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The Role of Course Delivery Modality in Dual Enrollment

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Abstract

Dual enrollment, or college courses offered in high school, can be delivered using a variety of modalities. Conducted in North Carolina, this study uses a statewide dataset to examine participation in and outcomes for three different delivery modalities for general academic courses and Career and Technical Education (CTE) dual enrollment courses: 1) on the college campus; 2) online; and 3) at a high school/other location. We use a propensity score weighting approach to compare outcomes for students who took the majority of their courses in a specific modality with students who did not take any dual enrollment at all. Analyses show that the proportion of courses taken online has increased substantially in recent years with over half of dual enrollment courses taken online during the study period. Course success rates vary by modality with the highest pass rates for courses taught at the high school/other location and the lowest pass rates for CTE courses taught online. However, the impact analyses show positive impacts on postsecondary enrollment and credential attainment for all three modalities with some of the strongest impacts on bachelor's degree attainment for online courses. Qualitative data provide high-level insights around strengths and challenges associated with each modality. We conclude that all three modalities are viable options for the expansion of dual enrollment.

The Role of Course Delivery Modality in Dual Enrollment

Introduction

Dual enrollment, or college courses offered in high school, is often seen as a way of helping increase the number of students enrolling and succeeding in postsecondary education. Analyses of recent federal data suggest that up to 2.8 million high school students are taking dual enrollment annually (Fink, 2025). There is also a growing body of research that shows that dual enrollment can improve students' high school, postsecondary, and workforce outcomes (Allen & Dadgar, 2012; An & Taylor, 2019; Edmunds, Unlu, Glennie, & Arshavsky, 2022; Edmunds, Unlu, Phillips, Mulhern, & Hutchins, 2024; Henneberger, Witzen, & Preston, 2022; Schaller, Routon, Partridge, & Berry, 2025; Taylor et al., 2022). Given the positive outcomes, there are substantial program and policy efforts to expand access to dual enrollment.

Expanding access to dual enrollment requires the use of a variety of delivery modalities and locations including online, in person on the college campus, and in person on the high school campus. This paper explores the prevalence of dual enrollment coursetaking via different modalities and how longer-term postsecondary outcomes vary by students' dual enrollment modality. It builds on a small body of existing research that has examined dual enrollment modalities (D'Amico, Morgan, Robertson, & Rivers, 2013; Liu, Minaya, Zhang, & Xu, 2020; Ryu, Schudde, & Pack-Cosme, 2024). Most of these studies sought to determine which modalities were more effective than the others and for which students. Our study takes a different approach, more similar to Liu et al. (2020); instead of pitting the modalities against each other, we seek to understand if taking dual enrollment through each modality, considered separately, is better than not taking dual enrollment at all. We take this approach because it is

likely that schools in certain areas—such as those in remote rural areas—may be limited in the types of dual enrollment delivery modalities that they can provide. For example, a high school may only offer dual enrollment courses online because it does not have a nearby college or any credentialed high school instructors who could teach college-level courses. In this paper, we operate from the assumption that different types of modalities are necessary to expand access to dual enrollment, and we want to determine whether all of these modalities have positive benefits for students when compared to not participating in dual enrollment at all.

We explore this issue in North Carolina, first conducting descriptive analyses around the types of modalities and the extent to which course delivery modality differs by type of course and by student and school characteristics. We then categorize students into mutually exclusive groups based on the modality of the majority of their dual enrollment courses, and we use a propensity score weighting approach to compare outcomes for students taking each modality with students not taking any dual enrollment. To preview our findings, we find that the prevalence of online coursetaking in North Carolina has increased over time with over half of dual enrollment courses now taken online. Online coursetaking was more prevalent among students taking general education courses and much less prevalent among students taking courses with a hands-on focus. We found that all three modalities were generally associated with positive effects on attainment of postsecondary credentials, with some nuance by the type of credential.

Literature Review

States use a range of different terms (dual enrollment, dual credit, concurrent enrollment) to describe college courses taken in high school. For the purposes of this paper, we use dual enrollment as an umbrella term to describe all college courses that are offered to high school

students by a postsecondary institution and where passing the course results in college credit that can be placed on a college transcript (College in High School Alliance, n.d.). This is different from other college-level courses, such as Advanced Placement, where students earn credit by passing an exam.

Dual Enrollment Participation and Outcomes

The U.S. has seen a dramatic increase in student participation in dual enrollment over the past couple of decades, with recent estimates suggesting that 2.8 million high school students took at least one dual enrollment course in the 2023-24 school year (Fink, 2025). However, research also suggests that participation is not necessarily equitable across different student subgroups. In most settings, dual enrollment participants are more likely to be female, White and not economically disadvantaged (An & Taylor, 2019; Pierson, Hodara, & Luke, 2017), especially when students are taking dual enrollment courses intended to transfer to a four-year postsecondary institution (Edmunds et al., 2024).

Research has shown that dual enrollment is generally associated with positive impacts on an array of outcomes (An & Taylor, 2019; Schaller et al., 2025; Taylor et al., 2022). In high school, dual enrollment can increase students' college readiness by building their understanding of college expectations (Edmunds et al., 2017), increasing college-going aspirations (Kanny, 2015), helping them build skills such as time management, note-taking and self-advocacy (Cortez, Varela, Jones, Chernosky, & Silva, 2024; Rodriguez et al., 2017), and improving high school graduation rates (Edmunds et al., 2024). Studies have also shown that dual enrollment is associated with increased college enrollment (Allen & Dadgar, 2012; An, 2013; Schaller et al., 2025), although there are some mixed findings related to four-year college enrollment (Edmunds et al., 2024; Taylor et al., 2022). In general, research has shown that dual enrollment results in

higher levels of college academic performance and persistence (An & Taylor, 2019; Struhl & Vargas, 2012) and a higher likelihood of earning a postsecondary credential at both two-year and four-year institutions (An & Taylor, 2019; Miller et al., 2018; Schaller et al., 2025; Struhl & Vargas, 2012).

The general consensus in the literature is that dual enrollment benefits all subgroups, although there is differing evidence as to whether some populations benefit more than others. For example, some studies have shown that impacts on college enrollment and postsecondary degree attainment are positive but weaker for students of color as compared to White students (Liu et al., 2020; Struhl & Vargas, 2012; Taylor, 2015). Some studies have found that economically disadvantaged students benefit less (Miller et al., 2018; Taylor, 2015), while others have found higher benefits for economically disadvantaged students (Edmunds, Unlu, Furey, Glennie, & Arshavsky, 2020). There is also some evidence that students in rural settings benefit from dual enrollment more than students in urban settings, likely because they tend to have less access to other types of advanced courses (Edmunds, Phillips, Mulhern, Hutchins, & Visser, in press).

Dual Enrollment Implementation

The implementation of dual enrollment courses can differ along various dimensions, including course subject, modality, and location of the course. Courses may be offered in an array of subjects, which generally can be grouped into two primary categories: 1) general education courses that can lead to an associate degree or that can be transferred to a four-year institution; and 2) Career and Technical Education (CTE) courses that are usually associated with specific technical credentials, certificates or diplomas, or workforce-based majors (Edmunds et al., 2024). Although prior research has generally examined dual enrollment courses

as a single category, growing evidence suggests that whether the course has a more academic or career focus has important implications for the types of students who participate as well as students' longer-term outcomes (Edmunds et al., 2024; Ryu et al., 2024). For example, a study of Texas dual enrollment coursetaking found that students taking academic dual enrollment had different gender, racial, economic and academic backgrounds than students taking CTE dual enrollment courses (Ryu et al., 2024). This suggests that research should be done separately by the type of courses students are taking, which is what we do in this study.

Another significant way in which dual enrollment implementation differs is by course delivery modality and location. For example, courses can be taught on the college campus, on the high school campus, at a community center, or online. Data suggest that the vast majority of dual enrollment courses nationwide are offered on the high school campus, with approximately 80 percent of courses on the high school campus, 17 percent on the college campus, and 8 percent online[1]; however, these data are from over a decade ago (National Center for Education Statistics, 2019). Modality can differ meaningfully by state; for example, an analysis of Florida's data (Liu et al., 2020) (also looking at cohorts from more than a decade ago) found that half of students took dual enrollment primarily on the college campus and 40 percent took it primarily in-person not at the college campus (likely mostly on the high school campus) (the roughly 10 percent remainder took courses mostly online). A more recent analysis of Texas data (Ryu et al., 2024) found that course modality differed by course subject. Only 10 percent of CTE dual enrollment courses were offered online in contrast to 34 percent of academic dual enrollment courses.

[1] In these data, online could also have been coded as on the high school or college campus, which is why the totals equal more than 100% in this study.

An additional way in which the delivery of dual enrollment can differ is by the course instructor. Although data on instructors are very limited, a recent survey reported that the vast majority of courses taught on the college campus and online are taught by college instructors. The majority of courses taught on the high school campus use high school instructors, although there are a substantial number of partnerships that have college instructors teaching on the high school campus (Williams & Kilgore, 2025).

