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Exploring the Implications of the Expanded Graduation Menu Guidelines: An Evaluation of the Capstone Experience in One High School

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A report prepared by the Center for Assessment, Design, Research and Evaluation (CADRE) at the CU Boulder School of Education.

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About CADRE

The Center for Assessment, Design, Research and Evaluation (CADRE) is housed in the School of Education at the University of Colorado Boulder. The mission of CADRE is to produce generalizable knowledge that improves the ability to assess student learning and to evaluate programs and methods that may have an effect on this learning. Projects undertaken by CADRE staff represent a collaboration with the ongoing activities in the School of Education, the University, and the broader national and international community of scholars and stakeholders involved in educational assessment and evaluation.

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Executive Summary

This exploratory study examines the capstone experience for one high school located in a rural district in Colorado. Results from this study yielded insights about how the school's instructional model supports the capstone project work, and how outcomes on the capstone projects correspond to other valued outcomes on the state's graduation menu. Key findings in this report include:

- Most teachers and students believe that the project-based coursework encountered in many classes can provide students with the requisite knowledge and skills to successfully engage in a culminating capstone project.
- Student success with the capstone experience can be largely influenced by the strength of the relationships formed with the capstone advisor to guide and navigate students through the long-term capstone project.
- Outcomes on the capstone project are largely consistent with outcomes on other graduation menu options, including passing concurrent enrollment courses and receiving industry certifications, despite the fact that a large proportion of students do not meet the benchmarks for the SAT tests.

This last point reveals a narrative about student success that broadens the limited definition of success afforded to students through the state's selected high school standardized test. Based solely on the SAT benchmarks identified on the state's graduation menu, many students would not have met the graduation readiness benchmark. However, based on the capstone, industry certification, and concurrent enrollment passing rates achieved at this school, almost all students at this school have clearly achieved the capacity and the ability to be successful in completing post-secondary courses or entering into the workforce with more than one industry certification. This broadened definition taken up by the state to evaluate what it means to demonstrate graduation competency is important because this has the potential to inspire more students to view themselves as capable and ready to pursue post-secondary opportunities down the line.

The results shared in this study cannot be generalized across schools since the capstone process at this high school is required of all students, and the school-wide project based instructional model taken up is not commonly found in other settings. In other words, capstone implementation and expectations vary widely across schools. Currently, CDE is working with a broad array of stakeholders to define clearer guidelines and expectations for the capstone work to ensure that this avenue can, over time, reflect a more rigorous and robust process for evaluating graduation competency.

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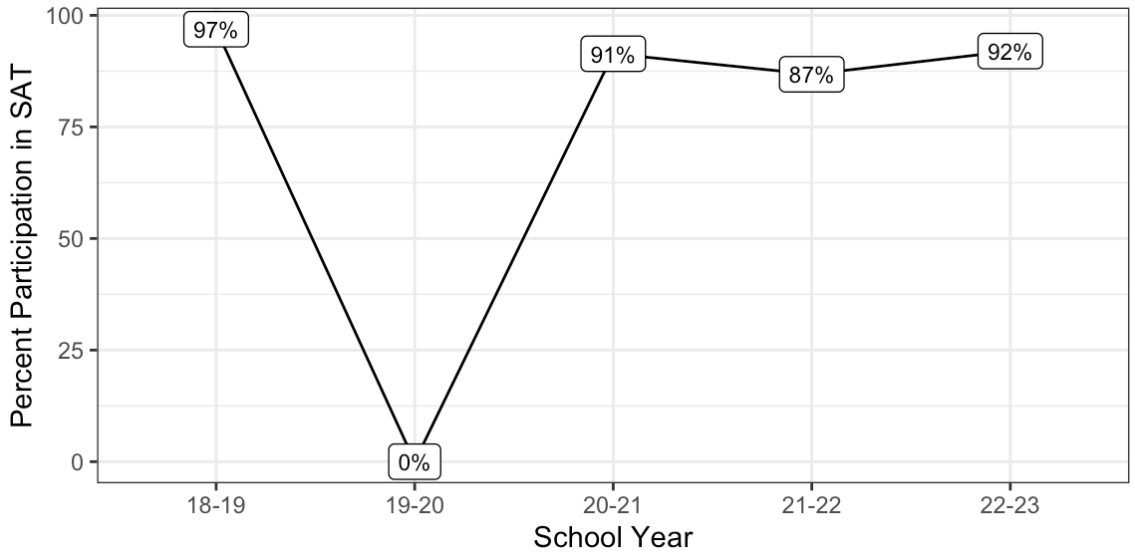
Introduction

This report highlights key findings from a yearlong study conducted at Osprey High School[1] located in a rural district in Colorado by the Center for Assessment, Design, Research, and Evaluation (CADRE) at the University of Colorado Boulder. This study gathered student and teacher perspectives on the school's capstone focus, and examined outcomes associated with capstone and other key performance indicators of workforce or post-secondary readiness. The findings from this study contribute to the scarce literature base tracking empirical findings from capstone projects. This report also provides the Colorado Department of Education (CDE) with preliminary information on whether the expanded graduation menu options are also resulting in expanded opportunities to learn for students to become better prepared for post-secondary and workforce options following high school. We provide background information about the school and the capstone work underway to illuminate important context for understanding the results shared in this report.

Background

This study focused on the capstone work in Osprey High School (OHS) in the Osprey School District (OSD) since OHS represents one of the few schools throughout the state that has implemented capstone projects for more than five years. OHS started to systematically collect the capstone scores for students on the final summative presentation task, once the school decided in 2020-21 to implement the policy of using capstone as a graduation requirement for all students. In the past this was presented as an option for some students, and the 2020-21 year marked the first year where all students were required to participate in a capstone project. This policy shift was influenced in part by the COVID-19 pandemic but also in part due to low participation rates each year on the SATs. Figure 1 shows the participation rates for the SATs since the 2018-19 school year. About 97% of OHS grade 11 students participated in the SAT prior to the COVID-19 pandemic, but participation rates dropped to between 87% and 92% beginning in 2020-21.

Figure 1. SAT participation rates for grade 11



[1] Osprey High School (OHS) is a pseudonym assigned to the case study high school.

According to the school leader and other teacher leaders at the school, their population of students do not currently deem the SATs to be important for the future despite the fact that students are required to take this test for state and federal reporting and accountability purposes. This led to the decision to use the capstone projects as a primary means for ensuring that students were meeting graduation requirements and demonstrated readiness to complete high school.

Unique to OHS, the capstone journey represents a multi-year process that begins in grade 9 and ends in grade 12 with a summative presentation task. The summative task in grade 12 represents the culminating presentation of the capstone project, based on having fulfilled multiple tasks over the years building up to the final presentation. By design and due to the multi-year nature of the capstone process, students are expected to pass the final presentation since the majority of students could not have reached this point unless they have demonstrated successful completion of all prior capstone project activities. That is, by the time students reach this culminating performance task in grade 12, the student has demonstrated adequate progress for meeting most requirements on the capstone project.

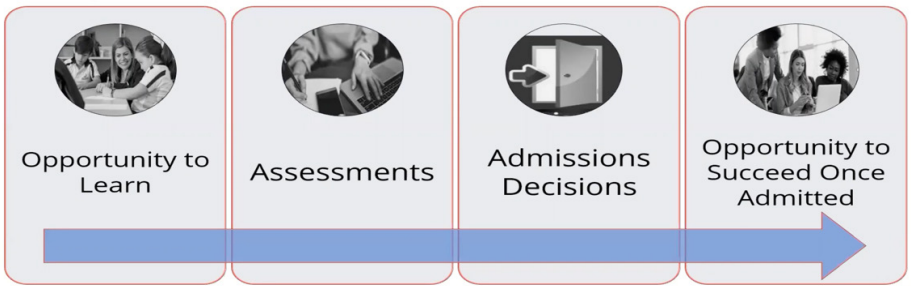
The implication of this design is that, unlike the SAT tests, capstone scores on this test are not intended to differentiate performance between students. All students reaching the culminating task are expected to pass and are given opportunities to remediate if they do not meet expectations. However, students who score a 2.7 or above on the culminating project are given the opportunity to compete for scholarship funds to be applied to their future post-secondary institution of choice. This opportunity is optional and only a subset of students who meet or exceed 2.7 participate in this competition round. This 2.7 cut-point represents the one score that differentiates the performance of those who passed the capstone from those who are eligible to compete for a scholarship.

In addition to their capstone, OHS is well-known in the region for having a robust career and technical education (CTE) program and as indicated by several students participating in focus group sessions, “the school attracts a lot of students who choice in from long-distances” to participate in these programs. The school requires students to select a pathway or concentration (e.g., health, STEM focus, skilled trades, etc.) that provides them with opportunities to explore potential careers and disciplinary interests related to post-secondary interests.

Research Questions

Three primary research questions guided this study, and we refer to a diagram developed by Ercikan & Klieger (2022) to explain how these questions tie to evaluations of high school graduation readiness.

Figure 2. Evaluating high school outcomes. Source: Ercikan & Kleiger, 2022



In Figure 2, opportunity to learn determines in large part whether students can perform well on high school assessments used to determine graduation readiness. The idea behind this first box is that the types of learning opportunities afforded to students in high school play an important role for demonstrating knowledge and skills required to meet graduation requirements. In the second box from the left, the assessments used to evaluate graduation competency or readiness represent the array of assessments itemized in Colorado's graduation menu guidelines which includes the SAT as well as other non-standardized measures such as the capstone used in OHS, and other formats such as student portfolios. In Colorado, all students must take the SATs but the other menu options provide flexibility for students to demonstrate additional ways of demonstrating graduation readiness outside of a standardized format and in more applied ways. The third box from the left, admissions decisions, relates to opportunities to extend or deepen studies beyond high school based in part on performance on the assessments used to evaluate readiness. Within the context of this study, the third box would also include entry into the labor force. The final box, opportunity to succeed, pertains to students successfully completing a post-secondary degree to achieve both short and long-term academic and/or career objectives.

In our study, research question 1 (RQ1) centers on the first box (beginning from the left-hand side) in Figure 2, and asks: To what extent does the instructional model at the high school prepare students for successfully engaging in a capstone experience? Sub-questions falling under RQ1 are as follows:

RQ 1a. To what extent do teachers believe the instructional model facilitates student success on the capstones?

RQ 1b. To what extent do students believe that the instructional model has set them up well for the capstone experience?

Returning to Figure 2, in light of the instructional project-based model taken up by the school and the exposure to capstone beginning in grade 9, the hope is that the learning journey encountered during a student's tenure through high school is coherently connected to the final demonstration of learning. In other words, completing the capstone project serves as a logical culminating presentation of learning rather than an event that does not build on prior knowledge and skills learned. Establishing this coherence creates what Shepard et al. (2018) call *horizontal coherence* across classrooms where both students and teachers see a clear connection between the educational experiences afforded to students and the culminating capstone task.

