	0.03*	(0.01, 0.04)	1.03
Language arts courses taken	-0.04***	(-0.05, -0.03)	0.96
Mathematics courses taken	0.07	(0.06, 0.09)	1.07
Science courses taken	0.12	(0.11, 0.13)	1.13
CTE skilled technical sciences courses taken	-0.02***	(-0.03, -0.01)	0.98
Fine arts courses taken	-0.03***	(-0.04, -0.02)	0.97
Health movement fitness courses passed	-0.01***	(-0.02, 0.01)	0.99
College Readiness	0.04*	(-0.03, 0.10)	1.04
Immigrant	0.10	(-0.08, 0.27)	1.11
Low-Income	-0.14***	(-0.18, -0.11)	0.87
Refugee	0.48	(0.19, 0.76)	1.62
Special Education	-0.28***	(-0.37, -0.20)	0.76
Female	-1.19***	(-1.23, -1.15)	0.30
English Learner	-0.40***	(-0.58, -0.21)	0.67
Asian	0.25	(-0.27, 0.77)	1.28
Black	-0.64***	(-1.18, -0.10)	0.53
Hispanic	-0.43***	(-0.94, 0.08)	0.65
Native American	-0.39***	(-0.93, 0.16)	0.68
Multiracial	-0.20***	(-0.76, 0.35)	0.82
Pacific Islander	-0.91***	(-1.45, -0.36)	0.40

Note: *p<0.05; **p<0.01; ***p<0.001*

For students who obtained a post-secondary award, a binary variable was created to indicate whether the student received at least one award in a STEM-related field at either a degree-granting institution or a technical college. The binary STEM award variable is the dependent variable for the next logistic regression model. Decision tree and random forest models were used to select the top ten course features. Due to top features overlapping, eleven most important course features were selected. For the STEM award model, the eleven most important courses features included mathematics courses taken, social studies courses taken, student option courses taken, CTE skilled technical sciences courses taken, science courses taken, foreign language courses taken, fine arts courses passed, CTE business education courses taken, fine arts courses taken, health movement fitness courses taken, and language arts courses taken. Students' demographic data were added to the course data along with college readiness ranking for the final logistic regression model of STEM award. Only students who obtained at least one award from a post-secondary institution were included in this model. The results for the logistic regression model are reported below in Table 11.

Table 11: Regression coefficients, 95% confidence intervals, and odds ratios for at least one award in STEM. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% confidence interval	Odds Ratio
(Intercept)	0.75	(-0.16, 1.65)	2.12
Mathematics courses taken	0.09***	(0.06, 0.12)	1.09
Social studies courses taken	-0.04*	(-0.07, -0.01)	0.96
Student option courses taken	-0.04***	(-0.06, -0.02)	0.96
CTE skilled technical sciences courses taken	0.00	(-0.02, 0.02)	1
Science courses taken	0.16***	(0.13, 0.19)	1.17
Foreign language courses taken	-0.03*	(-0.06, 0.00)	0.97
Fine arts courses passed	-0.01	(-0.04, 0.02)	0.99
CTE business education courses taken	-0.06**	(-0.10, -0.02)	0.94
Fine arts courses taken	-0.03*	(-0.05, -0.01)	0.97
Health movement fitness courses taken	-0.11***	(-0.13, -0.09)	0.90
Language arts courses taken	-0.04**	(-0.07, -0.01)	0.96
College Readiness	-0.23**	(-0.39, -0.07)	0.80
Immigrant	0.20	(-0.22, 0.62)	1.22
Low-Income	-0.10*	(-0.19, -0.01)	0.91
Refugee (insufficient sample size)	--	--	--
Special Education	0.32**	(0.12, 0.51)	1.38
Female	-1.31***	(-1.40, -1.22)	0.27
English Learner (insufficient sample size)	--	--	--
Asian	-0.54	(-1.41, 0.33)	0.58
Black (insufficient sample size)	--	--	--
Hispanic	-1.57***	(-2.43, -0.71)	0.21
Native American (insufficient sample size)	--	--	--
Multiracial (insufficient sample size)	--	--	--
Pacific Islander (insufficient sample size)	--	--	--

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$

3.5 | Objective Five - Effect of high school course-taking pattern on time to post-secondary enrollment

When studying the length of time between high school completion and enrollment at a degree-granting institution, the enrollment was an average of 1.6 years after high school for those who were college ready, an average of 2.1 years for those who were partially ready, and 2.0 years for those who were not college ready. The spike in number of students enrolling at 3 years after high school could be an indicator of students who returned from serving an ecclesiastical mission and then enrolled at a post-secondary institution. The number of students in each of these categories can be found in Appendix Table G. Figure 1 below illustrates the distribution of students and the amount of time to enrollment by college readiness. The Y-axis scales of each subplot reflect the differences of the number of students in each college-readiness category.

Regression models were built to further study the time between completing high school education and the earliest post-secondary education enrollment. Students who intend to attend degree-granting institutions and those who intend to attend technical colleges may enroll in different timeframes. Separate models were built for those who enrolled at degree-granting institutions and those who enrolled at technical colleges. Only students who enrolled were included for the regression models, regardless of college readiness.

The feature selection process for course data remains the same. The top 10 course features from decision tree and random forest were combined to create a set of most important course features. These course features were combined with students' demographic data and college readiness ranking as the independent variables for the final regression model, where the amount of time between high school graduation and post-secondary enrollment was the continuous dependent variable.

For degree-granting institutions, the top course features included mathematics courses taken, social studies courses taken, student option courses taken, fine arts courses taken, health movement fitness courses taken, foreign language courses taken, science courses taken, social studies courses passed, fine arts courses passed, CTE skilled technical sciences courses taken, language arts courses taken, and CTE business education courses taken. The results for the regression model are reported on the next page in Table 12.

When studying the length of time between high school completion and enrollment at a technical college as certificate-seeking, the enrollment was an average of 2.0 years after high school for all students regardless of their college readiness ranking. The number of students in each of these categories can be found in Appendix Table H. Figure 2 on the next page illustrates the distribution of students and the amount of time to their earliest technical college enrollments by college readiness. The Y-axis scales of each subplot reflect the differences of the number of students in each college-readiness category.

The regression model of time to enrollment at technical colleges only includes certificate-seeking students. The top course features for these students included CTE skilled technical sciences courses taken, language arts courses taken, CTE family and consumer sciences courses taken, CTE health science courses taken, mathematics courses taken, social studies courses taken, CTE business education courses taken, fine arts courses taken, foreign language courses taken, science courses taken, health movement fitness courses taken, and student option courses taken. The results for the regression model are reported in Table 13.

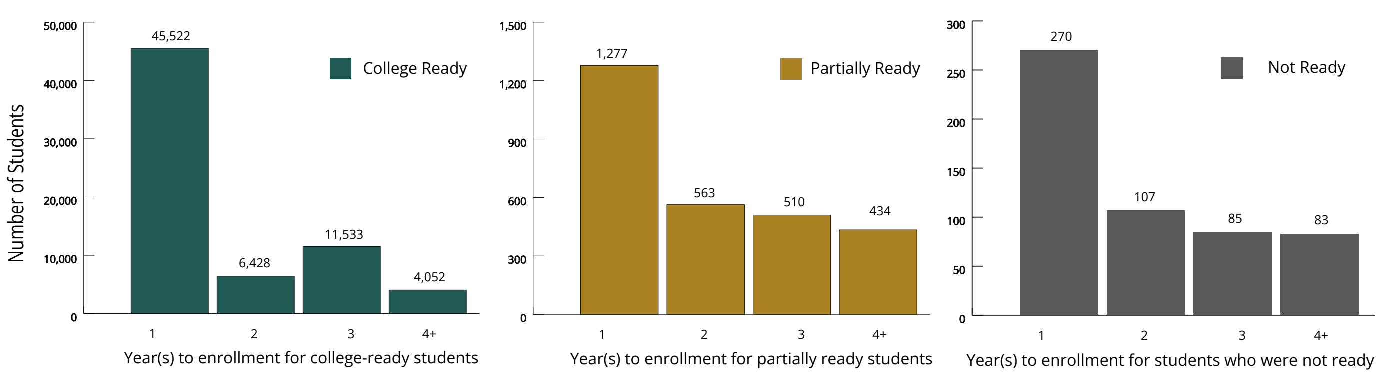

Figure 1: Time to students' first enrollment at a degree-granting institution by college readiness.