Research on Dual Enrollment Course Modality

A recent review of the dual enrollment literature identified the need for additional research on course modality and the relationship between modality and outcomes (Taylor et al., 2022). To date, there is only a small set of studies that has looked at different types of modalities and connected those to outcomes. Several of these studies have compared outcomes for students taking courses in different types of modalities, with mixed results in terms of which modality was found to be more effective. Two studies found no differences by modality. One of these studies finding no differences (Hu & Chan, 2021) used data from the High School Longitudinal Study of 2009 to compare outcomes for students who took all their dual enrollment courses on the high school campus (84 percent of the sample) to outcomes for students who took at least one course on the college campus (16 percent of the sample). They found no differences in high school outcomes or postsecondary enrollment by delivery modality and concluded that "resources should continue to be allocated to DE programs in different settings to provide all students access to college-level courses" (Hu & Chan, 2021, p. 22). Another study reached a similar conclusion (Clayton, Faria, & Witowsky, 2025), using data from Colorado to conduct a matched comparison study comparing outcomes for students taking courses at the high school

(80 percent of the sample) with outcomes for students taking courses at the college campus (12 percent)[2]. They found no statistically significant differences between modalities in terms of early college GPAs or number of credits earned and argued that both modalities should be offered.

In contrast, other studies have found some differences by modality. A small survey study in a technical college (Alsup & Depenhart, 2023) compared outcomes for students taking courses on the college campus versus on the high school campus. They found that 11th and 12th grade dual enrollment students who completed their courses on the college campus reported higher levels of integration and potential persistence than students who took their courses on the high school campus (however, this could have been due to pre-existing differences among the students). Another study (D'Amico et al., 2013) found that students who took courses on the college campus were more likely than students who took their courses on the high school campus to persist at the technical college in which they had enrolled, although the study was limited in the outcomes it could explore. A much larger study using statewide administrative data in Texas (Ryu et al., 2024) looked at differences in outcomes by course type (academic, CTE), course location (high school, community college, other location), and modality (online or in person). For both academic and CTE courses, taking courses at the college (versus at the high school or another location) was associated with worse course performance as was taking the course online versus in person. Taking courses on the college campus was associated with increased postsecondary enrollment overall, driven by increased enrollment at a two-year institution. Interestingly, despite the lower pass rates for online courses, taking courses online (relative to

[2] The balance of the sample was students who were taking courses online or in a combination of modalities and these students were excluded from further analyses.

face-to-face) was associated with a 1.2 and a 2.2 percentage point increase in the probability of any college enrollment and public university enrollment, respectively.

The previous studies compared outcomes by modality for students—all of whom took dual enrollment. We found two studies that compared outcomes by modality to students not taking dual enrollment. One study (Arnold, Knight, & Flora, 2017) used data from a single college and compared dual enrollment students with college students taking the same course. This study compared dual enrollment students taking different modalities with regular college students taking the course in-person on the college campus. They found that dual enrollment students performed worse relative to college students taking the same course when the course was taken on the college campus than when they were taken online or at the high school. It suggested that "online courses can be a convenient, cost-effective solution to staffing issues" (Arnold et al., 2017, p. 30). Another larger study (Liu et al., 2020) used data from Florida to look at differences in participation by modality (face-to-face on college campus; face-to-face off campus; online). They found the largest positive benefits for students who took courses in-person on the college campus, followed by in-person off campus, and then online, although this differed by subgroup. For example, Black students who took courses online had the largest benefits compared to Black students in other modalities. In contrast, Hispanic and White students gained the most by taking their courses in person on the college campus. This study did not, however, look at the extent to which modality differed by course topic.

There is very little research that has been done on instructor types, mostly because of a lack of data. A notable exception is the study by Ryu et al. (2024), which was able to distinguish between college and high school instructors. They found that course pass rates were lower for

students who took courses from college instructors than for high school instructors, although taking a course with a college instructor was also associated with a higher likelihood of college enrollment (Ryu et al., 2024). Regrettably, we do not have data identifying the course instructor and are unable to look at this; we discuss the implications of this in our limitations section.

Theoretical Framework

Why might the location or modality of a course matter? In this study, we apply sociological theories of social roles and anticipatory socialization to dual enrollment students (Karp, 2012) to consider the answer to this question. A social role is defined as "a comprehensive pattern of behavior and attitudes, constituting a strategy for coping with a recurrent set of situations" (Turner, 1990, p. 87). In shifting from high school to college—whether a four-year or a two-year—students are expected to take on a different role with different expectations of knowledge, skills and behaviors (Duncheon, 2020; Edmunds et al., 2022) as they become socialized into the new organization (Chao, O'Leary-Kelly, Wolf, Klein, & Gardner, 1994). Anticipatory socialization reflects the activities in which high school students engage as they prepare to take on a new role (Cuellar & Allen, 2024).

Using this framework suggests that one of the ways that dual enrollment helps high school students be more successful in postsecondary education is by allowing them to rehearse their new role as college students:

> Dual enrollees get ready for college success by learning—before they actually matriculate—all aspects of the college role. They acquire the technical demands of how to do college-level work. They also learn normative expectations—the habits, attitudes, and behaviors of successful college students—and discover strategies to enact these

> expectations successfully by seeing how other people react to their 'college tries.' (Karp, 2012, p. 23).

We might expect that different dual enrollment course modalities will provide different anticipatory socialization experiences and allow for different levels of role rehearsal. We also acknowledge that socialization is only part of the story and that there are logistical and capacity issues that might make it more or less challenging to offer courses in a specific modality, so we consider these at the same time that we identify the potential socialization benefits for each modality.

Taking courses on the college campus is often seen as providing students with an experience that most closely mirrors what they will experience in college and is seen by some researchers or advocates as providing students with better or more authentic preparation (An & Taylor, 2019; Karp, 2012). However, there can be substantial logistical challenges to offering courses at the college campus, including transporting students to the college and differences in scheduling between high schools and colleges (Edmunds, Arshavsky, et al., 2022).

Taking courses online may assist students in learning how to be successful in virtual environments, which are becoming increasingly common in post-COVID-19 pandemic postsecondary settings (Hart, Hill, Alonso, & Xu, 2025). Additionally, offering dual enrollment courses online may be particularly useful for schools in rural areas where students have less access to other types of college-level courses, such as Advanced Placement (An & Taylor, 2019). Online courses can help address scheduling and transportation issues, but students may face issues with internet access, particularly in remote rural areas.

Courses offered on the high school campus, particularly if they are taught by high school instructors, may be seen as providing students with the lowest potential amount of anticipatory socialization opportunities. However, these types of courses can actually make dual enrollment more accessible to students, which helps address issues of equity (An & Taylor, 2019). Similar to online, courses on the high school campus resolve challenges related to transportation and scheduling; additionally, there is some evidence that high school instructors provide more support than college instructors, which might lead to students receiving better grades (Clayton et al., 2025). As a result, although there are questions about whether courses offered on the high school campus provide students with the necessary socialization and familiarity with the potential rigor of college courses, these concerns may be offset by the greater access and potentially stronger course performance that high school-based delivery can facilitate.

Study Contributions

Our study contributes to the existing literature in several ways. First, we examine these issues in a new state (North Carolina) that has a robust dual enrollment program with stronger online participation than any of the other states that have been examined to date. We apply a similar approach as Liu et al. (2020), in which we look at three different modalities: 1) in person on the college campus; 2) online; and 3) in person at another location (high school, community center, etc.). We also differ from most of the previous literature and follow Liu et al. (2020)'s approach by comparing outcomes of students in different delivery modalities to those of students not participating in dual enrollment. Additionally, we address a limitation in the Liu report, and follow a portion of the approach in the Ryu et al. (2024) article by doing our analyses separately by course type. Unlike the other studies, we are able to incorporate data from the National Student Clearinghouse, which allows us to capture students' postsecondary enrollment and

credential attainment regardless of where they enroll. Finally, we pay attention to differences by locale, given that students at rural schools may be more limited in their access to advanced courses.

Study Context

Our study takes place in North Carolina, where we look at the state's dual enrollment program, Career and College Promise (CCP). North Carolina has a decades-long history of supporting dual enrollment. CCP, the current iteration, was enacted in 2011 and includes three distinct pathways that were intended to focus students' coursetaking: 1) the College Transfer Pathway; 2) the Career and Technical Education (CTE) Pathway, and 3) the Cooperative Innovative High School (CIHS) Pathway. The first two pathways can be implemented in any non-CIHS high school across the state. The College Transfer Pathway includes courses that lead to an associate degree and can transfer to a four-year institution. This pathway includes a college transfer success course and college courses in English, mathematics, and other subjects. After a student completes the College Transfer Pathway courses, they may enroll in a course of study leading to an associate degree. Most of the College Transfer Pathway courses are covered by an articulation agreement that guarantees these courses will be accepted at University of North Carolina (UNC) System schools. The CTE Dual Enrollment Pathway is designed for students to earn college credits aligned with career clusters and that can lead to technical credentials, certifications, or workforce-oriented majors. The third pathway (CIHS, otherwise known as early colleges) consists of small schools, often housed on college campuses, that have a goal of students earning an associate degree or two years of transferable credit at the same time that they

earn a high school diploma. This paper focuses on the first two pathways; the CIHS pathway has very different approaches to course delivery and is excluded from these analyses.

Participation in both the College Transfer and CTE Pathways during the period we analyze in this paper was primarily limited to students who were high school juniors or seniors[3] and who met specific eligibility criteria. For both pathways, there were no tuition charges for the college courses; however, students or their school/district were required to cover the costs of textbooks, fees, and transportation.

CCP is overseen by officials from the North Carolina Department of Public Instruction, the North Carolina Community College System, the UNC System, and the North Carolina Independent Colleges and Universities. CCP courses are all college-level courses offered through partnerships between high schools and local colleges (typically community colleges). They may be taught at a local college campus, at the high school, or online. According to data collected during site visits, these courses are most frequently taught by college faculty, but qualified high school teachers may teach them on the high school campus. The courses offered in the College Transfer and CTE Dual Enrollment Pathways are exclusively offered by community colleges.