Research question 2 (RQ2) centers on the second box in Figure 2 and asks: To what extent do the signals of graduation readiness provided by the capstone scores appear consistent with other signals of graduation readiness approved by the Colorado Department of Education's graduation menu guidelines?

Under the unique context of OHS, all students are expected to pass the capstone and therefore the vast majority of students receive an average passing score of 2. However, we also know that capstone scores can vary across students and that capstone projects with higher scores, particularly 2.7 and above, are more likely to reflect higher quality capstone projects. The SAT serves as one signal of postsecondary readiness, and other signals for graduation readiness recognized by high schools and the state include passing concurrent enrollment courses and meeting industry certifications. These other evaluations of graduation readiness hold value to

the state and districts since passing concurrent enrollment courses allows students to accrue college-credit for future use and earning industry certification verifies students' readiness for entering vocational careers of interest. The analyses undertaken to explore RQ2 focuses on determining the extent to which capstone scores can provide viable information about readiness in ways that appear to be consistent with other measures approved by CDE. In other words, do students who generally pass the capstone also tend to receive industry certifications and/or pass concurrent enrollment courses?

Research question 3 (RQ3) focuses on the relationship between the second and third box in Figure 2 and asks to what extent does performance on the capstone predict the likelihood of students deciding to enroll into college following graduation? This question examines whether the capstone scores can predict students' successful admission into a postsecondary institution following graduation.

Methods

Samples

Qualitative Work

For the set of qualitative studies undertaken to address RQ1, Table 1 presents the total number of teachers and students interviewed in this study. At OHS, capstone coaches serve as mentors who provide guidance and assistance to teachers on the capstone process. The decision to develop this coaching group was made to establish a distributed leadership structure for the capstone work and ensure that experienced teachers can mentor other teachers through the capstone process. This structure also ensures that the capstone curriculum, policies, and any supportive guidance tools (e.g., capstone rubric) and documents are co-designed by teachers rather than developed solely by leadership for teachers.

Table 1. Samples by interviewed group

Group	Total Number
Classroom teachers	8
Capstone coaches	4
Students	16

The sample of classroom teachers interviewed represented a range of veteran and new teachers instructing in English language arts, math, science and other disciplinary areas. We asked school leaders to identify both novice (i.e., fewer than two years of experience in the classroom) and veteran teachers (i.e., more than six years of experience) to collect. Out of the eight teachers, exactly half consisted of novice teachers.

The four capstone coaches interviewed represent the total population of coaches at the school. Finally, the group of students interviewed in focus groups represents a convenience sample of students (i.e., scholarship and non-scholarship) who had completed their capstone projects and volunteered to speak about their capstone experience and the extent to which this connected with the learning experiences offered at the school.

Quantitative Work

The sample used to conduct the quantitative analyses is restricted to students that graduated in a year in which the capstone for all policy was in place and all students completed a capstone: Spring 2021, Spring 2022, and Spring 2023. The sample contains one observation per student collapsed across years.[2] The sample is limited to students with both an SAT score and a capstone score. The total analytic sample contains 425 students. Analyses that include students' enrollment in college, however, are limited to a slightly smaller sample, as college enrollment data is not available for students in the 2023 cohort. Appendix A displays summary statistics by cohort and variable.

Data Collection

Qualitative Work

The qualitative work to explore RQ1 entailed carrying out individual interviews with individual teachers and conducting focus groups with capstone coaches and students. All interviews were conducted either in-person or virtually, and all focus groups were conducted in-person. All recordings were then transcribed and subsequently analyzed. Analytical approaches and codes employed are discussed further in Appendix B.

Quantitative Work

Analyses conducted to address RQ2 and RQ3 rely on student-level quantitative data from OHS and CDE. These data include student demographic information, capstone performance, GPA, performance on the SAT, participation in concurrent enrollment, career and technical education (CTE) certificate receipt, post-secondary plans, and college enrollment.

RQ2 relies on data from the SAT, concurrent enrollment, and CTE, which are all included in the graduation menu options put forth by the state. Concurrent enrollment courses are college level courses that students can take to receive college credit. Successful completion of concurrent enrollment courses indicates student readiness to achieve academically in a post-secondary education institution. Students can also earn certificates in a career or technical education field. Successful completion of one or more CTE certificate programs signals readiness to engage in the workforce post-graduation. By examining the relationship between capstone performance and performance in these other target outcome areas, we can better understand the extent to which capstones provide similar or unique information about students postsecondary and workforce readiness.

[2] In cases where students were designated as FRL-eligible in some years but not in others, the sample classifies students as FRL-eligible. In cases where students were flagged as receiving special education (SPED) supports in some years but not others, the sample classifies them as receiving SPED supports.

RQ3 relies on survey data about students' post-secondary plans as well as National Student Clearinghouse data about student college enrollment in the year following high school graduation. Survey data on students' post-secondary plans is used to examine the relationship between capstone performance and students' perceptions of college as an available post-secondary option. College enrollment data is used to explore the extent to which capstone performance is predictive of post-secondary enrollment in college.

Students must meet certain benchmarks on the SAT and the capstone to be considered passing. On the SAT, students must earn at least a 500 in math and at least a 470 in evidence-based reading and writing (EBRW) in order to meet the benchmark. On the capstone, students must earn a score of two to pass. However, a score of 2.7 or above makes students eligible to participate in a competition to earn scholarship money. Figures in Appendix C display the distributions of SAT math, SAT ELA, and capstone scores across all students in the analytic sample. While the majority of students meet the SAT-EBRW benchmark, less than half of students meet the SAT math benchmark. And while nearly all students receive a score of at least two and pass the capstone, only about half of all students receive a score of 2.7 or above. Many of the following analyses rely on these cut scores. Details for conducting the analyses to address RQs 2 and 3 are described in Appendix D.

Results

Research Question 1

We address this question by exploring to what extent the instructional model used at the school sets students up for success on the capstone projects from the perspective of teachers first before shifting to examining this question from the perspective of students.

Teachers

We conducted individual interviews with teachers (including capstone coaches) instructing in different subjects and grade levels to determine the degree to which they believed the project-based learning model deployed in classrooms helped prepare students for the capstone experience. For the vast majority (i.e., 8 out of 9 teachers), designed activities and lesson plans they implement using a project-based approach in their classes have direct connections to the capstone projects. We identified two primary areas where teachers tracked clear connections between the project-based model and the capstone:

Attending to cross-cutting traits and skills. Out of the nine teachers interviewed, seven provided concrete examples of how the various traits and skills (knowledge, integrity, tenacity, agency, agility, civility, innovation, empowerment, leadership, contribution, communication, reflection, collaboration, solution-seeking) valued by the district are embedded in the learning experiences offered to students. Since these traits and skills are directly evaluated in the capstone projects, these areas represent shared learning values and principles that cut across most disciplines, coursework, and capstone projects.

For example, one novice teacher shared that although performance outcomes may vary on the project-based tasks enacted in classrooms, one of her project tasks required students to direct or have agency to determine the deliverable for the task. As noted by this teacher, "certainly results [on the PBL tasks] can be mixed. We saw a wide range of projects in different states of project success yesterday, but it was interesting to really see students have an authentic learning experience, where they were making those decisions about their learning with guidance rather than being told by me every step of the way…long story short, that's why [i.e., due to the PBL model] I came to be here!"

Similarly, a veteran teacher at the school who organized science projects highlighted the inquiry-based model used to have students determine the direction of their inquiry and to also develop skills around presenting to outside experts so that students gain confidence in communicating ideas and information to external audiences. According to this teacher, "we really do meet all of the [capstone] components within the project if they want to use it [for a capstone]…so this specific project you [observed] yesterday….they'll present to a chemist or an engineer who comes in…so it's not just me that they're presenting to, because they're comfortable enough with me, but [they know] somebody else is coming in who knows chemistry so I have to know what I'm talking about."

The feedback provided from these two teachers largely echoed the input we received from five other teachers who provided different examples of how the performance-based activities accompanied by formal and informal assessments, were designed to promote essential or 21st century skills deemed to be critical for either the workplace or for pursuing post-secondary learning opportunities. We note here though that the PBL presence appeared to be more limited in Mathematics. Although we observed two math teachers engaging in PBL work, both teachers indicated in their interviews that this instructional model was not the "regular" approach taken in their department and that only a few teachers are exploring ways to integrate projects into their lesson plans. However, for the other disciplinary areas, the teachers indicated that their departments made a concerted effort to use a PBL lens to organize their lessons and instructional approach.

Real-world applications. For four of the nine teachers interviewed who instructed career and technical education (CTE) courses, the connections to capstone projects were more seamless since the opportunities afforded in CTE courses such as the culinary arts or mechanical engineering focus on direct applications to real life career scenarios - which also capture the essence of many capstone project designs. To be clear, not all capstone projects must align with career choices, but as indicated by the school leader and the capstone coaches, connecting projects with work-based internships can facilitate successful completion of capstone requirements.

All four CTE teachers we interviewed spoke directly about the instructional tasks that provided entry points into considering careers in their respective fields. For example, the four CTE teachers highlighted how many students launch capstone projects directly from the applied experiences learned in their CTE courses. One teacher noted how a student's capstone project focused on designing the interior of the food truck used by the culinary arts program by integrating their design and drafting skills from other CTE courses to the culinary arts. Another teacher spoke to how a CTE course taught allowed students to learn basic financial management skills required to launch their own business, and noted how one alumnus launched

a business in the community following graduation using the knowledge and skills acquired from a capstone project connected to coursework taken in their chosen CTE pathway. And a third CTE teacher highlighted that because the mechanical engineering courses demand students to engage in all areas of the capstone (e.g., research, applying knowledge and skills, and presenting results) several students taking more advanced courses can use these courses to fulfill the capstone project demands.

In the other non-CTE courses, the project-based activities that five teachers reflected on during the interviews emphasized the connections between how knowledge and skills learned in the respective disciplinary area could solve problems and issues encountered in real-life scenarios. For example, the Algebra 2 teacher mentioned that opportunities to connect math to everyday problems and scenarios encountered in jobs such as construction, enabled students to appreciate how mathematical practices and content learned have utility in the workplace. Similarly, the science teacher also spoke to the importance of applying chemistry and physics to solve real world challenges, but also emphasized the importance for students to understand their role as agents to consider how this work benefits the broader community. Although the science teacher was one of the few teachers to speak of the importance of ensuring that project-based learning can benefit the public good, this community orientation is emphasized as an important design principle for shaping the capstone projects.

Areas for Continued Improvement. Despite the fact that the interviewed teachers could easily speak to how project-based learning drove the curriculum and instructional activities enacted across classrooms and embodied many elements of the capstone process, some teachers and interviewed capstone coaches recognize that the enactment of this work is difficult and requires sustained professional development to ensure equitable opportunities for students.