Table 12: : Regression coefficients and 95% confidence interval for time to degree-granting institutions enrollment. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval
(Intercept)	2.70***	(2.46, 2.94)
Mathematics courses taken	0.00	(0.00, 0.01)
Social studies courses taken	0.00	(-0.01, 0.00)
Student option courses taken	0.00*	(0.00, 0.01)
Fine arts courses taken	0.00*	(0.00, 0.01)
Health movement fitness courses taken	0.00	(0.00, 0.01)
Foreign language courses taken	-0.01***	(-0.02, -0.01)
Science courses taken	-0.01***	(-0.02, -0.01)
Social studies courses passed	0.00	(-0.01, 0.00)
Fine arts courses passed	0.00	(-0.01, 0.00)
CTE skilled technical sciences courses taken	0.00	(-0.01, 0.00)
Language arts courses taken	0.01***	(0.01, 0.02)
CTE business education courses taken	-0.01**	(-0.02, 0.00)
College Readiness	-0.34***	(-0.36, -0.31)
Immigrant	-0.09*	(-0.17, -0.02)
Low-income	0.03**	(0.01, 0.04)
Refugee	-0.25***	(-0.37, -0.13)
Special Education	0.01	(-0.03, 0.05)
Female	-0.64***	(-0.65, -0.62)
English Learner	-0.05	(-0.11, 0.02)
Asian	-0.33**	(-0.57, -0.09)
Black	-0.20	(-0.44, 0.04)
Hispanic	-0.24*	(-0.47, 0.00)
Native American	-0.20	(-0.45, 0.04)
Multiracial	-0.22	(-0.47, 0.04)
Pacific Islander	0.17	(-0.07, 0.41)

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$

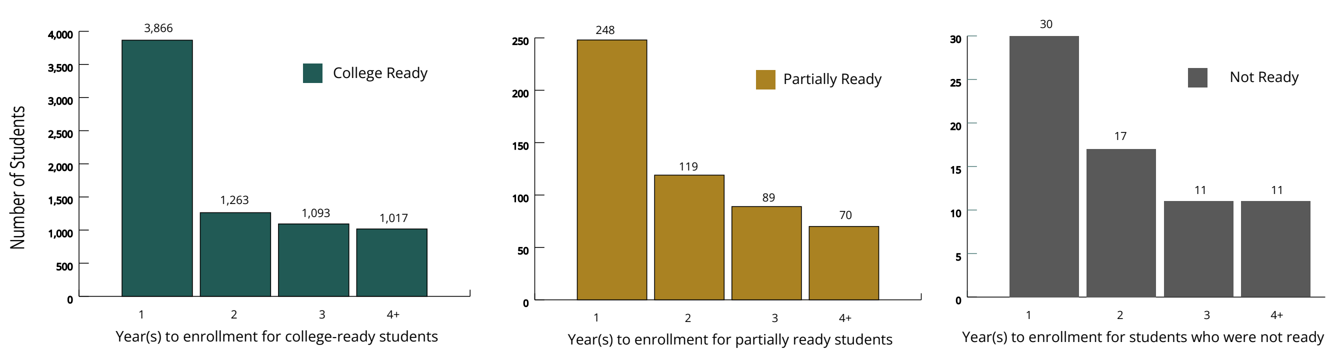

Figure 2: Time to students' first enrollment at a technical college by college readiness.

Table 13: Regression coefficients and 95% confidence interval for time to enrollment at technical colleges. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval
(intercept)	2.08***	(1.44, 2.72)
CTE skilled technical sciences courses taken	-0.05***	(-0.06, -0.04)
Language arts courses taken	-0.04***	(-0.06, -0.02)
CTE family and consumer sciences courses taken	0.01	(-0.01, 0.03)
CTE health science courses taken	0.00	(-0.02, 0.01)
Mathematics courses taken	0.01	(-0.01, 0.03)
Social studies courses taken	0.02*	(0.00, 0.04)
CTE business education courses taken	0.00	(-0.03, 0.02)
Fine arts courses taken	0.01	(0.00, 0.02)
Foreign language courses taken	0.02*	(0.00, 0.04)
Science courses taken	0.00	(-0.02, 0.02)
Health movement fitness courses taken	0.01	(-0.01, 0.02)
Student option courses taken	-0.01	(-0.02, 0.00)
College Readiness	-0.03	(-0.12, 0.06)
Immigrant	-0.27	(-0.57, 0.04)
Low-income	-0.06*	(-0.12, 0.00)
Refugee	-0.55	(-2.00, 0.89)
Special Education	-0.19***	(-0.29, -0.10)
Female	-0.39***	(-0.45, -0.32)
English Learner	0.22	(-0.03, 0.48)
Asian	0.27	(-0.40, 0.94)
Black	0.38	(-0.31, 1.06)
Hispanic	0.18	(-0.44, 0.80)
Native American	0.25	(-0.44, 0.94)
Multiracial	0.08	(-0.66, 0.82)
Pacific Islander	0.56	(-0.15, 1.27)

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$*

3.6 | Objective Six - Effect of high school course-taking pattern on time to post-secondary awards

The length of time between high school completion and students' first degree at a degree-granting institution is examined next. Degrees in this section include associate degree, bachelor's degree, and graduate degree. The time to degree was an average of 3.2 years after high school for an associate degree, and 4.5 years after high school for a bachelor's degree. The sample size is insufficient to report for length of time to obtain a graduate degree. The time to degree was an average of 3.6 years after high school for students who were college ready, 3.8 years after high school for students who were partially ready, and 4.0 years for those who were not ready. The pattern indicates that those who were college ready obtained their first award in the least amount of time, and it took the longest time for those who were not college ready to obtain their first award. The observation could be expected as those who were not college ready may need more time to complete college-level coursework required to obtain an award. Graduation data available for this study were prior to 2021. As a result, the amount of time to degree is skewed towards high school students who completed their first degrees in less than six years as USBE cohorts of 2014-2017 were studied. The number of students in each of these categories can be found in Appendix Table I. Figure 2 below illustrates the distribution of students and the amount of time to their earliest degree at a degree-granting institution by college readiness. The Y-axis scales of each subplot reflect the differences of the number of students in each college-readiness category.

As the length of the programs offered at degree-granting institutions and technical colleges are different, separate regression models are built. Only students who obtained an award are included in these models.

The feature selection process for course data remains the same. The top ten course features from the decision tree and random forest models were combined to create a set of most important course features. These course features were combined with students' demographic data and college readiness ranking as the independent variables for the final regression model, where the amount of time between high school graduation and the first post-secondary award was the continuous dependent variable.

For degree-granting institutions, the top course features included CTE health science courses taken, fine arts courses passed, CTE skilled technical sciences courses taken, mathematics courses taken, fine arts courses taken, science courses taken, social studies courses taken, language arts courses taken, student option courses taken, health movement fitness courses taken, and foreign language courses taken. The results for the regression model are reported on the next page in Table 14.