Methods

Overview

In this paper, we address the following research questions:

1. How does participation in different modalities of course delivery (online, on the high school campus, on the college campus) differ by student characteristics (race/ethnicity,

[3] A limited number of students could take dual enrollment in earlier grades. We include early high school dual enrollment coursetaking in our descriptive analyses of participation and course success rates but we exclude students who took dual enrollment in 9th or 10th grade from our propensity score weighting analysis so that we may include baseline factors from those years (e.g., GPA) as part of our weighting process. This exclusion drops approximately 1 percent of the would-be treatment group.

gender, economically disadvantaged status), by school characteristics including locale, and by course type?

2. What is the relationship between course modality and students' success in the course? How does that relationship differ by student characteristics and course type?
3. What are the impacts of dual enrollment on secondary and postsecondary outcomes for students who take courses in different modalities? To what extent do those impacts differ by dual enrollment pathway, student background characteristics, and by locale?
4. What are educators' beliefs about the influence that modality has on student access and success?

The research design uses multiple methods, including: 1) descriptive analyses to explore the characteristics of students taking different modalities of courses and the characteristics of schools with larger and smaller shares of coursetaking in each modality; 2) a propensity score weighting approach to examine the impact of participation in different types of dual enrollment modalities; and 3) qualitative analyses of interview data. In this paper, the primary emphasis is on the quantitative data although we also present high-level findings around implementation and perceptions of impact from the qualitative data.

Data

We use two key datasets in this study. The first is a student-level dataset that incorporates 1) K-12 data from the North Carolina Department of Public Instruction containing student background characteristics, achievement, and behavioral measures; 2) coursetaking, student performance, and credential attainment data from the North Carolina Community College System and the University of North Carolina System; and 3) postsecondary enrollment and

credential attainment data from the National Student Clearinghouse. We have linked these student-level data using North Carolina's Unique Identifier. The Community College System data includes detailed enrollment and coursetaking information for all dual enrollment students participating in the College Transfer or CTE Pathway. It includes the student's dual enrollment pathway, the subjects of the dual enrollment courses they took, students' grades in the courses, the location of the courses, and whether the course was taught online or in person/hybrid.[4] The dataset does not include information on instructor so we are unable to consider the influence of the type of instructor (high school or college) in our analyses.

The second dataset includes transcripts from interviews conducted with a range of high school and college staff from around the state. The interviews included various questions about which modality they use and how modality affects success.

Sample

We use three primary samples in the analyses. The first is a statewide student sample that includes all dual enrollment coursetaking for students enrolled at comprehensive high schools (i.e., those offering the College Transfer and CTE Pathways) over the 2014-15 to 2021-22 period. In total, it includes 191,235 students who took a total of 788,173 dual enrollment courses. We use this sample for our RQ1 and RQ2 descriptive analyses of dual enrollment coursetaking and course success rates by modality.

The second sample, which we use for the propensity score weighting analysis of long-term outcomes, includes seven cohorts of students who entered 11th grade from 2014-15 to 2020-21 (i.e., who we could follow through expected high school graduation in 2021-22). It includes

[4] Our analyses group all hybrid courses along with in-person courses as courses that included at least some in-person instruction. This is consistent with guidance provided to us by the NC Community College System.

students in either the College Transfer Pathway or the CTE Pathway (nearly 137,000 students) and comparison students (more than 491,000 students). We divide the College Transfer and CTE Pathway students into mutually exclusive treatment groups by pathway based on where they took the majority of their dual enrollment courses: online, in-person at the college campus, or in-person at the high school or another location.[5]

The third sample is for the interviews. We conducted a total of 48 interviews with district coordinators, high school principals, counselors, teachers, distance learning coordinators, college liaisons, and college program directors from eight districts and their partner colleges across diverse regions of North Carolina. The schools were geographically distributed around the state, in rural and urban areas, in higher income and lower income districts, and in districts serving higher and lower numbers of students who were members of historically underrepresented racial and ethnic groups.

Measures and Outcomes

Modality. The study focuses on examining three primary modalities through which dual enrollment is delivered in North Carolina: 1) online; 2) in person on the college campus; and 3) in person at another setting (which is usually the high school). The NC Community College System data include a binary indicator for whether a course is fully online and another variable indicating the extent to which a not fully online course is hybrid or fully in-person. The NC Community College System described that the indicator of whether a course is fully online is accurate; however, the distinction between hybrid and in-person is not always accurate given that

[5] We excluded from the propensity score weighting analysis students not taking a majority of their courses in a specific modality (e.g., who took one course in each modality), because our goal was to understand what makes each modality distinct; this affected less than 10 percent of the dual enrollment students in the would-be treatment group.

many courses that are primarily in-person also have substantial online components. As a result, we began by grouping courses into two different modes of delivery: online and in-person/hybrid. We then further divided the in-person/hybrid courses into the location of where they are taught. The NC Community College System data included a measure for where the course was taught—at the community college (main campus or multi-campus center), or at another setting, which included at the high school.[6]

Students can take courses in a mix of modalities. We handle this differently depending on the research question. For the descriptive analyses (RQ1) and the analyses of course success (RQ2), we conduct the analyses at the course level. Each course receives an indicator for which of the three modalities apply. For our propensity score analyses (RQ 3), we placed students into mutually exclusive groups based on the majority of dual enrollment courses they took. For example, students who took the majority of courses online were considered online students. Students who took courses that were equally divided between modalities (i.e., one course was on the college campus and one was online) were excluded from this portion of the analyses.

Student Pathway and Course Subject. We looked at modality separately by student pathway and course subject. Each student is required to be enrolled in a specific pathway—either the College Transfer Pathway or a specific program of study within the CTE Pathway. The College Transfer Pathway includes primarily general education courses that lead to an associate degree and that can transfer to a four-year institution. The CTE Pathway may include courses

[6] High school was reliably broken out as a separate location only starting in 2022-23; in all previous years, the high school campus was not reliably broken out from "other community location" in the NC Community College System data For the 2022-23 year, more than 50 percent (approximately 52%) of in-person/hybrid dual enrollment courses *not taught on the college campus* were taught on the high school campus so we assume the majority of these courses in previous years were also being taught on the high school campus. The Community College System confirmed that this was a reasonable assumption and that data to identify the precise percentage are not available.

that transfer to a four-year institution as well as CTE courses that do not transfer but that lead to technical credentials or diplomas. Students may ultimately take courses in a mix of pathways or topics. As a result, similar to the modalities, we handle the assignment of pathways and subjects differently depending on the analyses.

For RQs 1 and 2, which were course-level analyses, we identified individual courses as either being general education or CTE courses, using codes in the Community College System data. General education courses are typically academic courses, transferrable to a four-year institution; CTE courses are typically not transferrable to a four-year college, but some, such as Business 110 or Computer and Information Science 110, might be. We further broke out CTE courses by their three-digit course prefix to look at course subjects.

For RQ 3, our student-level analyses, we assigned students according to the pathway that they were taking—the College Transfer Pathway or the CTE Pathway. Students who were coded as belonging to both of the two pathways were kept in both pathways' treatment groups. Some of the programs of study (i.e., business, computer science, engineering) may include courses that can transfer to a four-year institution.

Student Characteristics. To explore participation, outcomes, and impacts by subgroup, we used a set of student characteristics derived from the data.

- Race/ethnicity. Our primary analyses grouped students by whether they were a member of a racial/ethnic group that has historically lower levels of participation in college (Black, Hispanic/Latino, Native American, Multiracial) or a group that has not been historically underrepresented (Asian and White).
- Gender. In the data, students were identified as either male or female.

- Economically disadvantaged status. Students were flagged in the dataset as being economically disadvantaged (North Carolina Department of Public Instruction, 2023) or not.
- Locale: We identified the locale of the school the student attends using the National Center for Education Statistics locale codes (National Center for Education Statistics, n.d.). We grouped these locales by city/suburban and rural/town.

Outcomes. We examined the following core outcomes.

- *Course performance.* For each course, we looked at whether students successfully completed the course (defined as earning a C or higher). This outcome was analyzed at the course level and came from the NC Community College System data.
- *Number of college credits earned in high school.* We examined the number of potential college credits earned in high school. This included credits earned through dual enrollment as well as credits earned by passing the AP exam with a 3 or higher. Dual enrollment credits came from the Community College System data and the AP exam scores came from the NC Department of Public Instruction. This outcome was examined at the student level.
- *Enrollment in postsecondary education within one year of graduating from high school.* We looked at enrollment in any institution, in two-year and in four-year institutions. If students were simultaneously enrolled in a two-year and a four-year, they were included in both outcomes. These data came from the National Student Clearinghouse; we excluded postsecondary enrollments that occurred while students were still enrolled in high school.

- *Attainment of a postsecondary credential.* We looked at attainment of certificates and diplomas, associate degrees, bachelor's degrees, and any postsecondary credential. We assess certificate/diploma and associate degree-earning within three years of 12th grade. We assess bachelor's degrees and any postsecondary credential-earning within six years of 12th grade. Credentials could have been earned during high school, and we utilized data from the Community College System and the University of North Carolina System to capture credentials earned during high school. Credentials earned post high school were captured through the National Student Clearinghouse.[7]

Analyses

The analytic strategy differed by research question. Both RQ 1 and 2 were course-level analyses. For RQ 1, we conducted descriptive analyses in which we described the number of courses being taken in each type of modality, by type of course (academic vs. CTE) and further by more detailed course subject for CTE courses. To look at specific subgroups, we used multivariate regression models to assess how student and school factors related to modality, holding other characteristics constant. To provide additional context around the characteristics of schools that had higher and lower rates of dual enrollment coursetaking in each modality, we calculated the proportion of courses taken at each school in each modality and divided schools into quartiles for each of the modalities (e.g., the top quartile by share of courses taken online or the bottom quartile by the share of courses taken in person on the college campus). We then summarized the characteristics of schools in each quartile for each modality—considering locale,

[7] The NSC data are requested by the North Carolina Department of Public Instruction for high school graduates and only for students' post-high school experiences. Given the large number of students who earn credentials while in high school, we supplemented these data with the data from the Community College System and University of North Carolina System.

school size, share economically disadvantaged, and share of students in historically underrepresented racial or ethnic groups.