For example, one teacher highlighted that, the PBL work is resource intensive and "not all students have access to do a project that they want without access to transportation…one kid has a car, and another doesn't…one kid's parents are willing to give them advice and support [on coursework and capstone], while another kid goes home to a house to take care of his other siblings...when you're a student with [little to no] resources, how do we create something that works for everyone?" This concern noted by one teacher pointed to an area that could potentially create unintended negative consequences for certain students who experience more difficulty with capstone or PBL activities due to not being able to access significant resources and time to engage in those activities.

Another area of concern shared by several teachers and the capstone advisors is that because not all teachers are comfortable with enacting the PBL model, this has clear implications for their level of preparedness to serve as capstone advisors or mentors for students. In this school, all teachers serve as capstone advisors for seniors and strong mentorship depends in large part with how teachers can establish caring relational bonds with students through the capstone process, but also with their capacity to guide students successfully through an extended project. If a teacher struggles with PBL work, one capstone coach shared that this teacher would also likely struggle with providing mentorship on the capstone since the capstone process follows a similar inquiry-driven process as PBLs.

Students

Interviewed students offered a mix of perspectives that pointed to the variability of their learning experiences in school. Out of the 16 students interviewed, approximately half indicated the importance of the project-based model and valued the opportunity to complete a capstone project, and another half indicated not seeing high value with the capstone work. We begin with the input received from students who placed high value on the project-based work and could see direct applications of this work for their capstone and future beyond high school. We then shift to share insights from students who did not perceive their learning experiences in the same positive light.

High value for PBLs and Capstone Experiences. For students who felt that project-based learning both in their regular classes and the capstone deepened their appreciation and acquisition of knowledge and skills, the following set of comments from four unique students reflected the type of positive input they provided for this learning model and for the capstone experience in general:

> *"I think it's a different way to see what people have to offer because a lot of education used to be spit out a bunch of knowledge that you've read from a book, and now you actually have to do the things to learn what's going on and what you actually need to do. That gives some experience in there, and also it helps kids, especially when they're more project-based learners, when they like to do things hands on instead of reading from a book because they just learn better that way."*
>
> *I just also feel like students all learn so differently, and having the option to do project-based learning type things…could help them expand and feel more comfortable in class. Because I know I get such bad test anxiety, and normally I do pretty okay on tests, but just the anxiety I get before it almost ruins it. And with projects, it's not so anxiety filled and it's not like you have to do everything right. It's kind of like do it at your own, not necessarily pace, but at your own ability, how you feel like you should be doing it.*
>
> *I didn't take one test the entire semester, and we just did projects, and I learned so much. I learned how to do my taxes. I learned a bunch of these things that are crucial for the real world, and I feel like I wouldn't be more engaged…if I hadn't been doing all those projects, because that is really what helped me.*
>
> *It shows that you can go out and do something on your own. Maybe the teachers don't help you out 100%, but you got to figure it out yourself. In work, you're not going to have everything handed to you and spoon-fed to you, so I think it's good that people learn to, "Okay, this is what I need to do. This is what I need to get done. I'm going to go do it. I'm going to go find my mentor, I'm going to go hunt for that" because then the real world of work, you're not going to be just handed that stuff. You're going to have to go and find it. I do think that that's very beneficial.*

For these and the other four students who shared a positive view of the project-based learning approach and the capstones, these views appeared largely grounded in an appreciation to pursue projects that have relevance and meaning to them as well as by learning through doing. Additionally, five out of the eight students highlighted appreciation for both project-based and capstone work to allow them to contribute to their communities or to the field. As one student

noted, “I felt that [my capstone] was pretty meaningful to me. So I do care about the planet, and it was pretty important to me…it felt like being able to show that this is something people can do, and it’s easy to do (i.e., a horticulture project)…this can inspire others to do the same thing.”

Another key theme that ran through the feedback shared by all eight of these students is the important relational bonds established with teachers who served as effective mentors and cared deeply about their students’ success in high school and/or in completing the capstone project. For example, one student described the dedicated supports that his capstone mentor provided to him and other students:

> *One of the teachers here, she is loved by all the students, and it’s because she takes the time [to check in on us]. She goes around every morning, she goes around to each individual person, checks in with them, sees how they’re doing, and then she goes over everything in detail for the entire week, every day…she’s really involved with [our capstone work]. And that’s why everyone respects her so much…because she actually cares about all of us. And I think that’s just what we as teenagers need, is someone that really cares, because some people may not be getting that at home. And it’s really important to get that from your teachers, especially because they’re teaching you and you’re learning from them, so you have to be able to trust them.*

This sentiment about being inspired or motivated to engage in the capstone project based on the trusting and supportive relationship established with teachers was echoed in the feedback shared by six other students. It is well established in the educational research literature that students are likely to feel more academically motivated and engaged in classes where teachers have made a conscious effort to establish strong trusting relationships with them (e.g. see, Birch, 1998; Croninger & Lee, 2001; Bryk, et al., 2010; Allen et al., 2013), and therefore it is not surprising that this appears to be a factor for contributing to student success on capstone projects.

In stark contrast to these positive perspectives, and perhaps not surprisingly, the majority (seven out of eight students) framed the evaluation of what they know and can do through the standardized SAT high school test in negative terms and questioned the validity of results from that testing experience. The following two comments captured the sentiments shared by others in this group:

> *I feel like the way [SATs} are set up is really like the big bad wolf. It puts a lot of students in frightening situations. Just a completely silent room. And it’s just you in a paper and a pencil. No talking aloud. I mean, I can understand why there’s no talking aloud. I mean, there’s a chance of cheating, getting wrong scores, and those scores can be a representative of you as a person and your ability to know this kind of information. But I feel like the way it’s implemented, like I said, is just too stressful for some students.*

> *I don’t really think it shows how much students learn because there are some students that aren’t good at taking tests at all, and then they’ll get a bad score. But that doesn’t mean they’re not smart. They just can’t really take tests that well, and it’s just hours sitting there taking it. And it’s just when you get toward the end, you don’t really try anymore. You’re just trying to get it done.*

Issues with Capstone Process. However, despite the positive input provided on the project-based work pursued in classes and in their capstone projects, almost all of these students identified problematic aspects with the capstone process. The most common issue identified

by these students was the rubric used to evaluate their projects. For five of the eight students, the students highlighted that the rubric has "changed" each year, and three of the students also noted that the grading criteria should align better with projects. To this last point, these students noted that having to fulfill math criteria when a project does not use math is problematic.

The second major theme that surfaced as problematic by these students was the capstone advisor assigned. Although most of these students had mentors and advisors that built strong and supportive relationships with them, three of the eight students noted that they had friends or peers where supportive and caring relationships with mentors/advisors were absent and they could directly see how this negatively impacted their capstone experiences. For example, one student noted, "I know there were a lot of kids with [a different experience] …half the time the[ir] advisors wouldn't respond or wouldn't do anything because they were like 'you missed the class. Sucks to be you' kind of thing." These students recognized that they benefitted greatly from their advisors but could understand why the capstone experience would not be valued by those assigned to advisors that in some cases, as described by one student, "didn't care about the capstone."

Connected to this second theme, the final theme that emerged related to the capstone advisor assigned was that for three students, they did not deem their initial capstone advisors to be "competent" in providing adequate guidance and had to proactively advocate for themselves to find another advisor that was either a good match for their interests or could provide "helpful tools" or "clear information" to fulfill capstone requirements. In one student's case, the student had gone through "multiple advisors" before finding a helpful mentor for her project. According to this student:

> *There are some teachers [who] don't really care about the Capstone, and so they don't learn the material. The school just assigns these teachers [who have no interest in the capstone] and says, "You're doing Capstone." The school provides a template [for the capstone process] and then [those teachers] don't know what to do with it. Half the time, [those] teachers are just like, "Here's the thing that you have to do by this date. Do it, or you won't get a pass." That's weird [to hear from these teachers] because they're not going into depth [about] why [these steps are] important. They're just saying you need to have it done."*

Overall, these three issues raised about the capstone experience highlight that even though the PBL instructional model appears to be supportive and compatible with the capstone work, students found that the capstone process itself – particularly the advisor assigned - can generate additional barriers that may hinder some students from achieving or feeling success on capstone projects.

Perceived Lower Value for the Capstone Projects. For the other group of students who communicated that they saw lower value in the capstone projects, these students fell into two distinct groups: students who did not see value in going through a capstone experience to demonstrate readiness, and students who enjoyed project-based approaches but felt they did not receive adequate supports to guide the capstone work.

For the smaller group of three students falling into the first group, the following quote from one student was distinct from the sentiments expressed by the other two students, “some people are not really good at making projects and some people learn in different ways. I feel like using that to gauge whether you’re ready for the real world isn’t very realistic.” For this student, she expressed a preference for taking a standardized test for demonstrating readiness and felt that project-based learning was “not enjoyable” for her. This student’s input was distinct from all other students in that she was the only person who expressed a dislike for project-based learning approaches. For the other two students in this group, the rationale for not perceiving value in the capstone project was directly associated with their choice of projects. These students indicated that they engaged in much more meaningful projects “after completing the capstone” but did not feel passionate about the projects they pursued. For one student, her interest in the project tapered off after she found it challenging to recruit students to attend her planned math tutoring sessions during the pandemic. For another student, she lost interest in her project and indicated that a different project would have “inspired [her] to be more interested with the capstone.” For these two students, they acknowledged that their own choices rather than the capstone process in-itself, resulted in a sub-optimal capstone experience.

For the five students who enjoyed project-based learning but did not have adequate supports to engage in the capstone work, these students highlighted similar challenges with the capstone process as the students who placed high value on the capstone experience for their educational journeys. For these students, these issues were more acutely felt in that these hindered their ability to feel successful navigating the process. Two of these students pinpointed the source of this issue to the capstone advisors assigned who “clearly didn’t want to [be involved] with capstone projects.” For one of these two students, he noted, “I went through so many advisors. It was like restarting every time, so I don’t think I had a very good experience just compared to some other people.” Unlike his peer who had a similar experience of multiple advisors but placed high value on the capstone experience, this student never found a good mentor for his capstone project and often “felt lost.” The other three students pinpointed the source of this issue to not receiving adequate clarity in the capstone guidance provided and also noted that the capstone process “was too long…and [this long] process makes it hard to understand what you need to do.” For these three students, they indicated that having “examples…such as videos” to reference at every stage of the process would be helpful so that the process was better scaffolded with clearer expectations for all students. A theme that did not come up in the feedback from this group of students, but that surfaced in an interview with one teacher, is the ability for students to successfully complete the capstone projects when faced with constraints to limited resources. Although this issue was not identified by students as a key barrier for engaging in the capstone project work, we note that this still could potentially be a challenge for other students that were not interviewed.