Finally, the length of time between high school completion and students' first certificate at a technical college is studied. The time to certificate was an average of 2.6 years after high school for students who were college ready and students who were partially ready, and 2.7 years for those who were not ready. As with degree-granting institutions, awards data available for this study were prior to 2021. As a result, the amount of time to award is skewed towards high school students who completed their first certificate in less than six years as USBE cohorts of 2014-2017 were studied. The number of students in each of these categories can be found in Appendix Table J. Figure 4 illustrates the distribution of students and the amount of time to their earliest certificate at a technical college by college readiness. The Y-axis scales of each subplot reflect the differences of the number of students in each college-readiness category.

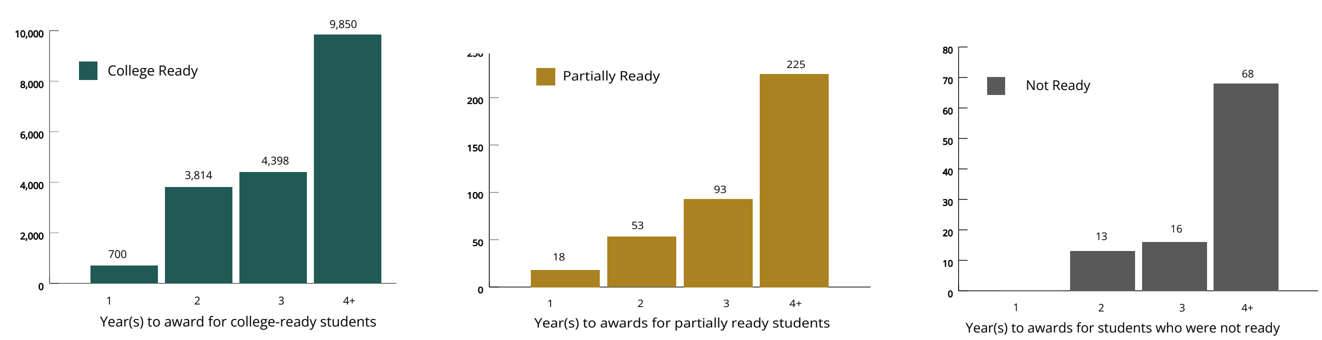

Figure 3: Time to students' first degree at a degree-granting institution by college readiness. For student who were not ready and received their first degree at year one, the sample size is insufficien tto display.

Table 14: : Regression coefficients and 95% confidence interval for time to degree at degree-granting institutions. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval
(intercept)	4.90***	(4.29, 5.51)
CTE health science courses taken	0.01*	(0.00, 0.02)
Fine arts courses passed	0.01*	(0.00, 0.02)
CTE skilled technical sciences courses taken	-0.02***	(-0.03, -0.01)
Mathematics courses taken	-0.01	(-0.02, 0.01)
Fine arts courses taken	0.01*	(0.00, 0.02)
Science courses taken	-0.02***	(-0.04, -0.01)
Social studies courses taken	0.01	(-0.01, 0.02)
Language arts courses taken	0.00	(-0.01, 0.02)
Student option courses taken	-0.01*	(-0.02, 0.00)
Health movement fitness courses taken	-0.02***	(-0.03, -0.01)
Foreign language courses taken	-0.01	(-0.02, 0.01)
College Readiness	-0.15**	(-0.24, -0.06)
Immigrant	0.04	(-0.17, 0.25)
Low-income	-0.17***	(-0.21, -0.13)
Refugee	0.04	(-0.38, 0.46)
Special Education	0.04	(-0.09, 0.16)
Female	-0.67***	(-0.71, -0.63)
English Learner	-0.12	(-0.37, 0.13)
Asian	-0.22	(-0.81, 0.38)
Black	-0.34	(-0.97, 0.28)
Hispanic	-0.51	(-1.10, 0.08)
Native American	-0.61	(-1.24, 0.02)
Multiracial	-0.76*	(-1.41, -0.11)
Pacific Islander	-0.27	(-0.90, 0.37)

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$*

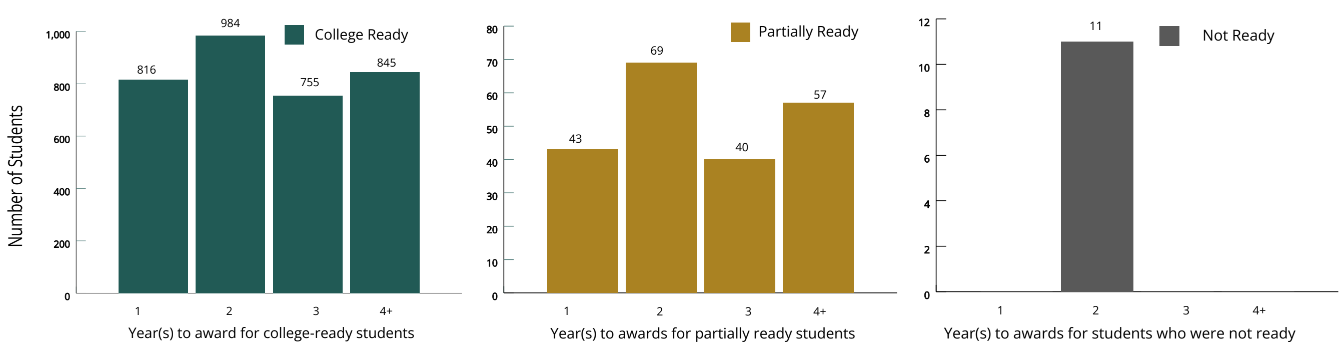

Figure 4: Time to students' first award at a technical college by college readiness. For student who were not ready, most of the awards data had insuffucent sample sizes for display.

Overall, the length of time to award peaked at four years for degree-granting institutions and two years for technical colleges, corresponding to the length of the programs offered at these institutions respectively. The average amount of time to both enrollment and award are more consistent at technical colleges than at degree-granting institutions regardless of college readiness, suggesting more homogeneity among students who attended technical college.

For students who received a certificate from a technical college, the time to award model only included those who were certificate-seeking. The top course features for these students included language arts courses taken, science courses taken, CTE business education courses taken, CTE family and consumer sciences courses taken, CTE health science courses taken, social studies courses taken, student option courses taken, mathematics courses taken, health movement fitness courses taken, fine arts courses taken, CTE skilled technical sciences courses taken, and fine arts courses passed. The results for the regression model are reported below in Table 15:

Table 15: Regression coefficients and 95% confidence interval for time to certificate at technical colleges. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval
(Intercept)	2.52***	(1.60, 3.44)
Language arts courses taken	-0.03*	(-0.06, 0.00)
Science courses taken	-0.03*	(-0.06, -0.01)
CTE business education courses taken	0.00	(-0.04, 0.04)
CTE family and consumer sciences courses taken	0.03*	(0.01, 0.06)
CTE health science courses taken	-0.01	(-0.03, 0.02)
Social studies courses taken	0.04*	(0.01, 0.07)
Student option courses taken	-0.01	(-0.03, 0.00)
Mathematics courses taken	0.03	(0.00, 0.06)
Health movement fitness courses taken	-0.01	(-0.03, 0.02)
Fine arts courses taken	0.00	(-0.02, 0.02)
CTE skilled technical sciences courses taken	-0.05***	(-0.07, -0.03)
Fine arts courses passed	0.00	(-0.03, 0.03)
College Readiness	0.01	(-0.14, 0.16)
Immigrant	-0.05	(-0.55, 0.46)
Low-income	0.00	(-0.09, 0.09)
Refugee (insufficient sample size)	---	---
Special Education	-0.19*	(-0.34, -0.04)
Female	-0.47***	(-0.57, -0.37)
English Learner	-0.05	(-0.48, 0.37)
Asian	0.81	(-0.13, 1.76)
Black	0.31	(-0.69, 1.31)
Hispanic	0.37	(-0.50, 1.25)
Native American	0.17	(-0.82, 1.16)
Multiracial	0.06	(-1.07, 1.19)
Pacific Islander	0.63	(-0.39, 1.64)