For RQ 2, we looked at the association between course success and modality both purely descriptively and using a multivariate regression model that included modality as the independent variable, a course success indicator as the dependent variable, and a wide range of student and school characteristics as covariates in the model.

For RQ 3, our student-level analyses of impact, we applied a propensity score weighting approach that we have already used to assess the impact of dual enrollment coursetaking in North Carolina (Authors). We began by dividing students into their dual enrollment pathways (College Transfer or CTE). Then, as noted above, we categorized each student by the majority of courses they have taken. Using online as an example, we separately flagged College Transfer and CTE Pathway students by whether the majority of their dual enrollment courses were taken online. We then compared students taking dual enrollment in a specific pathway using a specific modality with a group of comparison students who were not taking dual enrollment at all. Because students who choose to take dual enrollment are different than those who do not, we cannot simply compare results for participants and non-participants. To address this, we used propensity score weighting to construct a comparison group that closely matches dual enrollment participants on observed characteristics. We did these weightings separately for each Pathway/Modality combination. Using our online example, we compared outcomes for students in the College Transfer Pathway who took mostly online dual enrollment courses to a weighted comparison group that did not take any dual enrollment (students in both groups may have taken AP classes, which we are treating as part of the business-as-usual condition).

We created our weighted comparison groups using generalized boosted modeling (GBM) to automatically select the covariates and interactions to include as well as the functional form that leads to the best balance across the treatment and comparison groups (McCaffrey et al., 2013). We implemented the GBM using the *Twang* package in Stata (Cefalu, Liu, & Martin, 2015) and included student- and school-level covariates. The student-level covariates included baseline end-of-course exam scores and high school GPA, demographic characteristics, economic disadvantage status, 9th and 10th grade coursetaking patterns (e.g., number of honors courses, AP courses, CTE courses), as well as absences and suspensions in 8th-10th grade. School-level covariates included urbanicity, school racial/ethnic composition, size, charter status, county economic development tier, and school-level averages of all student-level covariates. We did not require students to be within the same schools because we were concerned that unobservable differences in the types of students who participate in CCP versus not may be magnified within schools.

Propensity score weighting allows us to account for observable and measurable differences between people in the treatment and comparison groups. However, this approach does not allow us to address any unobserved differences, such as motivation, that may lead students to participate in dual enrollment. We did include a wide range of covariates that we believe are good proxies for motivation and aspirations (including 9th and 10th grade CTE, honors, and AP coursetaking patterns) and have found in prior work in a very similar setting that these methods were robust to a variety of assumptions (Edmunds, Unlu et al., 2024; Fuller et al., 2023). In addition, propensity score methods have been used in other research examining the effects of dual enrollment programs (e.g., An, 2013; Henneberger, Witzen, & Preston, 2022).

Table 2 presents the baseline characteristics of our sample and the results of our weighting approach for each delivery modality within the College Transfer Pathway; Table 3 presents the same for the CTE Pathway. After weighting, the differences between the treatment groups and their respective weighted comparison groups were less than 0.08 standard deviations for each measure, with the vast majority of differences less than 0.05 standard deviations. These baseline differences meet What Works Clearinghouse standards for baseline equivalence (What Works Clearinghouse, 2022).

TABLES 2 and 3 HERE

Then, we used these weights in regression models to estimate how participating in a specific modality of dual enrollment within a specific pathway is associated with core high school and postsecondary outcomes. The model we use is:

$$Y_{ij} = \beta_0 + \beta_1 Trt_{ij} + \boldsymbol{X_{ij}\beta_2} + \boldsymbol{Z_j\beta_3} + \varepsilon_{ij} \quad (1)$$

where Y_{ij} represents the outcome for student i in school j; Trt_{ij} is an indicator for whether the student participated in the relevant pathway (CTE or College Transfer); $\boldsymbol{X_{ij}}$ is the vector of student-level covariates and it includes indicators for a student's cohort; $\boldsymbol{Z_j}$ is the vector of school-level covariates; and ε_{ij} is the student-level residual. We fit the models separately for each Pathway/Modality group, and we report the coefficient $\beta_1$which indicates how the outcome differs for students in the treatment group relative to the comparison group. We ran doubly robust models (Bang & Robins, 2005) with the student- and school-level covariates used to construct the propensity score weights also included as controls in the regression models. We clustered standard errors at the high school level. Missing covariate values were imputed using

multiple stochastic imputation where we computed ten imputed values for each missing covariate. Outcome values were not imputed.

Relative to RQ 4, all interviews were transcribed and placed in Atlas.ti for coding. We used inductive coding to identify themes around respondents' perceptions of how the modality of delivery affects students' outcomes including any feedback around which populations of students were likely to do better or worse in each delivery modality.

Results

We present the findings organized by the research questions.

Participation by Modality and Course Type

Analysis of dual enrollment coursetaking over time indicates that the number of courses taken has dramatically increased—driven by both more students taking dual enrollment and higher numbers of courses being taken by each student. Figure 1 shows coursetaking increased three-fold, by nearly 100,000 courses taken, over the years from 2014-15 to 2021-22.

FIGURE 1 HERE

Figure 1 also shows that the proportion of courses taken online also dramatically increased. In 2014-15, coursetaking was close to evenly divided across the three modalities with 32% of course enrollments occurring online. The proportion of online courses (shown by the dotted line) was slowly increasing and then jumped to a high of 80% during the peak of the COVID-19 pandemic in 2020-21. The proportion then dropped in 2021-22 but still remained high at 66%.

Our analyses show there are very different patterns of course modality by course type. Table 3 shows that the majority of general education courses taken were online with about a quarter on the college campus and 13 percent in other locations (likely predominantly at the high

school). In contrast, CTE courses were about equally likely to be taken in each of the three modalities with roughly a third of courses taken in each modality.

TABLE 3 HERE

Figure 2 shows the proportion of online courses taken by CTE subject. Not surprisingly, courses with a strong hands-on component, such as welding, automotive, cosmetology or nursing assistant courses, were taken online very infrequently. In contrast, courses in business, information systems, and medical assisting had over 70 percent of their courses taken online.

FIGURE 2 HERE

Table 4 presents the results from regression analyses that connected student and school characteristics with the likelihood of taking courses in a specific modality, holding other characteristics constant. In this table, we focus on the distinction between taking courses online versus on the college campus.

TABLE 4 HERE

As shown in Table 4, we found that female students were more likely than male students to take courses online rather than on the college campus regardless of the type of course. Members of historically underrepresented racial and ethnic groups were less likely than their counterparts not in those groups to take courses online than on the college campus regardless of the type of course. Economically disadvantaged students were equally likely as not economically disadvantaged students to take general education courses online versus on the college campus but less likely to take CTE courses online. Students in urban areas (city or suburban schools) were less likely to take courses online than on the college campus relative to students in rural/town settings regardless of the course topic.

Course Modality and Course Success

Our results indicated that there is some variation in course success by modality. We assessed course success by modality in two ways. First, we looked at success rates by modality and type of course purely descriptively. We see that students taking courses in person at the high school or other non-college-campus location experienced the highest course success (C or higher) rates: 90 percent for general education courses and 86 percent for CTE courses. As shown in Table 6, students taking general education courses had very similar course success rates for courses taught online versus on the college campus. In contrast, online CTE courses had the lowest success rates relative to the other modalities. Table 6 also displays descriptive variation in success rates by modality by student and school subgroups. We see, for example, starker variation by modality in success rates for CTE courses especially for economically disadvantaged students and members of historically underrepresented racial and ethnic groups.

TABLE 6 HERE

Next, we used multivariate regression to assess whether variation in course success rates holds up when accounting for other student- and school-level factors that influence success rates. We see in Table 7 that our findings from the descriptive analyses generally stood up when including in a linear probability model student demographics, economic disadvantaged status, achievement (8^{th} grade exam scores), school locale, grade fixed effects, school year fixed effects, and a continuous measure of the share of all courses in the course's subject area taken online.[8] For both general education courses and CTE courses, course success was less likely when taken

[8] We note that we ran logistic regression models in addition to linear probability models and the results display the same patterns in sign and statistical significance. We report the linear probability model results here for ease of interpretation. Full regression results are available upon request.

online relative to on the college campus—about 3 percentage points less likely for general education courses and about 9 percentage points less likely for CTE courses. These differences exceeded the descriptive, unadjusted differences by about 1-2 percentage points, indicating that students' background characteristics did play a role in the success rates when comparing online to other courses. By contrast, our regression models confirmed that success was more likely for courses taken in-person at the high school than on the college campus—about 4 percentage points more likely for both general education and CTE courses. These regression-adjusted differences were very similar to the descriptive differences. All adjusted differences in pass rates between modalities were statistically significant at the $p \leq 0.01$ level.