Research Question 2

We begin this section by exploring student attainment of graduation menu benchmarks for four graduation options pursued at OHS over a three-year period (2020-21, 2021-22, and 2022-23) and then examine the association between attainment on capstone relative to the other options. We examine capstone achievement relative to these other options to explore whether the signal of graduation readiness differs between the capstone and other options provided to students for demonstrating post-secondary or career readiness.

Performance on Graduation Menu Options by Demographic Characteristics

We begin this exploration of RQ2 by looking at performance on graduation menu options by all students and by student groups of interest (FRL, minority, and female). Table 2 below indicates the percentage of seniors that met the graduation benchmarks for each of the menu options reviewed in this report between 2020-21 and 2022-23.

Table 2. Percentages of total students meeting graduation menu benchmarks by year.

Year	Total students (N)	Capstone Benchmark (2 or above)	Pass 2 or more concurrent enrollment	Receive 2 or more industry certifications	Pass SAT benchmarks in EBRW and Math
2020-21	130	91%	65%	35%	35%
2021-22	121	93%	88%	52%	38%
2022-23	134	99%	93%	57%	25%

As indicated by Table 2, the vast majority of students in the district meet the capstone benchmarks. A large percentage of students (65% to 93%) also pass two or more concurrent enrollment courses and about half of all students (35% to 57%) receive two or more industry certificates over the course of high school. In contrast to the notable increases seen each year for concurrent enrollment and industry certifications, a substantially smaller percentage of students pass the SAT benchmarks in Math and EBRW (25% to 38%). That is, no more than a third of OHS students are deemed ready to graduate based on SAT results.

Table E1 in Appendix E shows the breakdown of these percentages by the three groups of interest. As seen in Table E1, the percentages of students meeting graduation benchmarks differ by group such that a larger percentage of non-FRL and non-minority students meet benchmarks than their FRL-eligible and minority peers. These discrepancies between groups, however, are smaller on the capstone than on other graduation menu options. For example, among students who graduated in 2023, 100% of non-FRL students met the capstone benchmark and 97% of FRL-eligible students met the capstone benchmark, while 35% of non-FRL students met the SAT benchmark and only 16% of FRL-eligible students met the SAT benchmark. Differences between female and male students differed by graduation menu option. Larger percentages of female students met capstone benchmarks and passed two or more concurrent enrollment courses, and larger percentages of male students received two or more industry certifications and passed SAT benchmarks. Overall, and for each year, Table E1 shows that compared to capstones, industry certification, and concurrent enrollment, FRL-eligible students are less likely to meet the graduation requirement for SATs.

As displayed in Table 2 and Table E1, the percentages of students meeting benchmarks differ across years. From this point onward, we limit our analyses to the 2022-23 academic year. We do this in part because we know that more robust capstone processes were put into place in

the most recent year, and since the most recent year captures more complete and accurate data records compared to the two years (2020-21 and 2021-22) immediately following the mandated COVID-related school closure in 2019-20.

To evaluate the magnitude of the relationships between demographic characteristics and graduation menu options, we illustrate the comparative probabilities of meeting graduation benchmarks by student group. Figures 3-6 below show how the estimated probabilities (and 95% confidence intervals) of meeting benchmarks change as a function of demographic characteristics (FRL, minority, female). As indicated in Figure 3, all students have nearly 100% probability of meeting the capstone benchmark of two, with FRL-eligible students and minority students slightly less likely to reach benchmarks than their peers. Discrepancies in the probabilities of meeting outcomes tend to be larger between student groups on the other graduation menu options. As indicated in Figures 4 and 5, non-FRL and non-minority students are more likely to pass two or more concurrent enrollment courses and receive two or more CTE certificates than their peers. Female students tend to be more likely than male students to pass two or more concurrent enrollment courses, while male students tend to be more likely than female students to receive two or more CTE certificates. On the SAT, non-FRL students and minority students have higher probabilities of meeting benchmarks than their FRL-eligible and White and Asian peers. Despite differences in the estimated likelihoods of meeting benchmarks between student groups, once you factor in chance, the estimated likelihoods are not significantly different from one another. That is, observed differences in likelihoods presented in these figures could be due to error in estimation as opposed to true differences between student groups.