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$

4 | Discussion

Using the coefficients from regression models built, odds ratios for students' college readiness outcome and post-secondary outcomes are obtained. The results of the ordinal logistic regression model of college readiness (see Table 2) indicate that holding all other variables constant, one additional social studies course passed in high school increased the odds of being college ready by 30%. One additional foreign language course taken increased the odds of being college ready by 26%. One additional language arts course passed increased the odds of being college ready by 21%. One additional mathematics course passed increased the odds of being college ready by 17%. Surprisingly, one additional science course taken decreased the odds of being college ready by 11%. One possible interpretation is that students perceive science courses to be difficult. According to self-determination theory (SDT), the perceived difficulty may play a role in the students' consequent disengagement (Patall, Hooper, Vasquez, Pituch, & Steingut, 2018; Deci & Ryan, 2000). Students who disengage from their studies or do not feel a sense of belong could potentially face negative educational outcomes (Strayhorn, 2018). The rest of the course data variables did not change the odds by more than 10%. On the other hand, with all other variables being the same, being an English language learner decreased the odds of being college ready by 48%. English learners' experience have long been studied (Ellis, 1989). Being an English learner in high school could influence individual's ability to connect and interact with other students and their teachers. The lack of communication may further impact English learners' sense of belonging and mental wellbeing. English learners may not grasp clearly the concepts being taught in courses with limited proficiency of the English language. Being a multiracial student decreased the odds of being college ready by 46%. Students from low-income families faced a 35% decrease in odds of being college ready. Special education students had a 12% decrease in odds of being college ready. The demographic data of students affected their odds of being college ready to a greater extent than courses taken or passed.

To study whether students continued their academic careers after high school, the binary post-secondary enrollment model showed for each increment in college readiness ranking, a student was over 5 times more likely to enroll at a post-secondary institution, with all other variables being equal. A refugee student was 119% more likely to continue to post-secondary education. Extensive research has been conducted in Australia and Canada demonstrating the resilience of refugee students. Despite the increased risk of culture shock and ethnic bullying, refugees students generally have high aspirations for post-secondary education and do well in post-secondary institutions given the support they need (Wilkinson, 2002; Wong, 2013; Harris & Marlowe, 2011). Female students were 24% more likely to enroll at a post-secondary institution. In contrast, a student who received special education was 52% less likely to enroll. A longitudinal study conducted in 2011 similarly found that students who received special education were less likely to enroll at a post-secondary institution. One possible explanation is that policies in post-secondary institutions do not provide adequate support that students with special needs require (Sanford, et al., 2011). An English learner was 43% less likely to continue onto a post-secondary institution. A student from a low-income family faced a 34% decrease in odds of enrolling for post-secondary education. Previous research conducted by the UDRC found that among individuals who experience intergeneration poverty, those who obtain a college degree have higher earning potentials (Martinez, 2019). Along with the finding from this study that students from low-income families face decreased odds of enrolling at post-secondary institutions, the complex relationship of low-income students entering post-secondary education and the impact of their post-secondary education on their economic status is evident. Among students of different racial identities, Pacific Islander students had a decreased odds of 62% at pursuing post-secondary education, multiracial students had a decreased odds of 50% of enrollment at a post-secondary institution, Native American students had a decreased odds of 50% of continuing, and Hispanic students faced a decreased odds of 43% at enrolling. Racial disparity in postsecondary enrollment has been well documented (U.S. Bureau of Labor Statistics, 2019). Previous research has shown the relationships between race and students' social and cultural capital, parental involvement, and socioeconomic status (Núñez & Bowers, 2011; Perna & Titus, 2005). Minority students may receive less encouragement from their family or peer group to pursue a post-secondary education. They may have less social or cultural capital to actively seek guidance or tutoring for post-secondary enrollment and preparation. Among the course data variables, an additional social studies course passed increased students' odds of enrollment by 10%. The other course variables did not affect the odds by more than 10%. Consistent with the pattern of the college-readiness model, students' demographic data were again playing a more prominent role than courses taken or passed in high school.

Among students who enrolled at a post-secondary institution, for each increment in college readiness ranking, a student was 58% more likely to obtain an award, with all other variables being equal. Female students were 108% more likely to receive an award. On the contrary, a refugee student was 47% less likely to receive a post-secondary award. An English learner was 40% less likely to obtain an award. A special education student was 30% less likely to receive an award. A student from a low-income family was 22% less likely to receive an award. Among students of different racial backgrounds, Pacific Islander students had a 67% decreased odds of obtaining an award, black students had a 52% decreased odds of receiving an award, multiracial students had a 51% decreased odds of receiving an award. Finally, none of the course variables affected the odds of obtaining a post-secondary award by more than 5%. Students' demographic data continued to have larger influences on students' receiving a post-secondary award than high school courses.

The logistic regression model for students' intent to study a STEM-related area shows that a refugee student was 61% more likely to declare a CIP in STEM, with all other variables being equal. An additional science course taken in high school increased students' odds of declaring intent to study STEM by 13%. Other course variables did not affect the odds by more than 10%. Female students were 70% less likely to declare intent to study STEM. English learners were 33% less likely to declare intent to study STEM. Special education students were 25% less likely to declare intent to study STEM. Students from low-income families were 13% less likely to declare intent to study STEM. Among students of different racial identities, Pacific Islander students were 60% less likely to study STEM, and black students had a decreased odds of 47% to declare intent to study STEM.

For students who received an award from a post-secondary institution, special education students were over 37% more likely to receive an award in STEM, while holding all other variables constant. An additional science course taken in high school increased students' odds of obtaining an award in STEM by 17%. An additional mathematics course taken in high school increased students' odds of obtaining an award in STEM by 9%. The other course variables did not affect the odds by more than 10%. Hispanic students had a decreased odds of 79% of receiving an award in STEM. Female students were 73% less likely to receive an award in STEM. Due to sample size, results are not reported for some minority groups, such as refugees, English learners, and racial minorities. Contrary to female students' higher odds of 24% and 108% at enrolling in post-secondary education and obtaining an award respectively, they face decreased odds of 70% and 73% at declaring an intent to study STEM and obtaining a STEM degree. Previous research has highlighted the biases against female students at science faculty from research-intensive universities (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). Female students were viewed as less competent and were offered less mentoring by both male and female faculty members. Faculty's attitude towards female students in science may in turn impact female students' inclination to study STEM or receive an award in STEM.

To study the amount of time between high school completion and enrolling at a post-secondary institution, separate regression models were built for degree-granting institutions and technical colleges. The model for degree-granting institutions shows the time to enroll decreased by 0.64 years for female students, with all other variables being equal. The time to enroll decreased by 0.34 years for each increment in college readiness. The time to enroll decreased by 0.33 years for Asian students. The time to enroll decreased by 0.25 years for refugee students. The time to enroll decreased by 0.24 years for Hispanic students. Students from low-income families took 0.03 years longer to enroll. Other variables were either not statically significant or affected this timeframe by less than 0.1 years.