TABLE 7 HERE

Impacts by Modality

When we compare results on key secondary and postsecondary outcomes by modality, we see that all three modalities generally had positive impacts on students relative to not participating in dual enrollment at all. Table 8 shows impacts by modality for the College Transfer Pathway. All three modalities had positive and statistically significant effects on college credits earned in high school,[9] any postsecondary enrollment and any postsecondary credential attainment. Impacts on any postsecondary credential attainment and on bachelor's degree attainment were largest for students taking most of their dual enrollment courses online. In

[9] College credits earned in high school include credits earned through the CCP dual enrollment program (which by construction are earned only by members of the treatment group) and AP credits (which can be earned by both treatment and comparison group members). Using the same analytic approach, we estimate the impact of participation in the CCP pathways on earning AP credits. For the College Transfer Pathway, comparison group students earn about 1 to 1.5 more AP credits, on average, than treatment group members (depending on the modality); for the CTE Pathway, comparison group members earn between 0.4 and 0.6 more AP credits, on average, than treatment students. This suggests that these courses are to some degree substitutes for each other.

comparing the levels of the treatment and comparison means across the estimates, it is important to keep in mind that the different modalities were associated with different student characteristics (see Tables 1 and 2). However, we also controlled for these characteristics in our impact analyses; this should help to mitigate the influence of any differences in background characteristics across the delivery methods.

TABLE 8 HERE

The CTE pathway shows similar findings in that the students who took the majority of their dual enrollment courses online experienced the largest impact on four-year enrollment and bachelor's degree attainment. Unlike the College Transfer Pathway, the CTE Pathway's other modalities were associated with negative impacts on bachelor's degree attainment, which is consistent with the overall impacts for the CTE Pathway (Edmunds et al., 2024). For the CTE Pathway, the impact on certificate or diploma receipt also varied notably by modality. There were positive impacts for all modalities but the impact for the two in-person modalities were much larger than for online, likely driven by the kinds of courses students were taking.

TABLE 9 HERE

To look at the differences in impacts by subgroups, we present the results for the two primary outcomes that had substantial differences by modality: bachelor's degree attainment and technical credentials. Moreover, we focus on the differences between online and in-person on the college campus[10]. As shown in Table 10 below, we see that most subgroups had similar patterns for outcomes by modality. When we look at the differential impacts between two corresponding subgroups (e.g., female/male; economically disadvantaged/not economically disadvantaged), we

[10] Results for other outcomes and modalities are available from the authors upon request.

see a few statistically significant differential impacts. In the College Transfer Pathway, participating in online dual enrollment courses had a larger impact on technical credentials for underrepresented racial and ethnic groups (compared to not underrepresented students) and for economically disadvantaged students (compared to not-economically disadvantaged students). For bachelor's degree attainment, the impact for online coursetaking was larger for economically disadvantaged students and for rural students. All groups generally benefitted equally from courses taught on the college campus.

For the CTE Pathway, impacts were generally similar in subgroups for the online courses. In contrast, for in-person on the college campus, impacts were more positive on bachelor's degree attainment for underrepresented racial and ethnic groups and economically disadvantaged students.

TABLE 10 HERE

Staff Perspectives of Modalities

Interviews provide additional insights about how modalities were implemented and students' performance. Because of space limitations, we focus here on some of the highlights of the results; we are creating other products that share implementation lessons learned including on supports for students taking different modalities.

More than half of the districts reported that course delivery methods were primarily determined by the community college, although district needs were often taken into account. Two delivery modes—in-person classes at the high school and online courses—were seen as helping to expand access by removing barriers related to transportation, distance, and scheduling.

Staff in half of the districts we visited noted that dual enrollment courses taught on high school campuses by high school teachers or community college faculty offered the best option

for supporting student success and reducing access barriers. However, it was hard to find qualified and interested teachers to teach these courses.

Asynchronous online classes were seen as the easiest to fit into student schedules, since they did not require meeting at specific times. Staff believed that students had become more comfortable with online learning and were more interested in taking classes online. As one staff member shared, “Compared to the first year that I did [DE], I don't have as many students saying, 'Oh, I have to have face-to-face,' or something like that. They're like, 'Oh, I want to take it online.' They seem to like that format and the convenience of that format, as opposed to having to travel to campus.”

In terms of connecting modality to student success, staff observed the same patterns shown in the quantitative data with generally higher success rates for high school courses taken in person on the high school campus and lower success rates for online courses. As conveyed by a high school counselor, “We see a big difference. Our students that are in our live classes inside the building with statistics, nursing, and criminology, have a really high success rate. Our students who do the virtual classes online, depending on the student, may not do as well.” One of the reasons students might not have done well was the struggle to build relationships with instructors in online classes. As one Distance Learning Facilitator put it, “Honestly, face-to-face is hands down the best. The kids can be in the classroom because they become more comfortable with the instructor. Online, it’s probably the least effective.”

Staff did acknowledge that some students could do well in in an online environment, particularly if they had time management and organizational skills or were motivated: “It

obviously takes a disciplined student to do the online coursework, but I think certain students do really well in those courses."

Overall, the qualitative data suggest that different delivery methods offer varying levels of course accessibility and student success, but each also presents unique implementation challenges. In the interviews staff emphasized the importance of offering multiple delivery modes to meet students' diverse needs. As one college liaison explained,

> Having those various methods of delivery - I think it's critical to the success and student participation. Students have such varied needs now in terms of their time, their schedules, and their work outside of school, that having those various methods of delivery, I don't think you can overstate its importance.

Limitations

This paper has some significant strengths, including a statewide dataset that reflects more recent data than many of the analyses done to date and a proportion of online coursetaking that allows a systematic examination of this relatively understudied modality. However, there are also some key limitations that the reader should keep in mind.

First, our impact analyses were done using a quasi-experimental weighting approach that could not completely account for unobservable characteristics such as motivation. A truly causal design would have randomly assigned participants to certain modalities of dual enrollment. We have attempted to mitigate potential threats to validity by using a large range of covariates, including demographic characteristics and previous achievement, as well as covariates such as 9th and 10th grade coursetaking patterns and behavior that can serve as proxies for interest and motivation. Additionally, we used generalized boosted modeling (McCaffrey, 2013) to create the weights, a robust weighting strategy that resulted in highly similar treatment-comparison levels

for all of the observable covariates. Nevertheless, if certain students were more or less attracted to specific modalities, we may not have fully captured those characteristics.

Second, we did not have data on instructor characteristics, including whether they were high school or college instructors. This should not play a role in our findings for online or college campus modalities, given that our site visits and interviews suggested that all of those instructors were college faculty. However, courses on the high school campus appear to have been taught by a mix of college faculty and high school teachers; as a result, the findings for that modality will reflect a combination of influences of the location, modality, and instructor type that we are not able to tease out.

Finally, North Carolina does have fewer courses offered on the high school campus and taught by high school faculty as compared to many other states, which has the potential to impact the generalizability of the findings. However, this disadvantage is offset by the larger number of online courses and courses taught on the college campus, which allow for rigorous and large-scale examinations of these two other modalities.

Discussion and Conclusion

Overall, our findings tend to mirror some of the key conclusions found by other researchers while adding some new insights. First, each dual enrollment course modality had benefits for students, indicating that all three modalities should be part of the dual enrollment toolbox and should be implemented depending on local context and capacity and the needs and interests of students. Second, our study highlights the importance of paying attention to both short-term outcomes (like individual course success) and longer-term impacts (such as

postsecondary outcomes) as policymakers and practitioners make decisions about which modalities to support.

Our analyses show that, in general, all three of the modalities we explored had positive impacts on students. As a result, we agree with the conclusions shown by other researchers that sites should continue to support a range of modality options (Clayton et al., 2025; Hu & Chan, 2021). However, consistent with other researchers, we also found differences by modality. Our detailed descriptive analyses by course subject suggest that these differences in impacts, particularly for the CTE pathway, were likely primarily driven by the types of courses that are associated with each modality. For example, the larger impacts on technical credentials for students taking courses in-person were consistent with our descriptive findings that hands-on courses were more likely to be offered in person; these hands-on courses are also the types of courses that are more likely to lead to certificates or short-term diplomas. In contrast, the kinds of courses that are more likely to be offered online are also the kinds of courses that are more likely to be associated with degrees or credentials offered at four-year institutions. Our findings thus suggest that researchers and policymakers may want to pay attention to the kinds of courses that are offered in which settings.

Our findings for the College Transfer Pathway, where students taking online courses were more likely to obtain a bachelor's degree, are generally consistent with the research from Texas (Ryu et al., 2024) which also saw increased university enrollment for students who were taking online courses. We believe that this likely has to do primarily with the experience of the counterfactual and argue that students who are taking primarily online courses may not have other options for advanced coursetaking in their area. For example, students in very remote areas may only be able to take online dual enrollment courses. In the absence of online offerings, these

students may not have any other opportunities to take advanced courses. This suggests that creating a robust set of online dual enrollment coursetaking offerings may be one way of improving postsecondary outcomes for students who might not have easy access to courses otherwise.

Interestingly, we also found the same situation as the Texas study (Ryu et al, 2024) in terms of students' course outcomes (i.e., success rates) being worse for students in online courses than in in-person courses. Our qualitative data also support this finding. This suggests that policymakers and practitioners should look at beefing up supports for students in online courses so that students can be more successful and some organizations have begun disseminating resources to assist in this (Williams, 2025). Yet, we also found that online courses had some of the strongest longer-term impacts, particularly related to four-year enrollment and credential attainment. This suggests that researchers should not take the shorter-term outcomes such as pass rates as the final word and should also consider longer-term outcomes.

If we consider our theoretical framework, which focuses on the anticipatory socialization nature of different modalities, we might have hypothesized that courses on the college campus would have had the largest impact on credential attainment because they most closely mirror the college experience and would therefore better prepare students for postsecondary education. Instead, we found that online courses made the largest difference, likely because they provided access to students who might have otherwise limited options to college-level courses. These findings indicate that policymakers and practitioners may want to emphasize the creation of a range of high-quality modalities that can reach students where they are.