Figure 3. Probability of meeting of exceeding the capstone benchmark of two

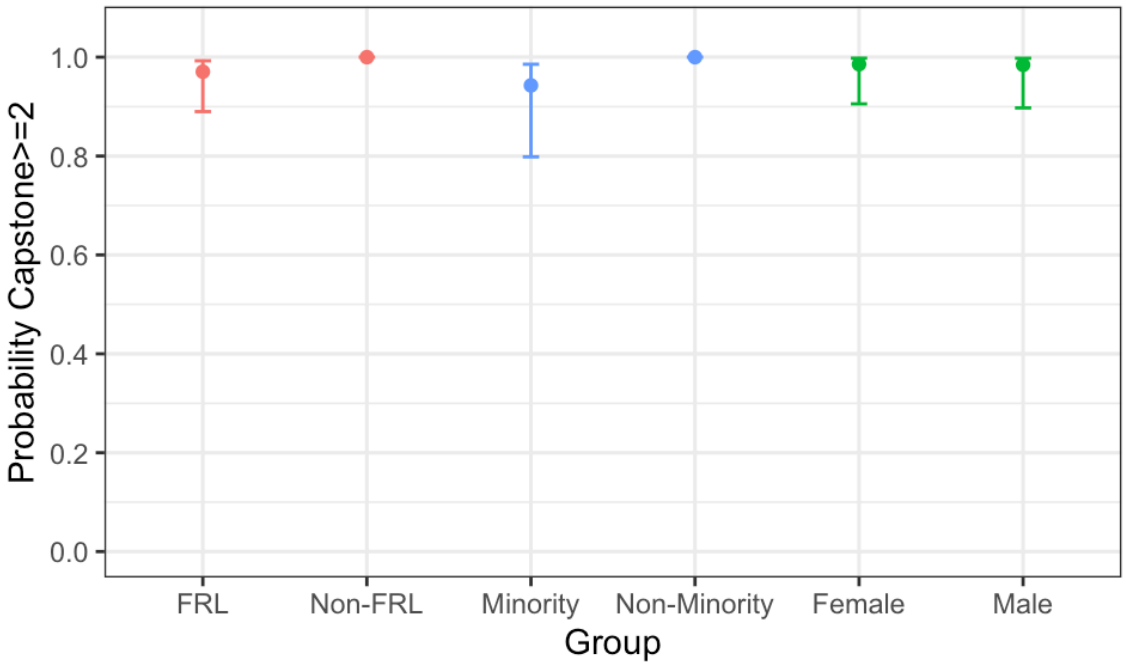


Figure 4. Probability of passing two or more concurrent enrollment courses

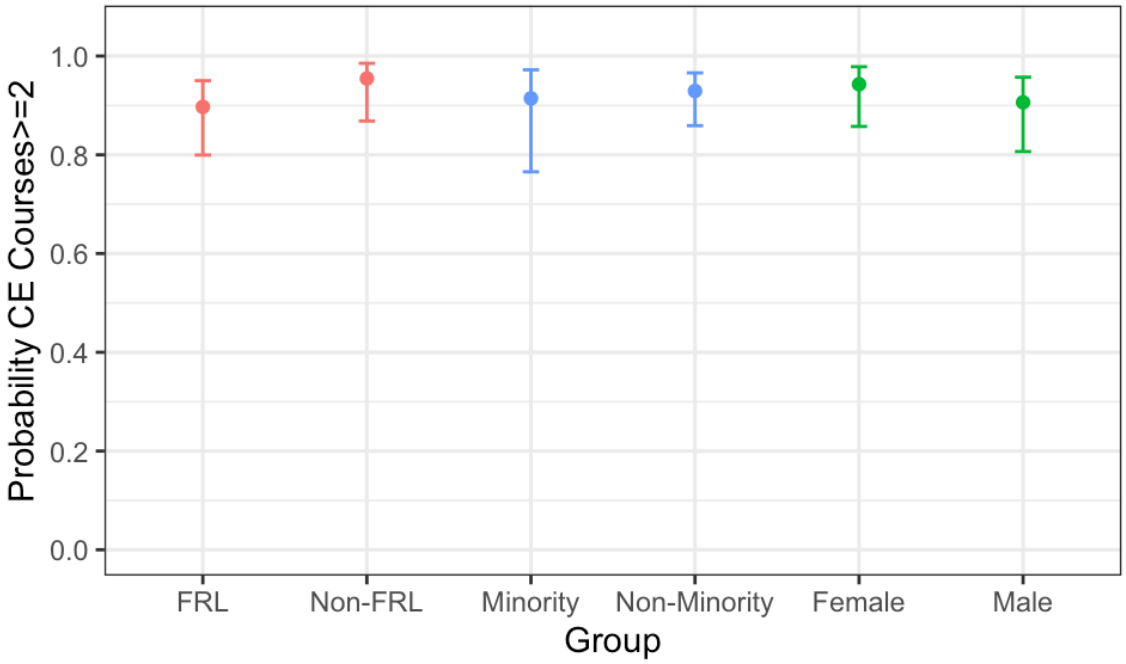


Figure 5. Probability of receiving two or more CTE certificates

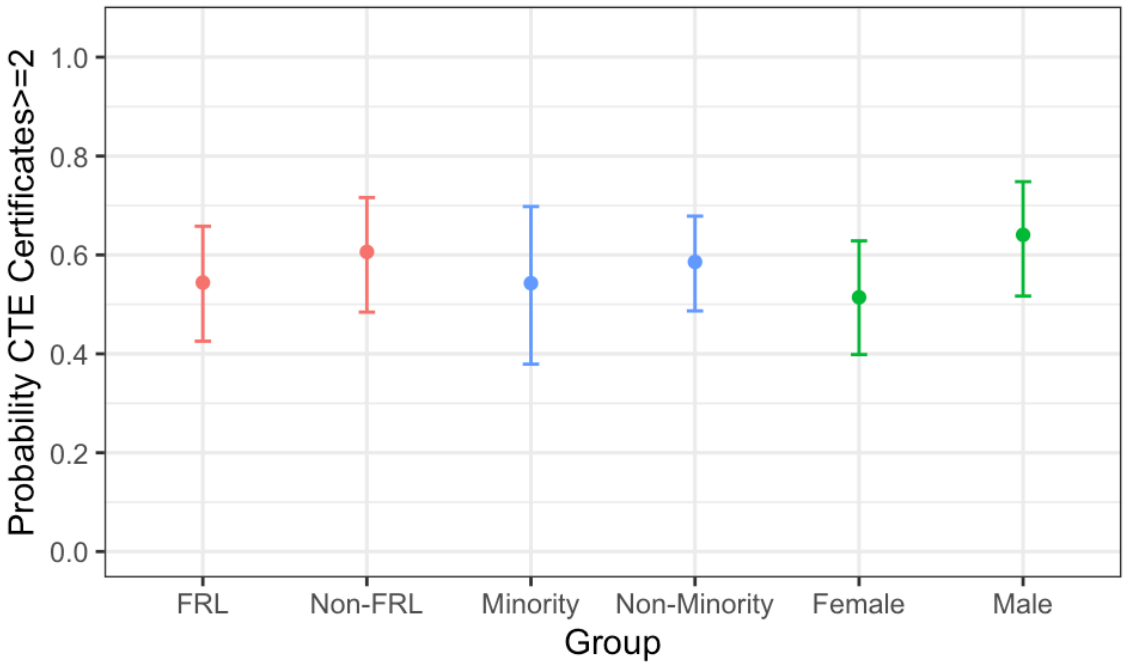
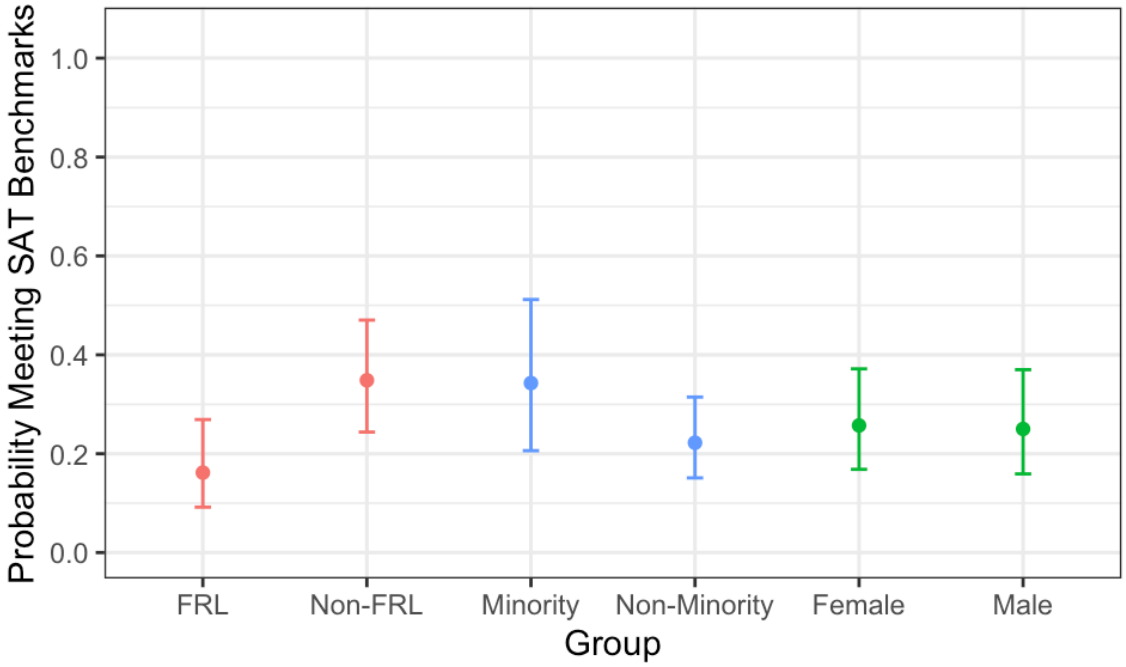


Figure 6. Probability of meeting both SAT benchmarks (math and EBRW)



To further evaluate the likelihood of students with different characteristics meeting the benchmarks on each graduation menu option, we run a logistic regression model. Results of the logistic regression model, reported in odds ratios, can be found in Appendix F. Similar to results found in other studies (e.g., see Chetty et al., 2023) we find the odds of meeting both SAT benchmarks to be significantly higher for Non-FRL students relative to FRL-eligible students, controlling for student gender and whether or not the student is minority. FRL-eligible students are about 30% as likely to meet both SAT benchmarks relative to their peers. Beyond the SATs, the odds of meeting graduation menu benchmarks are not statistically significant when controlling for other demographic characteristics.

Performance on Graduation Menu Options Relative to Performance on the Capstone

Having observed that SATs, compared to other indicators, represent the only benchmark that differentiates performance across demographic groups, we further explore how performance on the capstone appears to be consistent with other graduation menu outcomes. Knowing that the capstone signals that the vast majority of students have met graduation readiness expectations, we look into understanding how students with varying performance on the capstone can also demonstrate readiness when factoring in the other three graduation menu options. This analysis uses these other graduation menu options as external criteria to check whether students judged as meeting readiness standards on the capstone are also likely to demonstrate readiness on other post-secondary and workforce readiness indicators.

The figures in Appendix G display the relationships between capstone scores and three outcome variables: SAT, number of concurrent enrollment courses passed, and number of CTE certificates received. As indicated in those figures, in general, capstone scores are found to be

positively correlated with other graduation menu options such that higher performance on the capstone is associated with higher performance on other outcomes. While most students can demonstrate readiness on the capstones, students with higher scores on the capstone project tend to receive higher SAT scores and pass more concurrent enrollment courses, particularly in the 2021-22 and 2022-23 cohorts. As indicated in Figure G3, however, the relationship between capstone scores and CTE certificates is less defined. In other words, students of all ability levels on the capstone are also likely to demonstrate success through the receipt of CTE certifications.

To evaluate the magnitude of the relationships between capstone performance and graduation menu options, we illustrate the comparative probabilities of meeting graduation benchmarks by capstone score. Figures 7-9 below show how the estimated probabilities (and 95% confidence intervals) of meeting benchmarks change as a function of capstone score (ranging between 1.8 and 3.0). Each estimated probability has the same reference condition of a male student who is not eligible for FRL, not classified as minority, and who has a GPA of 3.0. As indicated in the figures, students with capstone scores of 3.0 have the highest probabilities of meeting graduation requirements. For example, students with a capstone score of 3.0 have about a 29% chance of meeting SAT benchmarks, while students with a capstone score of 2.0 have about a 7% chance of meeting the same benchmarks.