Similarly, for technical colleges, the time to enroll decreased by 0.39 years for female students, with all other variables being equal. The time decreased by 0.19 years for special education students. For students from low-income families, the time to enroll decreased by 0.06 years. Other variables were either not statically significant or affected this timeframe by less than 0.1 years.

Finally, to study the time between high school completion and students' first post-secondary awards, separate models were built for degree-granting institutions and technical colleges. Holding all other variables constant, the time to receive a degree decreased by 0.76 years for multiracial students. The time to receive a degree decreased by 0.67 years for female students. The time decrease by 0.17 years for low-income students. For each increment in college readiness, the time decreased by 0.15 years. Other variables were either not statically significant or affected this timeframe by less than 0.1 years.

For technical colleges, the time to receive a certificate decreased by 0.47 years for female students, with all other variables being equal. The time decreased by 0.19 years for special education students. For each additional CTE skilled technical sciences course taken, the time decreased by 0.05 years. Other variables were either not statically significant or affected this timeframe by less than 0.05 years.

When examining the models for time to post-secondary enrollment award (Tables 12 - 15), the coefficients for the model terms are relatively small compared to the intercepts for each model, even when they are statistically significant. This pattern suggests that course data and demographic data had little impact on the timeframes overall. In other words, though demographic background and high school course contribute to whether student enroll or receive an award, those who enroll or receive an award appeared to have taken similar amounts of time.

Overall, students' college readiness plays a large role in their post-secondary education outcomes. The advantage of being college ready is evident in the models for post-secondary enrollment and post-secondary award. Students' demographic data affect post-secondary education outcomes to a greater extent than course data, highlighting the challenges faced by minority students. When course data do play a role, the number of courses taken tends to have a larger effect on students' educational outcomes than the number of courses passed. In general, this study found similar timeframes for students' receiving their first post-secondary awards as previous research conducted. Students are taking longer than the conventional 4 years to complete a bachelor's degree, or longer than 2 years to complete an associate degree (Chen, et al., 2020).

Students' postsecondary outcomes depend on many factors. High school students have many years of complex interactions with their family of origin, cultural, social, political, and educational environments prior to completing high school. Compared to other students, some students are better prepared academically and have greater confidence and resources in their ability to succeed in post-secondary institutions. Once students enter post-secondary institutions, the activities and peer groups students engage with may play in role in their obtaining an award or choosing to study STEM. Students' background and high school experiences interact in complex ways to influence their academic careers. The complicated set of factors that interact to influence students' post-secondary outcomes cannot be accounted for by any one single element. With the limitations of this study, data not available for this study could be relevant. For example, a sense of belonging could be critical in students' success at college (Strayhorn, 2018). How students connect with their environment and others could have an impact on their post-secondary outcomes. An indicator was not available for students whose parents had no education beyond high school (Choy, 2001). Literature has demonstrated the challenges faced by first-generation college students. Effective involvement of parents (Perna & Titus, 2005) could serve as social capital that promotes enrollment at post-secondary education.

4.1 | Future Research

In addition to studying student engagement and parental education level and involvement, the impact of remote learning due to the COVID-19 pandemic could be examined when data become available. Access to technology and the internet as well as parental involvement could all play an important role. Remote learning could not happen without devices or reliable internet access. With an increased amount of time at home with caregivers, parents' ability to guide and oversee high school students may have an increased effect on students' academic performance. In addition, recent studies (Liang, 2020; Reed, 2021) have found serious mental health problems faced by young people. Future studies could benefit from including data regarding how the pandemic has impacted students' mental wellbeing, and establish a relationship between academic achievement and mental health of students.

5 | Conclusion

The quality of students' academic experience and the intensity of the high school curriculum affect post-secondary education outcomes. Following USBE cohorts from 2014 to 2017, this study examined the importance of high school course-taking patterns and students' demographic data. While some courses such as social studies and foreign language increase the odds for students to be college ready, students' demographic background appears to have a stronger influence on students' enrollment, achievement, pursuance of STEM, and time frame for enrollment and award at post-secondary institutions. Being college ready plays a significant role in students' enrolling, obtaining an award, and studying STEM in post-secondary institutions.

Demographic data demonstrate disadvantages faced by students from low-income families, students who received special education, female students, English learners, and racial minority students. Being in these minority groups affect students' odds at enrollment, obtaining an award, and studying STEM to a greater extent than their high school coursework.

The results from this study provide valuable insight for Utah students, school administrators, and policymakers. Understanding the role of high school coursework and student demographic background contributes to an informed perspective on course selection, programs, best practices, and policies that can make a difference in students' success in post-secondary education.

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Data Partners

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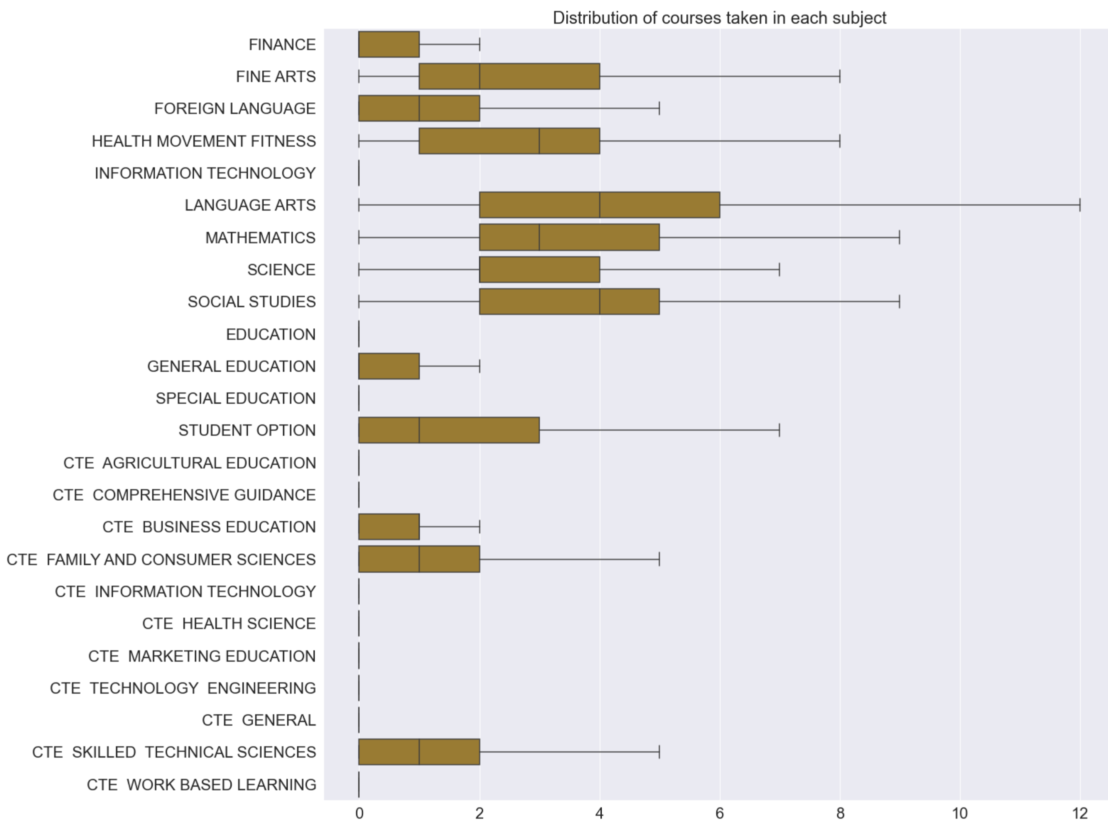
Appendix A

The degree-granting institutions of USHE include: the University of Utah, Utah State University, Weber State University, Southern Utah University, Dixie State University, Snow College, Utah Valley University, and Salt Lake Community College.