It is important to note that the anticipatory socialization theory for dual enrollment has been developed primarily around the assumption that dual enrollment students intend to go to a postsecondary institution after high school. However, it is possible that, for CTE students who are earning a postsecondary credential in high school, this anticipatory socialization may translate to the workforce. This would be an area for future research.

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Tables and Figures:

Table 1: Summary Statistics and Balance Table for the College Transfer Pathway, by Modality

	Treatment Mean	Unweighted Control Mean	Weighted Control Mean	Weighted Standardized Effect Size
Online	(N=58,132)	(N=491,458)		
Female	66.3%	46.3%	65.4%	0.018
White	71.5%	48.2%	69.5%	0.044
Black	11.0%	27.1%	12.0%	-0.031
Asian or Pacific Islander	3.4%	3.2%	3.2%	0.008
Hispanic	8.9%	14.8%	9.8%	-0.031
Native American	1.0%	1.1%	0.9%	0.013
Multiracial	4.2%	5.7%	4.6%	-0.019
Mobility	6.4%	12.1%	6.8%	-0.015
Age	16.2	16.4	16.2	-0.006
Gifted	34.8%	15.2%	33.5%	0.027
Disability status	1.3%	12.9%	1.6%	-0.026
Economic Disadvantage	20.2%	44.2%	22.0%	-0.044
Absences	6.01	8.15	6.21	-0.035
Ever Out of School Suspension	1.3%	8.3%	1.7%	-0.031
Ever In-School Suspension	2.6%	10.1%	2.8%	-0.012
8th grade math	0.74	-0.03	0.72	0.020
8th grade reading	0.67	-0.05	0.66	0.017
Unweighted GPA	3.61	2.75	3.59	0.050
Honors courses	4.18	2.06	4.10	0.039
AP courses	0.46	0.19	0.44	0.015
High school CTE courses	1.27	1.26	1.26	0.009
School: enrollment	1,157	1,424	1,170	-0.022
School: large city locale	3.9%	17.8%	4.5%	-0.032
School: small/medium city locale	8.2%	13.3%	8.3%	-0.003
School: suburban locale	20.1%	26.2%	21.3%	-0.032
School: town locale	12.2%	8.1%	12.3%	-0.002
School: rural locale	55.6%	34.7%	53.6%	0.041
School: share econ. disadvantaged	35.2%	39.9%	35.0%	0.011
School: share underrep. race/eth.	38.2%	47.6%	38.4%	-0.006
College Campus	(N=22,406)	(N=491,458)		
Female	60.8%	46.3%	60.3%	0.011
White	66.2%	48.2%	64.7%	0.031
Black	15.2%	27.1%	16.0%	-0.021
Asian or Pacific Islander	3.1%	3.2%	3.3%	-0.010

	Treatment Mean	Unweighted Control Mean	Weighted Control Mean	Weighted Standardized Effect Size
Hispanic	9.2%	14.8%	9.2%	-0.001
Native American	1.3%	1.1%	1.3%	0.004
Multiracial	4.9%	5.7%	5.5%	-0.026
Mobility	10.7%	12.1%	9.8%	0.030
Age	16.2	16.4	16.2	-0.014
Gifted	36.0%	15.2%	35.0%	0.022
Disability status	1.7%	12.9%	2.1%	-0.028
Economic Disadvantage	24.1%	44.2%	25.0%	-0.021
Absences	5.96	8.15	6.07	-0.020
Ever Out of School Suspension	1.7%	8.3%	1.9%	-0.020
Ever In-School Suspension	3.2%	10.1%	3.0%	0.010
8th grade math	0.69	-0.03	0.67	0.026
8th grade reading	0.64	-0.05	0.62	0.022
Unweighted GPA	3.51	2.75	3.49	0.051
Honors courses	3.91	2.06	3.84	0.036
AP courses	0.41	0.19	0.39	0.024
High school CTE courses	1.25	1.26	1.24	0.009
School: enrollment	1,380	1,424	1,406	-0.043
School: large city locale	9.6%	17.8%	10.3%	-0.022
School: small/medium city locale	14.6%	13.3%	14.4%	0.008
School: suburban locale	25.5%	26.2%	26.4%	-0.020
School: town locale	11.3%	8.1%	11.4%	-0.003
School: rural locale	39.0%	34.7%	37.6%	0.028
School: share econ. disadvantaged	40.6%	39.9%	40.1%	0.034
School: share underrep. race/eth.	43.7%	47.6%	43.8%	-0.002
Other Location	(N=9,183)	(N=491,458)		
Female	56.5%	46.3%	54.9%	0.033
White	75.3%	48.2%	73.7%	0.039
Black	9.5%	27.1%	10.1%	-0.021
Asian or Pacific Islander	1.6%	3.2%	1.9%	-0.025
Hispanic	8.5%	14.8%	8.5%	-0.002
Native American	0.7%	1.1%	0.7%	0.000
Multiracial	4.4%	5.7%	5.1%	-0.033
Mobility	4.4%	12.1%	5.1%	-0.031
Age	16.2	16.4	16.2	0.000
Gifted	39.1%	15.2%	37.8%	0.028
Disability status	1.1%	12.9%	1.5%	-0.041
Economic Disadvantage	25.3%	44.2%	27.0%	-0.039

	Treatment Mean	Unweighted Control Mean	Weighted Control Mean	Weighted Standardized Effect Size
Absences	5.58	8.15	5.77	-0.039
Ever Out of School Suspension	1.7%	8.3%	2.1%	-0.027
Ever In-School Suspension	3.2%	10.1%	3.5%	-0.015
8th grade math	0.77	-0.03	0.74	0.045
8th grade reading	0.71	-0.05	0.69	0.030
Unweighted GPA	3.60	2.75	3.57	0.078
Honors courses	3.89	2.06	3.77	0.064
AP courses	0.25	0.19	0.23	0.046
High school CTE courses	1.42	1.26	1.44	-0.020
School: enrollment	923	1,424	959	-0.083
School: large city locale	0.2%	17.8%	0.6%	-0.082
School: small/medium city locale	9.7%	13.3%	10.4%	-0.026
School: suburban locale	19.4%	26.2%	19.4%	-0.001
School: town locale	14.8%	8.1%	14.1%	0.020
School: rural locale	55.9%	34.7%	55.4%	0.010
School: share econ. disadvantaged	41.6%	39.9%	41.9%	-0.027
School: share underrep. race/eth.	33.9%	47.6%	34.0%	-0.003

Notes: This table shows the characteristics of the treatment and comparison groups for the College Transfer Pathway analysis, by modality. It includes average characteristics of both the unweighted and weighted comparison group and the final column shows the difference between the treatment and weighted comparison groups in terms of standard deviations. This table displays the characteristics and balance for the largest samples included in the impact analyses. Balance tables for the samples for which we can assess outcomes three and six years post high school as well as for additional student- and school-level characteristics included in the propensity score weighting models but not displayed in the table above are available upon request; differences do not exceed 0.25 standard deviations for any measures for any samples and fall below 0.05 standard deviations for most.

Table 2: Summary Statistics and Balance Table for the CTE Pathway, by Modality

	Treatment Mean	Unweighted Control Mean	Weighted Control Mean	Weighted Standardized Effect Size
Online	(N=31,028)	(N=491,458)		
Female	65.5%	46.3%	64.2%	0.028
White	64.1%	48.2%	62.5%	0.033
Black	15.8%	27.1%	16.8%	-0.026
Asian or Pacific Islander	2.6%	3.2%	2.6%	0.005
Hispanic	12.0%	14.8%	12.4%	-0.011
Native American	1.0%	1.1%	1.0%	0.002
Multiracial	4.5%	5.7%	4.8%	-0.018
Mobility	7.5%	12.1%	8.0%	-0.017
Age	16.3	16.4	16.3	-0.018
Gifted	22.3%	15.2%	21.2%	0.026
Disability status	3.3%	12.9%	3.7%	-0.021
Economic Disadvantage	31.0%	44.2%	32.4%	-0.030
Absences	6.59	8.15	6.74	-0.024
Ever Out of School Suspension	2.8%	8.3%	3.1%	-0.020
Ever In-School Suspension	4.7%	10.1%	5.0%	-0.014
8th grade math	0.34	-0.03	0.32	0.022
8th grade reading	0.35	-0.05	0.32	0.034
Unweighted GPA	3.33	2.75	3.29	0.060
Honors courses	3.30	2.06	3.18	0.051
AP courses	0.26	0.19	0.25	0.016
High school CTE courses	1.47	1.26	1.48	-0.007
School: enrollment	1,120	1,424	1,142	-0.036
School: large city locale	4.6%	17.8%	4.9%	-0.013
School: small/medium city locale	6.6%	13.3%	7.1%	-0.020
School: suburban locale	16.9%	26.2%	17.8%	-0.026
School: town locale	14.2%	8.1%	14.0%	0.007
School: rural locale	57.7%	34.7%	56.2%	0.030
School: share econ. disadvantaged	40.1%	39.9%	40.0%	0.006
School: share underrep. race/eth.	41.0%	47.6%	41.1%	-0.004
College Campus	(N=21,221)	(N=491,458)		
Female	47.9%	46.3%	47.7%	0.004
White	60.5%	48.2%	60.0%	0.010
Black	19.1%	27.1%	19.3%	-0.007
Asian or Pacific Islander	1.5%	3.2%	1.6%	-0.010
Hispanic	13.1%	14.8%	13.1%	0.001