Figure 7. Probability of meeting SAT benchmarks

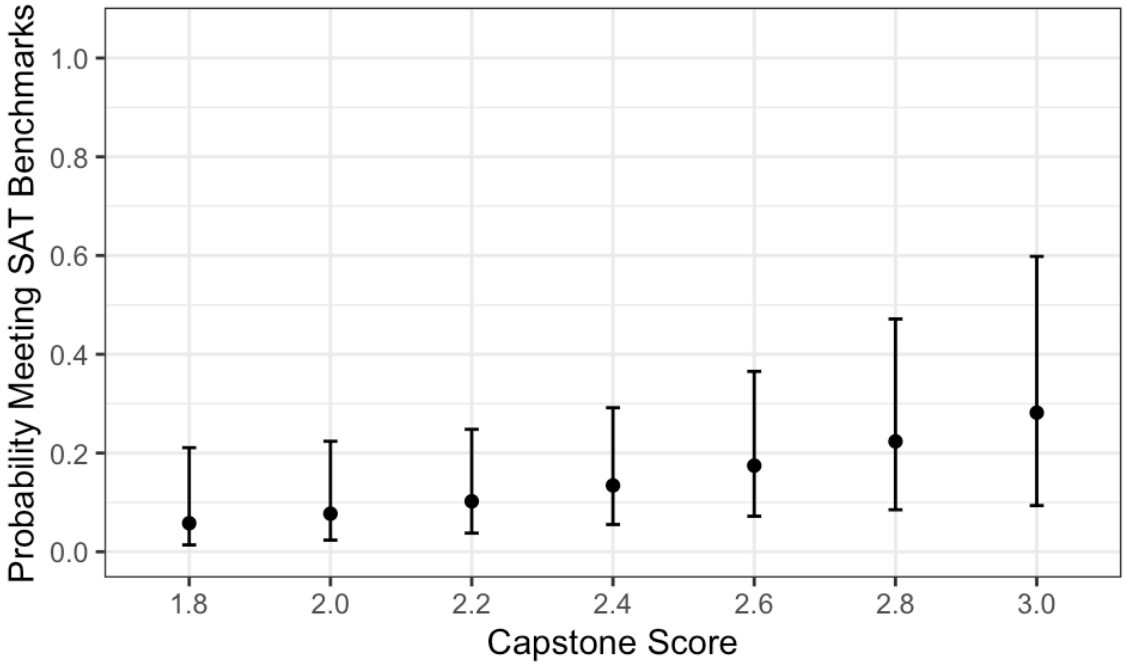


Figure 8. Probability of passing two or more concurrent enrollment courses

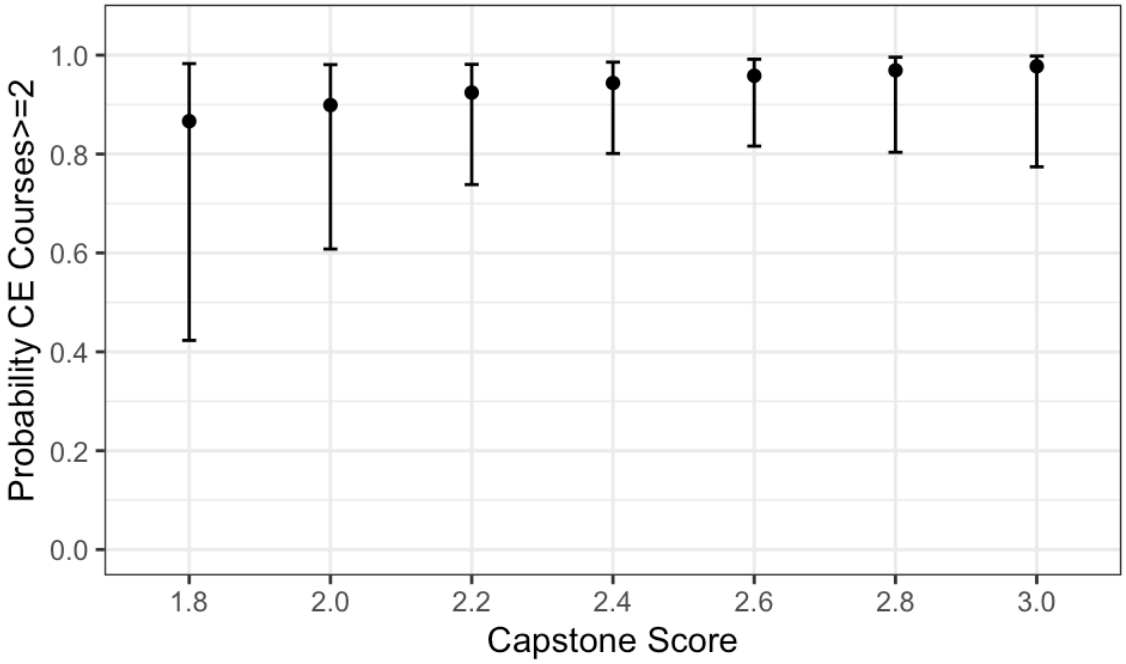
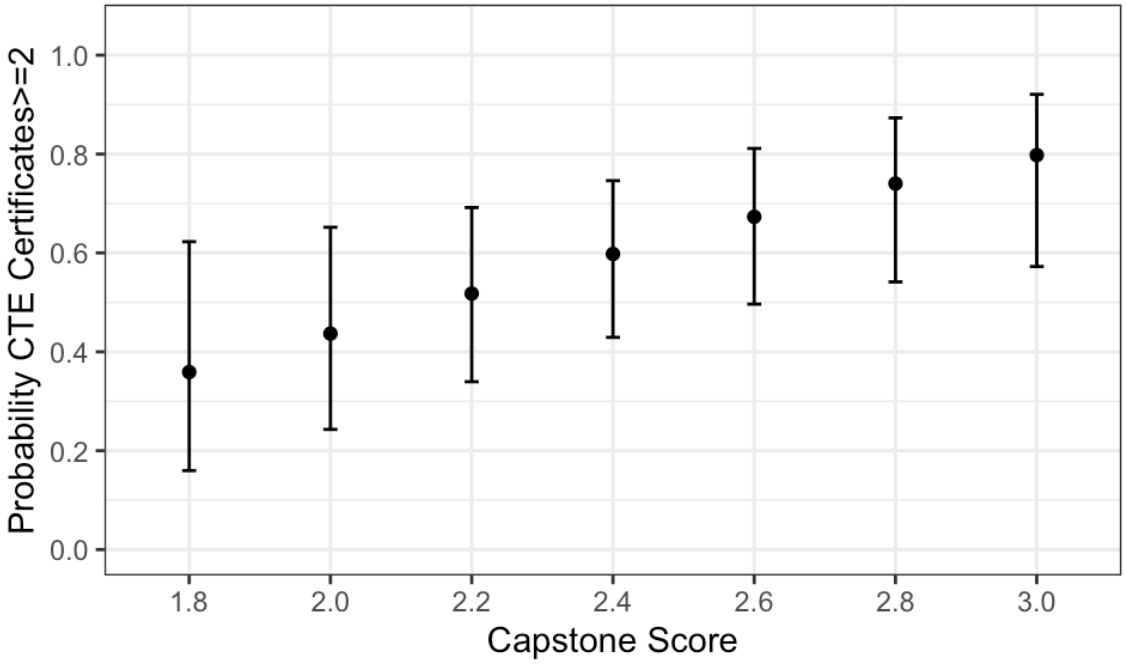


Figure 9. Probability of receiving two or more CTE certificates



To further evaluate the magnitude of the relationships between capstone performance and other graduation menu options, we run analyses to estimate the extent to which capstone performance is predictive of meeting other graduation menu requirements, controlling for student characteristics. Results from these models, reported in odds ratios, are displayed in Appendix H. We find capstone scores to be predictive of receiving two or more industry certificates and of meeting SAT EBRW benchmarks, when controlling for school year GPA, FRL-eligibility, minority status, and gender. In other words, among students with identical GPAs and demographic characteristics, students with higher capstone scores would be more likely to receive two or more industry certificates and more likely to meet SAT EBRW benchmarks relative to students with lower capstone scores.

Predicting Performance on Graduation Menu Options for Hypothetical Students

The prior section highlighted that capstone scores are consistent with other graduation menu options such that students with higher capstone scores also tend to be more likely to meet other graduation menu benchmarks. At the same time, results highlighted that a larger proportion of students meet capstone benchmarks relative to other graduation menu options, affording more students the opportunity to demonstrate graduation readiness. In this section, we transition to examining outcomes based on student profiles. These profiles capture different academic and demographic characteristics to understand the interactions of these two variables with the likelihood of achieving success on the examined graduation menu options.

The panels in Figures 10-12 depict the estimated performance of students with different academic performance and demographic profiles on graduation menu options each year. These panels draw on the data from the table in Appendix H to display the estimated performance for hypothetical students. Each dot in each panel represents a hypothetical student. In Figure 10 for example, the left panel displays the probability of meeting both SAT benchmarks (math and EBRW) for a student with an average GPA of 2.7 who is classified as minority and eligible for FRL. The middle panel displays the probability of meeting the same benchmarks for a student with an average GPA of 3.7 who is classified as minority and eligible for FRL. The right panel displays the probability for a student with an average GPA of 3.7 who is White/Asian and not eligible for FRL. The colors represent capstone scores, with pink representing a capstone score of 2.4, green representing a capstone score of 2.7 (the threshold for scholarship eligibility), and blue representing a capstone score of 3.0. The furthest left pink bar, for example, represents the probability of meeting the SAT benchmarks for a hypothetical student with a GPA of 2.7 who is classified as minority and eligible for FRL and who received a capstone score of 2.4.

In Figure 10, the panels suggest that the combination of higher capstone scores and higher GPAs regardless of demographics are associated with higher expected probabilities of meeting both SAT benchmarks. Since SAT is viewed as one measure of graduation readiness by the state, this finding suggests that students who are highly motivated to achieve a scholarship through the capstone process are also likely to demonstrate readiness on the standardized high school test and are also likely to have higher GPAs.

A comparison of the left panel and the middle panel in Figure 10 also reveals that students with higher GPAs (3.7 relative to 2.7) have a higher probability of meeting SAT benchmarks, regardless of capstone performance. A comparison of the middle panel and the right panel suggests that FRL-eligible and minority students tend to have slightly higher probabilities of meeting both SAT

benchmarks relative to Non-FRL, non-minority students. However, these estimates suggest that demographics (FRL eligible and minority status) play less of a role than GPA to predict whether a student will meet SAT benchmarks at this school.

Figure 10. The expected probability of meeting both SAT benchmarks based on capstone score, GPA, and demographics

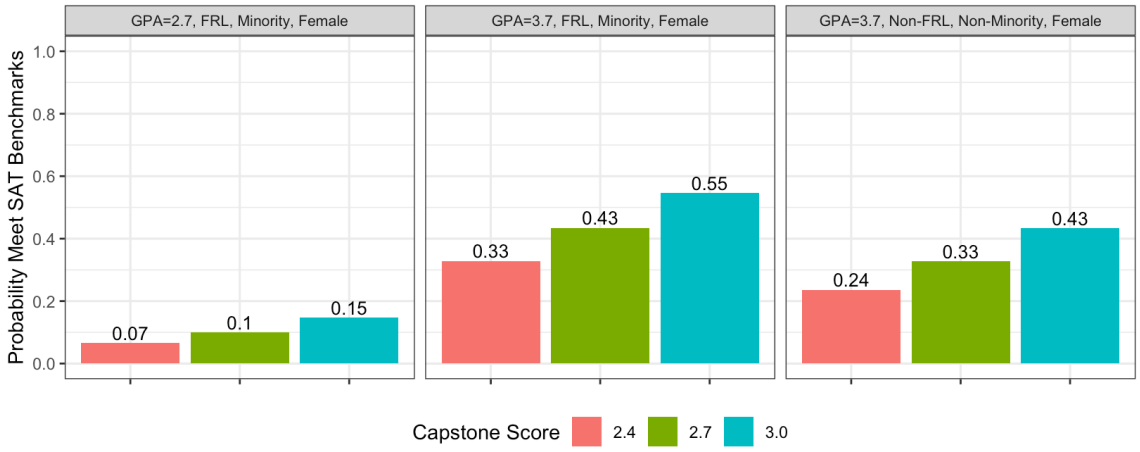


Figure 11 displays the likelihood of passing two or more concurrent enrollment courses based on GPA, demographics, and capstone performance. On average, a hypothetical FRL-eligible, minority student with a GPA of 3.7 is expected to pass more concurrent enrollment courses than an FRL-eligible, minority student with a GPA of 2.7. However, the likelihood of passing two or more concurrent enrollment courses does not vary substantially by demographic characteristics. FRL-eligible minority students are expected to pass a similar number of concurrent enrollment courses relative to Non-FRL non-minority students. And earning a capstone score of 2.4 versus 2.7 versus 3.0 has almost no bearing on the probability of passing two or more concurrent enrollment courses. The panels provide supportive information that, on average, students who meet the capstone requirement are also able to demonstrate capacity for engaging in concurrent enrollment coursework.

Figure 11. The expected number of concurrent enrollment courses passed based on capstone score, GPA, and demographics

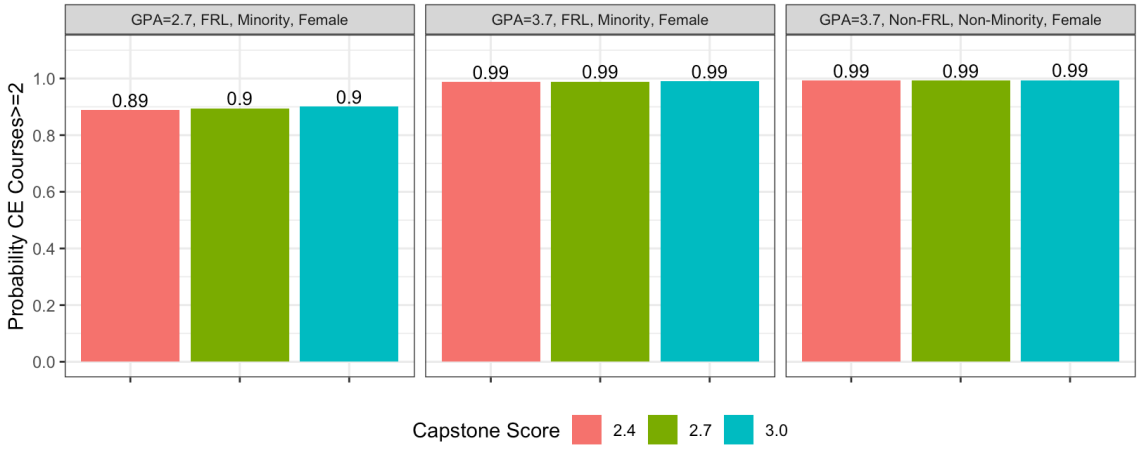
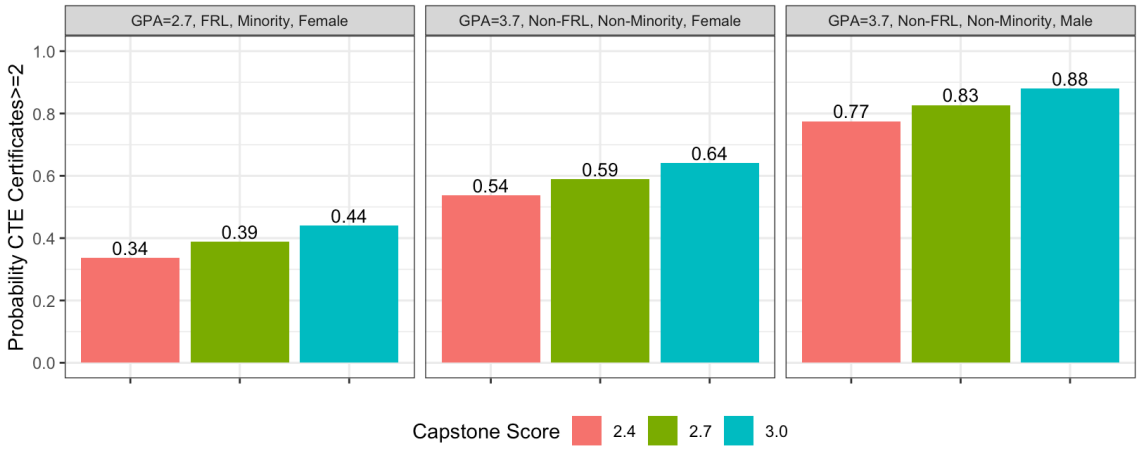