The technical colleges of USHE include: Bridgerland Technical College, Davis Technical College, Dixie Tech, Mountainland Technical College, Ogden-Weber Technical College, Southwest Technical College, Tooele Technical College, and Uintah Basin Technical College.

Appendix B

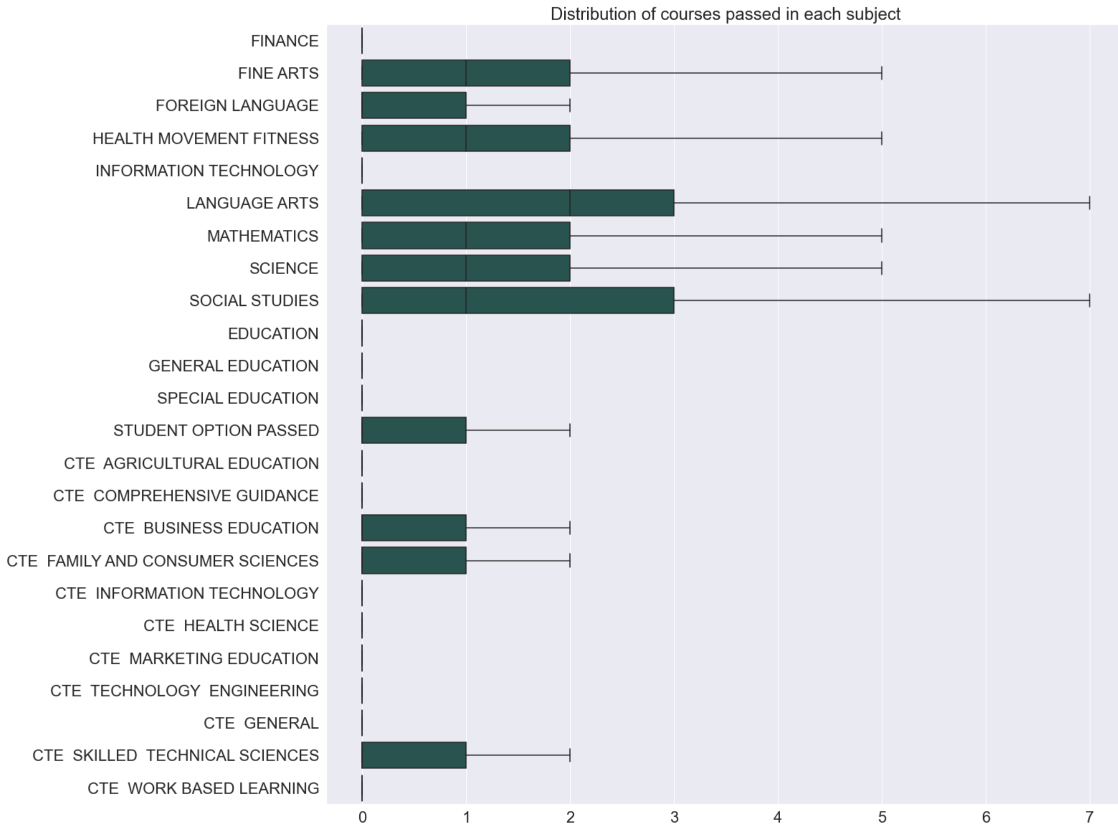
Boxplots were created to illustrate the distribution of the features. Appendix Figure 1 below demonstrates the distribution for the number of courses taken in each subject area. Outliers were removed to maximize plot area. For some courses, the average number of the courses taken is close to zero. For example, courses taken in information technology and education.



Appendix Figure A: Distribution of course features for the number of courses taken in each subject area.

Appendix C

Appendix Figure 2 on the next page illustrates the distribution for the number of courses passed in each subject area. Outliers were removed to maximize plot area. For some courses, the average number of the courses passed is close to zero. For example, courses in general education. In most cases, the average number of courses passed could be lower than the average number of courses taken shown in Appendix Figure A. For example, courses in finance.



Appendix Figure B: Distribution of course features for the number of courses passed in each subject.

Appendix D

To study whether students enrolled in a degree-granting institution after completing high school, the feature selection process described in section 2.3 was followed. The top course features included language arts courses taken, health movement fitness courses taken, CTE skilled technical sciences courses taken, language arts courses passed, foreign language courses taken, fine arts courses taken, social studies courses passed, mathematics courses taken, student option courses taken, science courses taken, and social studies courses taken. The results for the logistic regression model for enrollment at degree-granting institutions are reported on the next page in Appendix Table 1:

Appendix Table A: Regression coefficients, 95% confidence intervals, odds ratios for enrollment at degree-granting institutions. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval	Odds Ratio
(Intercept)	-2.91***	(-3.29, -2.52)	0.06
Language arts courses taken	-0.06***	(-0.07, -0.06)	0.94
Health movement fitness courses taken	0.01***	(0.00, 0.02)	1.01
CTE skilled technical sciences courses taken	-0.08***	(-0.08, -0.07)	0.92
Language arts courses passed	0.05***	(0.04, 0.06)	1.05
Foreign language courses taken	0.10***	(0.09, 0.11)	1.11
Fine arts courses taken	-0.01**	(-0.01, 0.00)	1.00
Social studies courses passed	0.06***	(0.05, 0.07)	1.06
Mathematics courses taken	0.00	(-0.01, 0.00)	1.00
Student option courses taken	-0.01***	(-0.01, 0.00)	1.00
Science courses taken	0.01***	(0.01, 0.02)	1.01
Social studies courses taken	-0.01	(-0.02, 0.00)	1.00
College Readiness	1.82***	(1.78, 1.85)	6.17
Immigrant	0.05	(-0.05, 0.16)	1.05
Low-income	-0.44***	(-0.46, -0.42)	0.64
Refugee	0.86***	(0.67, 1.05)	2.36
Special Education	-0.88***	(-0.92, -0.83)	0.42
Female	0.13***	(0.10, 0.15)	1.14
English Learner	-0.53***	(-0.62, -0.44)	0.59
Asian	0.07	(-0.31, 0.46)	1.07
Black	-0.14	(-0.53, 0.24)	0.87
Hispanic	-0.41*	(-0.79, -0.03)	0.66
Native American	-0.45*	(-0.84, -0.06)	0.64
Multiracial	-0.50*	(-0.90, -0.10)	0.61
Pacific Islander	-0.72***	(-1.11, -0.33)	0.49

Note: *$^*p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$*

Appendix E

To study whether students enrolled in a technical college after completing high school, the feature selection process described in section 2.3 was followed. The top course features included language arts courses taken, CTE business education courses taken, health movement fitness courses taken, CTE skilled technical sciences courses taken, foreign language courses taken, fine arts courses taken, mathematics courses taken, student option courses taken, science courses taken, CTE family and consumer sciences courses taken, and social studies courses taken. The results for the logistic regression model for enrollment at technical colleges are reported below in Appendix Table 2:

Appendix Table B: Regression coefficients, 95% confidence intervals, and odds ratios for enrollment at technical colleges. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval	Odds Ratio
(Intercept)	-3.90***	(-4.45, -3.35)	0.02
Language arts courses taken	0.04***	(0.03, 0.05)	1.04
CTE business education courses taken	-0.01	(-0.03, 0.02)	1.00
Health movement fitness courses taken	-0.07***	(-0.08, -0.05)	0.93
CTE skilled technical sciences courses taken	0.10***	(0.10, 0.11)	1.11
Foreign language courses taken	-0.06***	(-0.07, -0.04)	0.94
Fine arts courses taken	-0.04***	(-0.05, -0.03)	0.96
Mathematics courses taken	0.06***	(0.04, 0.07)	1.06
Student option courses taken	0.00	(0.00, 0.01)	1.00
Science courses taken	-0.06***	(-0.08, -0.05)	0.94
CTE family and consumer sciences courses taken	0.05***	(0.04, 0.06)	1.05
Social studies courses taken	-0.04***	(-0.06, -0.02)	0.96
College Readiness	1.05***	(0.98, 1.13)	2.86
Immigrant	-0.05	(-0.29, 0.20)	0.95
Low-income	0.00	(-0.05, 0.05)	1.00
Refugee	-1.64**	(-2.79, -0.50)	0.19
Special Education	0.05	(-0.03, 0.13)	1.05
Female	0.24***	(0.19, 0.29)	1.27
English Learner	-0.56***	(-0.77, -0.36)	0.57
Asian	-1.59***	(-2.16, -1.02)	0.20
Black	-1.39***	(-1.97, -0.80)	0.25
Hispanic	-1.01***	(-1.54, -0.48)	0.36
Native American	-1.58***	(-2.17, -0.99)	0.21
Multiracial	-1.29***	(-1.92, -0.67)	0.28
Pacific Islander	-1.95***	(-2.55, -1.34)	0.14

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$

Appendix F

Next, awards data from degree-granting institution are studied. The same feature selection process was followed. The top course features included language arts courses taken, health movement fitness courses taken, CTE skilled technical sciences courses taken, fine arts courses passed, mathematics courses passed, foreign language courses taken, fine arts courses taken, mathematics courses taken, student option courses taken, science courses taken, CTE family and consumer sciences courses taken, and social studies courses taken. The results for the logistic regression model for obtaining a degree from degree-granting institutions are reported below in Appendix Table 3:

Appendix Table C: Regression coefficients, 95% confidence interval, odds ratios for receiving at least one degree at degree-granting institutions. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval	Odds Ratio
(Intercept)	-5.24***	(-5.78, -4.70)	0.01
language arts courses taken	-0.03***	(-0.04, -0.02)	0.97
Health movement fitness courses taken	-0.02***	(-0.03, -0.01)	0.98
CTE skilled technical sciences courses taken	-0.07***	(-0.08, -0.06)	0.93
Fine arts courses passed	-0.06***	(-0.07, -0.05)	0.94
Mathematics courses passed	0.15***	(0.14, 0.16)	1.16
Foreign language courses taken	0.05***	(0.04, 0.06)	1.05
Fine arts courses taken	0.00	(-0.01, 0.01)	1.00
Mathematics courses taken	-0.04***	(-0.05, -0.02)	0.96
Student option courses taken	-0.03***	(-0.03, -0.02)	0.97
Science courses taken	0.01	(0.00, 0.02)	1.01
CTE family and consumer sciences courses taken	-0.06***	(-0.08, -0.05)	0.94
Social studies courses taken	0.02***	(0.01, 0.03)	1.02
College Readiness	1.86***	(1.78, 1.94)	6.42
Immigrant	0.14	(-0.04, 0.32)	1.15
Low-income	-0.45***	(-0.48, -0.41)	0.64
Refugee	0.02	(-0.34, 0.37)	1.02
Special Education	-1.18***	(-1.28, -1.08)	0.31
Female	0.73***	(0.69, 0.76)	2.08
English Learner	-0.88***	(-1.09, -0.68)	0.42
Asian	0.26	(-0.26, 0.79)	1.30
Black	-0.55*	(-1.09, -0.01)	0.58
Hispanic	-0.47	(-0.99, 0.05)	0.63
Native American	-0.51	(-1.06, 0.03)	0.60
Multiracial	-0.75*	(-1.31, -0.18)	0.47
Pacific Islander	-1.26***	(-1.82, -0.71)	0.28

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$

Appendix G

Finally, data of whether students receive a certificate from a technical college after completing high school were studied. The same feature selection process was followed. The top course features included language arts courses taken, CTE business education courses taken, health movement fitness courses taken, CTE skilled technical sciences courses taken, foreign language courses taken, fine arts courses taken, mathematics courses taken, student option courses taken, science courses taken, CTE family and consumer sciences courses taken, and social studies courses taken. The results for the logistic regression model for obtaining a certificate from a technical college are reported below in Appendix Table 4:

Appendix Table D: Regression coefficients, 95% confidence intervals, and odds ratios for at least one certificate at technical colleges. Numbers in parentheses indicate 95% confidence interval ranges.

Model Term	Parameter Estimate	95% Confidence Interval	Odds Ratio
(Intercept)	-4.67***	(-5.39, -3.95)	0.01
Language arts courses taken	0.04***	(0.02, 0.06)	1.04
CTE business education courses taken	0.00	(-0.03, 0.03)	1.00
Health movement fitness courses taken	-0.05***	(-0.07, -0.03)	0.95
CTE skilled technical sciences courses taken	0.09***	(0.08, 0.10)	1.09
Foreign language courses taken	-0.07***	(-0.09, -0.04)	0.93
Fine arts courses taken	-0.04***	(-0.06, -0.03)	0.96
Mathematics courses taken	0.05***	(0.02, 0.07)	1.05
Student option courses taken	0.00	(-0.01, 0.01)	1.00
Science courses taken	-0.07***	(-0.09, -0.04)	0.93
CTE family and consumer sciences courses taken	0.06***	(0.04, 0.08)	1.06
Social studies courses taken	-0.05***	(-0.07, -0.03)	0.95
College readiness	1.08***	(0.97, 1.19)	2.95
Immigrant	-0.16	(-0.54, 0.23)	0.85
Low-income	-0.03	(-0.10, 0.04)	0.97
Refugee	-11.79	(-178.85, 155.28)	0.00
Special Education	0.12*	(0.01, 0.24)	1.13
Female	0.59***	(0.52, 0.66)	1.80
English Learner	-0.68***	(-0.99, -0.36)	0.51
Asian	-1.49***	(-2.23, -0.75)	0.23
Black	-1.59***	(-2.37, -0.81)	0.20
Hispanic	-1.20***	(-1.89, -0.51)	0.30
Native American	-1.55***	(-2.32, -0.78)	0.21
Multiracial	-1.52***	(-2.38, -0.67)	0.22
Pacific Islander	-1.99***	(-2.78, -1.19)	0.14

Note: *$p<0.05$; **$p<0.01$; ***$p<0.001$

Appendix H

Appendix Table E: Decision Tree feature importance of courses for models in this study. Higher importance scores indicates course features that are more predictive.

Courses taken/ passed	College Readiness 0|1	College Readiness 1|2	Post-Secondary Enrollment	Post-Secondary Award	STEM Intent	STEM Award	Degree-granting time to enroll	Technical colleges time to enroll	Degree-granting time to award	Technical colleges time to award
Finance courses taken	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02
Finance courses passed	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fine arts courses taken	0.06	0.02	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.06
Fine arts courses passed	0.02	0.01	0.03	0.03	0.03	0.04	0.04	0.03	0.04	0.03
Foreign language courses taken	0.03	0.06	0.03	0.04	0.04	0.04	0.03	0.03	0.04	0.03
Foreign language courses passed	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02
Health movement fitness courses taken	0.06	0.01	0.05	0.04	0.06	0.06	0.05	0.05	0.05	0.06
Health movement fitness courses passed	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03
Information technology courses taken	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Information technology courses passed	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Language arts courses taken	0.09	0.02	0.05	0.05	0.04	0.04	0.05	0.05	0.05	0.06
Language arts courses passed	0.03	0.15	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Mathematics courses taken	0.06	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Mathematics courses passed	0.02	0.04	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
Science courses taken	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.05
Science courses passed	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.02
Social studies courses taken	0.06	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Social studies courses passed	0.05	0.10	0.06	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Education courses taken	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Education courses passed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix Table E (Continued): Decision Tree feature importance of courses for models in this study. Higher importance scores indicates course features that are more predictive.