	Treatment Mean	Unweighted Control Mean	Weighted Control Mean	Weighted Standardized Effect Size
Native American	1.2%	1.1%	1.2%	0.002
Multiracial	4.6%	5.7%	4.7%	-0.007
Mobility	10.3%	12.1%	10.3%	-0.001
Age	16.3	16.4	16.3	-0.011
Gifted	15.2%	15.2%	14.8%	0.013
Disability status	8.0%	12.9%	8.3%	-0.013
Economic Disadvantage	40.2%	44.2%	40.6%	-0.010
Absences	7.29	8.15	7.37	-0.011
Ever Out of School Suspension	5.9%	8.3%	5.8%	0.003
Ever In-School Suspension	9.1%	10.1%	9.0%	0.003
8th grade math	0.07	-0.03	0.06	0.013
8th grade reading	0.05	-0.05	0.04	0.012
Unweighted GPA	2.98	2.75	2.97	0.022
Honors courses	2.17	2.06	2.13	0.023
AP courses	0.12	0.19	0.12	0.017
High school CTE courses	1.62	1.26	1.61	0.003
School: enrollment	1,252	1,424	1,256	-0.007
School: large city locale	7.1%	17.8%	7.5%	-0.015
School: small/medium city locale	12.9%	13.3%	12.9%	-0.002
School: suburban locale	19.9%	26.2%	20.1%	-0.005
School: town locale	15.2%	8.1%	14.8%	0.009
School: rural locale	45.0%	34.7%	44.7%	0.007
School: share econ. disadvantaged	15.2%	16.8%	15.3%	-0.007
School: share underrep. race/eth.	44.4%	39.9%	44.3%	0.006
Other Location	(N=16,237)	(N=491,458)		
Female	41.6%	46.3%	41.2%	0.009
White	62.1%	48.2%	61.4%	0.014
Black	18.3%	27.1%	18.7%	-0.009
Asian or Pacific Islander	1.1%	3.2%	1.3%	-0.017
Hispanic	13.1%	14.8%	13.0%	0.001
Native American	0.9%	1.1%	0.9%	0.005
Multiracial	4.6%	5.7%	4.8%	-0.011
Mobility	7.3%	12.1%	7.9%	-0.022
Age	16.3	16.4	16.3	-0.004
Gifted	15.6%	15.2%	15.0%	0.016
Disability status	7.8%	12.9%	8.4%	-0.022
Economic Disadvantage	44.4%	44.2%	45.4%	-0.020
Absences	7.29	8.15	7.40	-0.018
Ever Out of School Suspension	7.2%	8.3%	7.3%	-0.005

	Treatment Mean	Unweighted Control Mean	Weighted Control Mean	Weighted Standardized Effect Size
Ever In-School Suspension	11.0%	10.1%	11.1%	-0.003
8th grade math	0.02	-0.03	0.01	0.017
8th grade reading	-0.01	-0.05	-0.03	0.015
Unweighted GPA	2.92	2.75	2.90	0.032
Honors courses	1.98	2.06	1.92	0.028
AP courses	0.09	0.19	0.09	0.001
High school CTE courses	1.72	1.26	1.71	0.014
School: enrollment	981	1,424	995	-0.034
School: large city locale	1.0%	17.8%	1.3%	-0.028
School: small/medium city locale	12.1%	13.3%	12.7%	-0.020
School: suburban locale	16.0%	26.2%	16.4%	-0.009
School: town locale	15.0%	8.1%	14.5%	0.014
School: rural locale	56.0%	34.7%	55.2%	0.015
School: share econ. disadvantaged	45.4%	39.9%	45.2%	0.008
School: share underrep. race/eth.	39.6%	47.6%	39.9%	-0.014

Notes: This table shows the characteristics of the treatment and comparison groups for the College Transfer Pathway analysis, by modality. It includes average characteristics of both the unweighted and weighted comparison group and the final column shows the difference between the treatment and weighted comparison groups in terms of standard deviations. This table displays the characteristics and balance for the largest samples included in the impact analyses. Balance tables for the samples for which we can assess outcomes three and six years post high school as well as for additional student- and school-level characteristics included in the propensity score weighting models but not displayed in the table above are available upon request; differences do not exceed 0.25 standard deviations for any measures for any samples and fall below 0.05 standard deviations for most.

Table 3: CTE and General Education Dual Enrollment Courses, by Modality

Course Type	Online	College Campus	Other location
Overall	54%	28%	18%
General Education	62%	25%	13%
CTE	32%	35%	33%

NOTES: Table displays the share of dual enrollment courses taken by modality over the 2014-15 to 2021-22 school years (N=788,173 dual enrollment courses). Numbers might not sum to 100% due to rounding and a small share (<0.5%) of courses with missing modality data.

Table 4: Relative Odds for Taking Courses Online Versus on the College Campus, by Course Type

	Overall	General Education	CTE
Female	1.28**	1.23**	1.43**
Underrepresented race/ethnicity	0.85**	0.81**	0.90**
Economically disadvantaged	0.95**	1.01	0.84**
City/suburban school	0.45**	0.41**	0.54**

NOTES: ** $p \leq 0.01$; Values shown are relative risk ratios and reflect how the odds of taking a course online compared to the odds of taking a course on the college campus changes for members of the subgroup relative to non-members of the subgroup; We fit regression models to assess how student and school factors relate to course modality; Models control for student demographics, economic disadvantaged status, achievement (8th grade exams), school locale, grade level fixed effects, school year fixed effects, and a continuous measure of the share of all courses in the subject area taken online; We present overall results (including a flag for CTE courses in the models) and then split sample results for general education and CTE courses.

Table 5: School Characteristics by Quartile of Share of Courses Taken, by Modality

Online	Quartile 1 (<34% of courses)	Quartile 2 (34-54% of courses)	Quartile 3 (54-71% of courses)	Quartile 4 (>71% of courses)
School: enrollment	558	905	993	686
School: city or suburb locale	50.0%	42.8%	45.5%	31.7%
School: rural or town locale	50.0%	57.2%	54.5%	68.3%
School: share econ. disadvantaged	46.1%	37.5%	36.0%	29.3%
School: share underrep. race/eth.	55.0%	52.1%	51.6%	43.3%
College Campus	(<12% of courses)	(12-27% of courses)	(27-48% of courses)	(>48% of courses)
School: enrollment	601	766	1,028	746
School: city or suburb locale	23.3%	33.8%	53.8%	59.3%
School: rural or town locale	76.7%	66.2%	46.2%	40.7%
School: share econ. disadvantaged	34.8%	33.5%	36.7%	44.0%
School: share underrep. race/eth.	43.1%	45.4%	53.8%	59.7%
High School/Other Location	(<0.3% of courses)	(0.3-4.4% of courses)	(4.4-21% of courses)	(>21% of courses)
School: enrollment	538	1,201	762	640
School: city or suburb locale	54.8%	58.6%	24.1%	32.4%
School: rural or town locale	45.2%	41.4%	75.9%	67.6%
School: share econ. disadvantaged	37.1%	31.4%	39.6%	41.0%
School: share underrep. race/eth.	57.1%	53.3%	46.2%	45.3%

Notes: This table shows the characteristics of schools in each quartile by share of dual enrollment courses taken in the specified modality. Includes both general education and CTE dual enrollment courses over the 2014-15 to 2021-22 school-year period. Results for general and CTE courses, considered separately, are available upon request to the authors. “econ. disadvantaged" refers to the share of students who are economically disadvantaged. “underrep. race/eth” refers to the share of students in racial or ethnic groups historically underrepresented in higher education and includes Black or African American, Hispanic, American Indian, and Multiracial students. N=581 schools in total, or 145-146 schools in each quartile.

Table 6: Success Rate for CTE and General Education Dual Enrollment Courses, by Modality and by Subgroup, Descriptive Results

Course Type	Subgroup	Online	College Campus	High School/Other location
General Education	All	84%	85%	90%
	Male	82%	83%	88%
	Female	84%	86%	91%
	EDS	75%	78%	85%
	Not EDS	85%	86%	91%
	URE	76%	80%	86%
	Not URE	86%	87%	91%
	Urban	83%	84%	90%
	Rural	84%	85%	90%
CTE	All	75%	82%	86%
	Male	73%	82%	85%
	Female	77%	83%	88%
	EDS	66%	79%	84%
	Not EDS	78%	84%	88%
	URE	69%	79%	84%
	Not URE	79%	84%	87%
	Urban	74%	81%	87%
	Rural	75%	83%	86%

Notes: These analyses were done at the course level.
How to read this table: This table shows descriptive analyses of pass rates for the two types of courses—general education and CTE. The first row in each grouping shows pass rates for all students by modality, followed by rows for each subgroup. For example, male participants in the General Education Pathway had pass rates of 82% in online courses, 83% in courses taken on the college campus, and 88% in high school/other course location.

Table 7: Course Success Rates Relative to Taking Courses on the College Campus, Multivariate Regression Models, by Modality

	General Education	CTE
Online	-3.0 pp***	-9.1 pp***
High School/Other Location	4.2 pp***	4.0 pp***

NOTES: *** $p \leq 0.001$; Values shown are regression coefficients on indicator variables in a linear probability model for taking a courses online or at the high school/other location and reflect how the odds of course success differ compared to the odds of course success when taking a course on the college campus. Models control for student demographics, economic disadvantaged status, achievement (8th grade exams), school locale, grade level fixed effects, school year fixed effects, and a continuous measure of the share of all courses in the subject area taken online.