Figure 12 displays the likelihood of earning two or more CTE industry certificates based on GPA, demographic characteristics, and capstone score. On average, students' GPAs, whether or not they are FRL-eligible, and whether or not they are minority impacts the likelihood of receiving two or more industry certificates. A hypothetical non-FRL, non-minority student with a GPA of 3.7 is expected to earn more industry certificates than an FRL-eligible, minority student with a GPA of 2.7. Gender is perhaps an even greater predictor of the number of industry certificates received by students. A comparison of the middle panel in Figure 12 (female) and the right panel (male) suggests that male students who are otherwise demographically identical to their female peers are over 20% more likely to earn two or more industry certificates relative to their female peers. In this figure, capstone score is less of a distinguishing factor between students. Although students with higher capstone scores are slightly more likely to earn two or more industry certificates relative to students with lower capstone scores, the differences between groups are small.

Figure 12. The expected number of industry certificates received based on capstone score, GPA, and demographics



Research Question 3

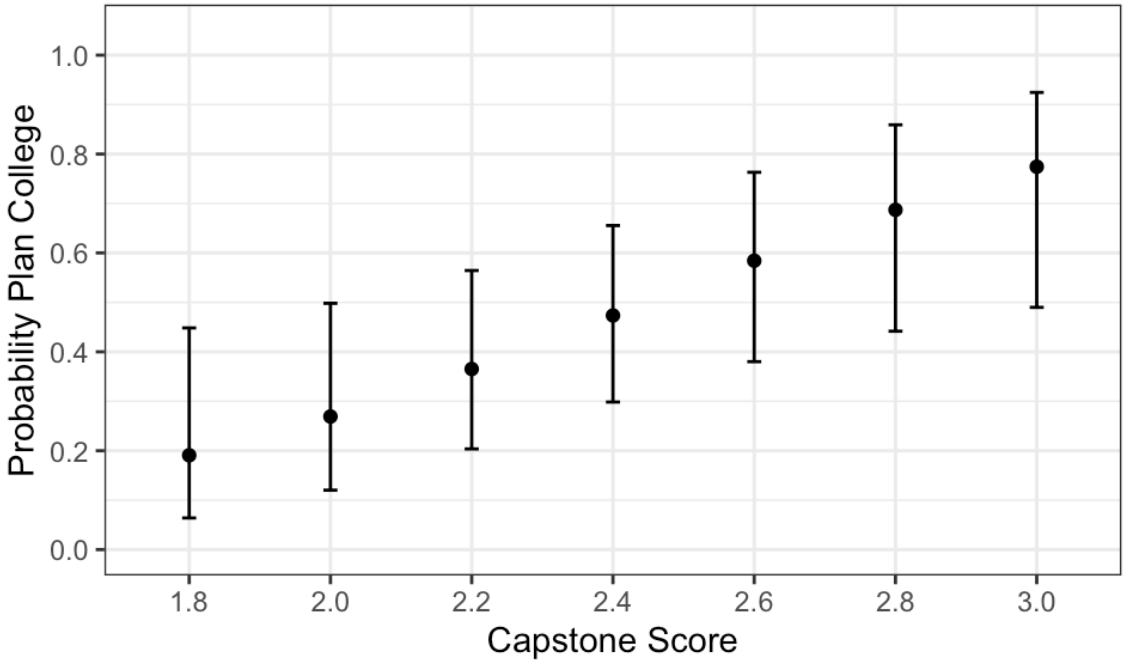
We now shift our analyses from examining graduation-readiness signals to examining the relationship between capstone scores post-secondary outcomes. We examine the relationship between capstone scores and students' intention to attend college, as well as the relationship between capstone scores and students' enrollment in college.

Intention to Attend College and College Enrollment Relative to Capstone Performance

To evaluate the magnitude of the relationships between capstone scores and plans to attend college, we illustrate the comparative probabilities of planning to attend college by student capstone score. Figure 13 below shows how the estimated probabilities (and 95% confidence intervals) of planning to attend college change as a function of capstone score (1.8 to 3.0). Each estimated probability has the same reference condition of a male student who is not eligible for FRL, not classified as minority, and who has a GPA of 3.0. As indicated in the figure, students with higher capstone scores have higher probabilities of planning to attend college relative to

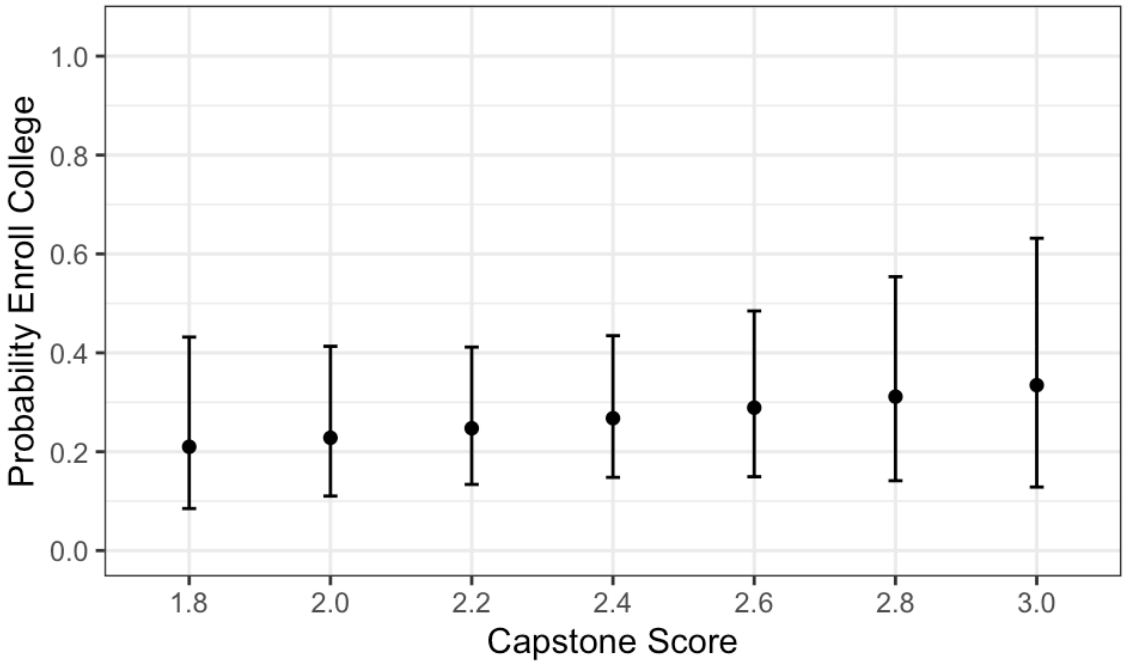
students with lower capstone scores. Based on the figure, a student with a capstone score of 3.0 has an estimated 78% probability of planning to attend college, while a student with a capstone score of 1.8 has an estimated 20% probability of planning to attend college.

Figure 13. Probability of planning to attend college



Similarly, we examine the relationship between capstone scores and enrolling in college. Figure 14 illustrates the comparative probabilities of enrolling in college by student capstone score using the same reference condition (male, non-FRL, non-minority, GPA of 3.0). Again, the figure indicates a positive relationship between capstone score and the probability of enrolling in college, but the relationship is weaker than the relationship between capstone scores and planning to attend college shown in Figure 13. That is, although students with higher capstone scores are more likely to enroll in college than students with lower capstone scores, the probability of enrolling in college for a student with a capstone score of 3.0 is about 33% (relative to about 78%) and the differences in probabilities between students of different capstone scores are smaller.

Figure 14. Probability of enrolling in college



To further examine the relationship between capstone scores and college plans and enrollment, we run a logistic regression model. We predict the likelihood of planning to attend college and of enrolling in college as a function of capstone scores, school year GPA, and demographic characteristics (FRL, minority, female). We also predict the likelihood of planning to attend college and of enrolling in college as a function of SAT scores, school year GPA, and demographic characteristics, to use as a comparison point to the capstone models. Results of the logistic regression model, reported in odds ratios, can be found in Appendix I.

Results indicate a relationship between capstone scores and a stated intention to attend college such that students who perform higher on the capstone are much more likely to plan to attend college than their peers. Despite capstone scores being predictive of intending to attend college, capstone scores are not found to predict whether students ultimately enroll in college the year after graduation. Note, however, that these results only reflect college enrollment in the year immediately following high school and do not capture, for example, enrollment in college after taking a gap year or after dedicating a period of time in the workforce. Therefore, it could be the case that most students at OHS who pass a capstone may eventually enroll in post-secondary opportunities down the line.

Another reason we may not observe a relationship between capstone scores and college enrollment is the prohibitively high costs of college education and the corresponding recent declines in college enrollment. Recent literature notes that since the onset of the COVID-19 pandemic, the opportunity costs of attending college as evidenced by declining enrollments are perceived to be high (e.g., Adler, 2021; Mitchell et al., 2019), particularly for low-income students (Hoover, 2020). A recent poll also attributes the decline in college enrollment to students and families prioritizing entering the workforce over attending college (Meltzer, 2023). Declining

national rates observed in college enrollment add nuance to the interpretation of the results that suggest no relationship between capstone performance and college enrollment.