Courses taken/passed	College Readiness 0|1	College Readiness 1|2	Post-Secondary Enrollment	Post-Secondary Award	STEM Intent	STEM Award	Degree-granting time to enroll	Technical colleges time to enroll	Degree-granting time to award	Technical colleges time to award
General education courses taken	0.04	0.01	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.03
General education courses passed	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01
Special education courses taken	0.04	0.03	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01
Special education courses passed	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Student option courses taken	0.06	0.01	0.05	0.05	0.04	0.04	0.06	0.06	0.06	0.05
Student option passed	0.02	0.01	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.02
CTE agricultural education courses taken	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.02
CTE agricultural education courses passed	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01
CTE comprehensive guidance courses taken	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
CTE comprehensive guidance courses passed	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTE business education courses taken	0.04	0.01	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03
CTE business education courses passed	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
CTE family and consumer sciences courses taken	0.04	0.01	0.04	0.04	0.03	0.02	0.02	0.03	0.02	0.03
CTE family and consumer sciences courses passed	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.02

Appendix Table E (Continued): Decision Tree feature importance of courses for models in this study. Higher importance scores indicates course features that are more predictive.

Courses taken/ passed	College Readiness 0|1	College Readiness 1|2	Post-Secondary Enrollment	Post-Secondary Award	STEM Intent	STEM Award	Degree-granting time to enroll	Technical colleges time to enroll	Degree-granting time to award	Technical colleges time to award
CTE information technology courses taken	0.01	0.01	0.02	0.01	0.03	0.03	0.02	0.02	0.01	0.01
CTE information technology courses passed	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01
CTE health science courses taken	0.02	0.05	0.02	0.02	0.03	0.02	0.03	0.04	0.04	0.04
CTE health science courses passed	0.00	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.02
CTE marketing education courses taken	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01
CTE marketing education courses passed	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
CTE technology engineering courses taken	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02
CTE technology engineering courses passed	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CTE general courses taken	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTE general courses passed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTE skilled technical sciences courses taken	0.03	0.01	0.04	0.04	0.04	0.03	0.03	0.05	0.03	0.04
CTE skilled technical sciences courses passed	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
CTE work based learning courses taken	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
CTE work based learning courses passed	0.00	0.02	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.00

Appendix H

Appendix Table F: Random forest feature importance of courses for models in this study. Higher importance scores indicates course features that are more predictive.

Courses taken/ passed	College Readiness 0|1	College Readiness 1|2	Post-Secondary Enrollment	Post-Secondary Award	STEM Intent	STEM Award	Degree-granting time to enroll	Technical colleges time to enroll	Degree-granting time to award	Technical colleges time to award
Finance courses taken	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Finance courses passed	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fine arts courses taken	0.06	0.05	0.05	0.06	0.05	0.05	0.06	0.05	0.06	0.05
Fine arts courses passed	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03
Foreign language courses taken	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.04	0.03
Foreign language courses passed	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Health movement fitness courses taken	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Health movement fitness courses passed	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Information technology courses taken	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Information technology courses passed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Language arts courses taken	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.04
Language arts courses passed	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Mathematics courses taken	0.07	0.05	0.04	0.05	0.04	0.05	0.05	0.05	0.04	0.04
Mathematics courses passed	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Science courses taken	0.05	0.06	0.04	0.04	0.05	0.05	0.05	0.04	0.05	0.04
Science courses passed	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.03	0.02
Social studies courses taken	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05
Social studies courses passed	0.04	0.05	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Education courses taken	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Education courses passed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix Table F (continued): Random forest feature importance of courses for models in this study. Higher importance scores indicates course features that are more predictive.

Courses taken/passed	College Readiness 0|1	College Readiness 1|2	Post-Secondary Enrollment	Post-Secondary Award	STEM Intent	STEM Award	Degree-granting time to enroll	Technical colleges time to enroll	Degree-granting time to award	Technical colleges time to award
General education courses taken	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.02
General education courses passed	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.01
Special education courses taken	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.02
Special education courses passed	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Student option courses taken	0.06	0.04	0.05	0.05	0.04	0.04	0.05	0.05	0.05	0.05
Student option passed	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.02	0.03	0.03
CTE agricultural education courses taken	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
CTE agricultural education courses passed	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CTE comprehensive guidance courses taken	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00
CTE comprehensive guidance courses passed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTE business education courses taken	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
CTE business education courses passed	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02
CTE family and consumer sciences courses taken	0.04	0.04	0.04	0.04	0.03	0.03	0.02	0.04	0.03	0.04
CTE family and consumer sciences courses passed	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02

Appendix Table F (continued): Random forest feature importance of courses for models in this study. Higher importance scores indicates course features that are more predictive.

Courses taken/ passed	College Readiness 0|1	College Readiness 1|2	Post-Secondary Enrollment	Post-Secondary Award	STEM Intent	STEM Award	Degree-granting time to enroll	Technical colleges time to enroll	Degree-granting time to award	Technical colleges time to award
CTE information technology courses taken	0.02	0.02	0.02	0.01	0.03	0.03	0.02	0.02	0.01	0.01
CTE information technology courses passed	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CTE health science courses taken	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.03
CTE health science courses passed	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
CTE marketing education courses taken	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CTE marketing education courses passed	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CTE technology engineering courses taken	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02
CTE technology engineering courses passed	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CTE general courses taken	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTE general courses passed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTE skilled technical sciences courses taken	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.04	0.04	0.05
CTE skilled technical sciences courses passed	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02
CTE work based learning courses taken	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CTE work based learning courses passed	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00

Appendix I

Appendix Table G: Number of students enrolled at degree-granting institutions in each college readiness category.

College readiness	Enrolled after one year	Enrolled after two year	Enrolled after three year	Enrolled after four year	Enrolled after five year	Enrolled after six year
Not ready	270	107	85	56	22	--
Partially ready	1,277	563	510	261	131	42
College ready	45,522	6,428	11,533	2,917	842	293

Note: -- insufficient sample size

Appendix Table H: Number of students enrolled at technical colleges as certificate-seeking in each college readiness category.

College readiness	Enrolled after one year	Enrolled after two year	Enrolled after three year	Enrolled after four year	Enrolled after five year	Enrolled after six year
Not ready	30	17	11	--	--	--
Partially ready	248	119	89	43	20	--
College ready	3,866	1,263	1,093	608	305	104

Note: -- insufficient sample size

Appendix Table I: Number of students receiving an award from a degree-granting institution in each college readiness category.

College readiness	Award after one year	Award after two year	Award after three year	Award after four year	Award after five year	Award after six year
Not ready	--	13	16	29	30	--
Partially ready	18	53	93	103	76	46
College ready	700	3,814	4,398	5,050	3,244	1,556

Note: -- insufficient sample size

Appendix Table J: Number of students receiving an award from a technical college in each college readiness category.

College readiness	Award after one year	Award after two year	Award after three year	Award after four year	Award after five year	Award after six year
Not ready	--	12	--	--	--	--
Partially ready	51	80	45	44	--	--
College ready	837	991	759	474	276	96

Note: -- insufficient sample size