Table 8: Impact of College Transfer Dual Enrollment Pathway, by Modality

Outcome	Online			In-person at College Campus			In-person at other location		
	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)
College Credits earned in high school	18.3	5.8	12.6*** (0.34)	15.4	5.1	10.3*** (0.30)	16.6	4.3	12.3*** (0.64)
Enrollment in any postsecondary institution	85.3%	76.0%	9.3 pp*** (0.58)	85.5%	76.9%	8.6 pp*** (0.59)	82.3%	73.4%	8.9 pp*** (0.88)
Enrollment in two- year	28.8%	22.2%	6.6 pp*** (0.46)	30.6%	22.4%	8.3pp*** (0.72)	29.5%	24.8%	4.7 pp*** (1.02)
Enrollment in four-year	61.0%	56.5%	4.5 pp*** (0.54)	58.9%	57.5%	1.3pp* (0.66)	56.8%	51.6%	5.3pp*** (0.97)
Earning any postsecondary credential (in 6 years)	76.2%	68.1%	8.2pp*** (0.77)	69.9%	63.3%	6.7pp*** (0.81)	69.4%	64.1%	5.3 pp*** (1.40)
Earning bachelor's degree (in 6 years)	64.0%	57.9%	6.2pp*** (0.82)	56.9%	53.5%	3.4pp*** (0.85)	56.3%	52.8%	3.5 pp*** (2.01)

Outcome	Online			In-person at College Campus			In-person at other location		
	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)
Earning associate degree (in 3 years)	14.3%	7.4%	7.0 pp*** (0.57)	13.6%	7.0%	6.6 pp*** (0.50)	13.2%	9.1%	4.1 pp*** (0.81)
Earning a technical credential/diploma (in 3 years)	5.5%	2.5%	3.1 pp*** (0.36)	4.7%	2.7%	2.0 pp*** (0.21)	7.3%	3.3%	4.0 pp*** (0.86)

Notes: * $p \leq 0.05$; *** $p \leq 0.001$. These analyses were done at the student level.

How to read this table: The table presents the mean for CCP participants, the weighted mean for the comparison group and the impact estimate with the standard error of that estimate in parentheses. For example, CCP participants taking primarily online courses earned on average 18.3 credits compared to 5.8 for the weighted comparison group, a statistically significant difference of 12.6 credits.

Table 9: Impact of CTE Dual Enrollment Pathway, by Modality

Outcome	Online			In-person at College Campus			In-person at other location		
	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)
College Credits earned in high school	13.7	3.1	10.6*** (0.29)	11.2	1.5	9.7*** (0.25)	11.5	5.2	10.1*** (0.40)
Enrollment in any postsecondary institution	78.1%	67.1%	11.1 pp*** (0.55)	64.0%	56.9%	7.1 pp*** (0.52)	56.0%	51.6%	4.4 pp*** (0.78)
Enrollment in two- year	37.1%	26.9%	10.2 pp*** (0.54)	39.9%	27.8%	12.1 pp*** (0.67)	33.1%	27.0%	6.1 pp*** (0.79)
Enrollment in four-year	45.0%	42.6%	2.4 pp*** (0.53)	26.5%	31.3%	-4.8 pp*** (0.52)	25.0%	26.3%	-1.3 pp* (0.63)
Earning any postsecondary credential (in 6 years)	56.2%	49.3%	6.9pp*** (0.89)	49.8%	38.9%	10.9 pp*** (1.01)	46.5%	35.0%	11.5 pp*** (1.11)
Earning bachelor's degree (in 6 years)	39.4%	37.0%	2.4 pp** (0.84)	25.8%	27.8%	-2.0 pp** (0.62)	22.9%	23.6%	-0.8pp (0.77)

Outcome	Online			In-person at College Campus			In-person at other location		
	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)	CCP Participants	Weighted Comparison Mean	Impact estimate (SE)
Earning associate degree (in 3 years)	13.6%	7.6%	6.0 pp*** (0.49)	11.3%	6.3%	5.0 pp*** (0.43)	9.4%	6.2%	3.2 pp*** (0.47)
Earning a technical credential/diploma (in 3 years)	9.0%	3.5%	5.5pp*** (0.44)	20.4%	3.2%	17.3pp*** (1.49)	19.3%	3.6%	15.7 pp*** (1.39)

Notes: * $p \leq 0.05$; *** $p \leq 0.001$. These analyses were done at the student level.

How to read this table: The table presents the mean for CCP participants, the mean for the weighted comparison group and the impact estimate with the standard error of that estimate in parentheses. CCP participants taking primarily online courses earned on average 13.7 credits compared to 3.1 for the weighted comparison group, a statistically significant difference of 10.6 credits.

Table 10: Impacts by Subgroup, Pathway and Modality (Percentage Point Impacts)

	College Transfer Pathway				CTE Pathway			
	Online		In-person on college campus		Online		In-person on college campus	
	Technical Credential	Bachelor's	Technical Credential	Bachelor's	Technical Credential	Bachelor's	Technical Credential	Bachelor's
Female	2.2***	6.2***	2.9***	2.6**	5.8***	2.6*	15.4***	-1.3
Male	1.7***	6.2***	3.4***	4.8***	5.1***	2.1^{t}	19.0***	-2.6***
Difference in impacts	0.5	0.0	-0.5	-2.2	0.7	0.5	-3.6**	1.3
Underrepresented racial/ethnic groups	2.8***	7.9***	3.1***	3.1^{t}	6.2***	2.7	18.0***	-0.5
Not underrepresented racial/ethnic groups	1.8***	5.7***	3.0***	3.6**	5.2***	2.3*	16.8***	-2.8***
Difference in impacts	1.0**	2.3	0.1	-0.4	1.0	0.4	1.2	2.3*
Economically disadvantaged	3.0***	9.9***	3.6***	5.8***	5.6***	4.7***	17.5***	-0.4
Not economically disadvantaged	1.8***	5.2***	2.9***	2.7**	5.5***	1.2	17.1***	-3.1***
Difference in impacts	1.3**	4.7**	0.7	3.1	0.0	3.5**	0.4	2.8***
Rural	2.1***	7.3***	3.2***	4.8***	5.6***	3.2**	16.8***	-1.8**

	College Transfer Pathway				CTE Pathway			
	Online		In-person on college campus		Online		In-person on college campus	
	Technical Credential	Bachelor's	Technical Credential	Bachelor's	Technical Credential	Bachelor's	Technical Credential	Bachelor's
Urban	1.9***	2.7*	2.9***	1.9	5.4***	-0.2	17.9***	-2.3^{t}
Difference in impacts	0.2	4.5**	0.4	2.9^{t}	0.2	3.3^{t}	-1.1	0.5

^{t} $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$. These analyses were done at the student level.

How to read this table: This table shows the impact estimate (difference between treatment and comparison students) for each subgroup within each modality and pathway. The difference in impacts is the difference in impact estimates between the two corresponding subgroups (females and males). For example, females in the College Transfer Pathway taking majority online courses had a statistically significant 2.2 percentage point impact on technical credentials and a statistically significant 6.2 percentage point impact on bachelor's degree. Males in the College Transfer Pathway had statistically significant impact of 1.7 percentage points on technical credentials and 6.2 percentage points on bachelor's degree attainment. The difference in technical credential attainment between females and males was 0.5 percentage points and 0.0 percentage points in bachelor's degree attainment; neither of which was statistically significant.

Figure 1: DE Course Enrollments by Location/Modality Over Time

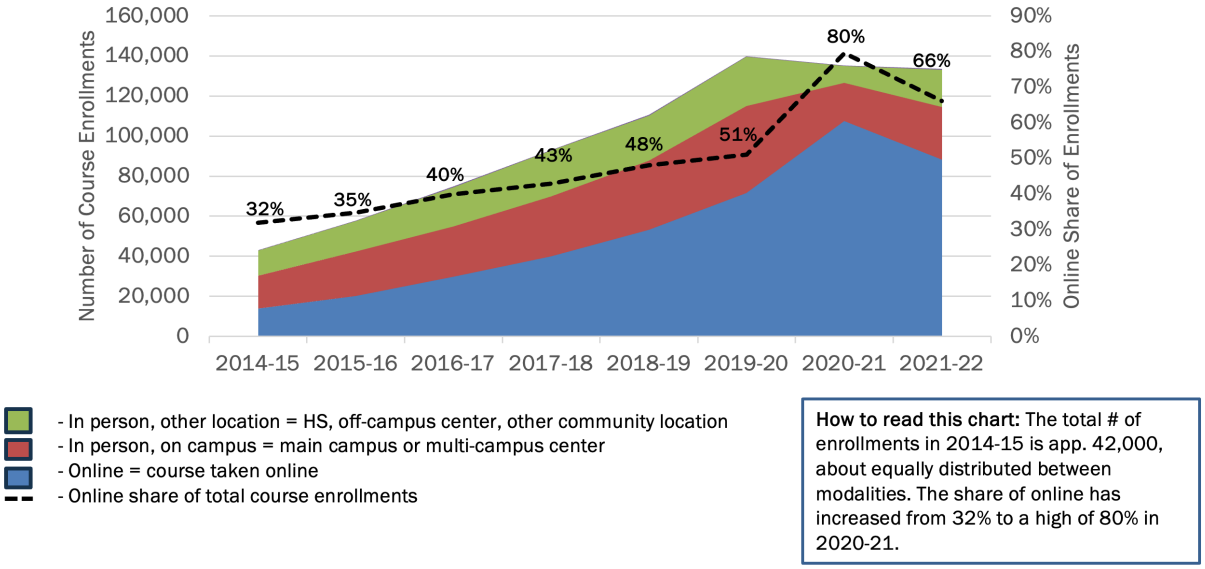

Figure 2: Share of CTE DE Course Taken Online, by Course Subject