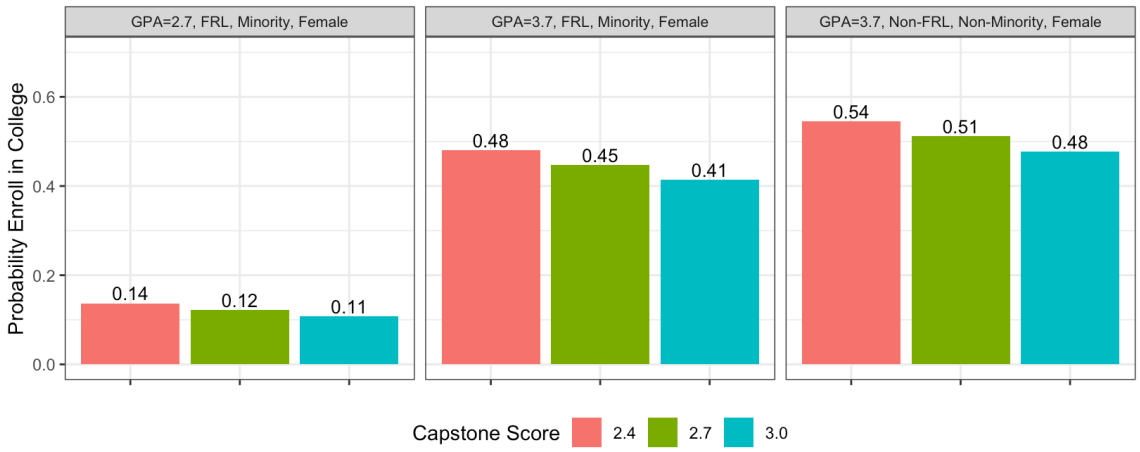
Results presented in Appendix I also display results of models estimating the extent to which meeting SAT benchmarks is predictive of planning to attend college and enrolling in college. These results provide a comparison point to the relationship between capstone scores and college outcomes to help determine whether capstone performance is more or less predictive of college outcomes relative to SAT performance. Results suggest that meeting SAT benchmarks is not predictive of planning to attend college nor enrolling in college.

Estimating the Likelihood of College Plans and Enrollment through Student Profiles

Figure 15 below displays the likelihood of enrolling in college for hypothetical students with varying GPAs, FRL-eligibility, minority status, and capstone scores. The left panel displays the expected likelihood of enrolling in college for a student with a GPA of 2.7 who is minority and eligible for FRL. The middle panel displays the expected likelihood of enrolling in college for a student with a GPA of 3.7 who is minority and eligible for FRL. The right panel displays the expected likelihood of enrolling in college for a student with a GPA of 3.7 who is White or Asian and not eligible for FRL. On average, students with higher GPAs are much more likely to enroll in college relative to students with lower GPAs. When comparing the left panel and the middle panel, a student with a GPA of 3.7 is about 30% more likely to enroll in college than a student with a GPA of 2.7. A comparison of the middle panel and right panel suggests that students with the same GPA and same capstone score are fairly similarly likely to enroll in college regardless of FRL eligibility and minority status.

Interestingly, the relationship between capstone score and likelihood of enrolling in college in Figure 15 is perhaps the opposite of what we would expect. Across demographics and cohorts, students with a capstone score of 3.0 are slightly less likely to attend college relative to students with a capstone score of 2.7 or 2.4. This trend differs from the observed trend in all other figures of expected outcomes for hypothetical students. We expect this result may be connected to changes in college enrollment patterns as previously mentioned. Without college enrollment data beyond the first year following high school graduation, we are unable to explicitly test this hypothesis.

Figure 15. The expected probability of enrolling in college based on capstone score, GPA, and demographics



Discussion

The results from this study point to important infrastructure and policy implications for other sites wishing to engage in similar work to provide high school students with alternative pathways to demonstrate graduation readiness. In our qualitative explorations, the feedback received from teachers and students indicate that the majority of individuals in both groups appear to see a clear correspondence between the instruction model pursued by the school and the capstone projects. This horizontal coherence established through the instructional model of learning in the general classroom activities and capstone projects is critical since this ensures that students do not enter the capstone process without having previously experienced project-based learning. As Jordan (2016) notes, capstone experiences can be undermined when students are not accustomed to authentic project-based work that require students to drive their own learning. At OHS, our findings suggest that students appear to be given adequate opportunities to learn through the project-based curriculum offered in all disciplinary areas, and particularly through the CTE focused courses and pathways offered at this school.

However, as identified by some teachers and several students, opportunity for students to feel or to achieve success on the capstone can be hindered through several factors associated with the capstone process itself such as: assignment to an ineffective capstone advisor; the extended (multi-year) nature of the capstone process that is particularly difficult for some students to seriously take up during the earlier high school years; the lack of adequate information or guidance to help scaffold students through the process; or, students selecting projects that do not sustain their interests. For the group of students who saw high value in the capstone process, most of these students had experienced issues with the capstone process but were able to personally overcome or persevere in large part due to the strong trust and mentorships established with their capstone advisor.

For the second group of students who did not attribute high value to the capstone process, the majority of these students did not speak about their advisors in the same supportive vein as the first group of students. In this second group, four out of six students spoke about their advisor interactions in less positive terms. These key differences between the two groups of students appear to suggest that the quality of supportive and trusting relationships set with advisors play a critical role that can facilitate success or potentially erode student experiences with the capstone. Even if the school shortens the timeframe for the capstone process or provides better communication and guidance about capstone expectations, pairing a student with an advisor that does not have the disposition or willingness to support and mentor a student through a capstone project may contribute to creating inequitable learning experiences for some students at this school.

Turning to the results associated with RQ2 and RQ3, these findings point to two important areas. First, when using concurrent enrollment and industry certification as external criteria for evaluating capstone performance, the findings suggest that, on average, students are also likely to achieve similar outcomes on those two graduation menu options. The implications of this are that capstone performance for this school is consistent with the readiness signals provided by one other post-secondary and workforce readiness measures. However, the SAT signal appears

to be consistent for only a subset of students who demonstrate higher capstone performance (i.e., meet the scholarship 2.7 and above threshold). This finding suggests that for these students and based on their SAT scores, an additional opportunity space opens up for them to gain admission into more competitive universities and colleges. To be clear, students with lower scores are still able to access post-secondary opportunities as signaled by having accrued college credit, but students with higher capstone scores will have more favorable SAT scores as evaluated by more competitive colleges and universities that have returned to or continue to maintain test-based admissions policies.

We emphasize that these findings cannot generalize to other sites since the contextual factors and the ways in which capstone has been implemented at this school likely differs from many other high schools with their own capstone processes and expectations. At this school, the results appear to support the idea that the capstone process can provide an equitable approach to evaluating student graduation readiness relative to the default conventional approach of using standardized test scores to demonstrate student success. This is important because should the SAT benchmarks serve as the only evaluative tool of readiness, then the earlier and likely similar performance achieved on the PSAT could have the negative effect of deterring or demotivating students from seeing themselves as capable or worthy of pursuing concurrent enrollment opportunities. Although the prospect of engaging in a complex multi-year project can be daunting for some students, the project-based instructional model coupled with the universal capstone approach at this school starts from a distinct asset driven approach that builds on students' strengths and interest, while, simultaneously positioning students for postsecondary and workforce opportunities as evaluated by other external measures.

The Colorado Secondary, Postsecondary, and Work-based Learning Integration Task Force recently released a report highlighting their recommendations for supporting "the equitable and sustainable expansion and alignment of programs that integrate secondary, postsecondary, and work-based learning opportunities in every region of the state" (2023, p. 3). Their recommendations included, among others, "addressing the structural and systemic barriers that disproportionately harm the education and employment prospects" of minoritized student populations (2023, p. 27). Results presented in this report highlight the capstone as an equitable and sustainable path for integrating secondary, postsecondary, and work-based learning opportunities. Sites seeking or currently implementing capstone work should evaluate and consider how their capstone projects build on students' strengths and interests while affording challenging and rich experiences that prepare them for futures beyond high school.

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Appendix A: Summary Statistics for the Analytic Sample by Cohort

	Cohort	2020-21	2021-22	2022-23
Capstone Scores	Mean	2.37	2.41	2.45
	SD	0.40	0.33	0.30
	N	130	121	134
GPA	Mean	3.32	3.30	3.21
	SD	0.49	0.51	0.63
	N	130	121	134
SAT Math	Mean	469.69	489.09	459.55
	SD	89.13	83.60	78.74
	N	130	121	134
SAT EBRW	Mean	502.85	495.54	487.54
	SD	91.70	87.08	83.44
	N	130	121	134
Concurrent Enrollment	Mean	3.18	7.35	8.17
	SD	4.06	4.97	4.39
	N	130	121	134
CTE	Mean	1.20	1.95	2.81
	SD	1.34	1.65	3.64
	N	130	121	134
Post-Secondary Plans	Mean	0.52	0.67	0.68
	SD	0.50	0.47	0.47
	N	130	121	134
College Enrollment	Mean	0.52	0.35	*Not available for 2023 cohort*
	SD	0.50	0.48	
	N	130	121	

Appendix B: Qualitative Methods Description

Data gathered from the semi-structured interviews and recordings were transcribed and analyzed using thematic analysis (Braun & Clarke, 2021) in Dedoose (version 9.0.107). The data analyses performed were iterative and three separate reviews of each transcript was conducted by the Project P.I. before coding for primary and secondary themes that cut across the different groups (students and teachers) interviewed for this study. The primary themes in this study are defined as key themes that surfaced more frequently between groups and secondary themes are defined as themes that surfaced more frequently within-groups. For example, a primary theme that surfaced clearly across the transcripts between groups are the descriptions of how regular coursework were organized using the project-based learning model and how those in large part correspond with the capstone approach. No data points provided by each group were found to counter this theme, and pointed interview questions about the role of project-based learning in regular coursework and the capstone provided adequate data points supporting this theme. In other words, feedback from students, teachers, and capstone mentors to teachers clearly supported the notion that for the most part, project-based learning is an instruction model that is upheld across classes, despite variation in how these may be implemented more effectively or not.

An example of an important secondary theme that surfaced prominently in the voices of students captured was the importance of forming trusting relationships with a capstone advisor and how these relationships can help students persevere (or not depending on the strength of the relationship) through experienced challenges with the capstone process. This was not a theme that surfaced in the data collected from capstone mentors to teachers, or classroom teachers but surfaced as a unique viewpoint shared from the perspective of students that viewed the capstone work in both positive and negative ways.

Overall, the thematic analysis took on more of an inductive approach, though an important focal area was to initially scan for evidence that the learning experiences of students supported the project-based approach used for the capstone. Both primary and secondary were confirmed only after the three reviews were completed, and adequate chunks of data could be found throughout the transcripts to support or justify theme identification. A triangulation check was carried out by discussing these themes in ongoing discussions with the school leader who has carried out extensive classroom observations and engaged in discussions with both capstone mentors and students. According to the school leader, these findings for the most part were consistent with the observations and concerns of his leadership and capstone advisory team, and the school continues to engage in continuous improvement processes to strengthen the capstone process and structures each year.

Appendix C: Distributions of SAT Math, SAT EBRW, and Capstone Scores

Figure C1. Distribution of SAT-Math scores

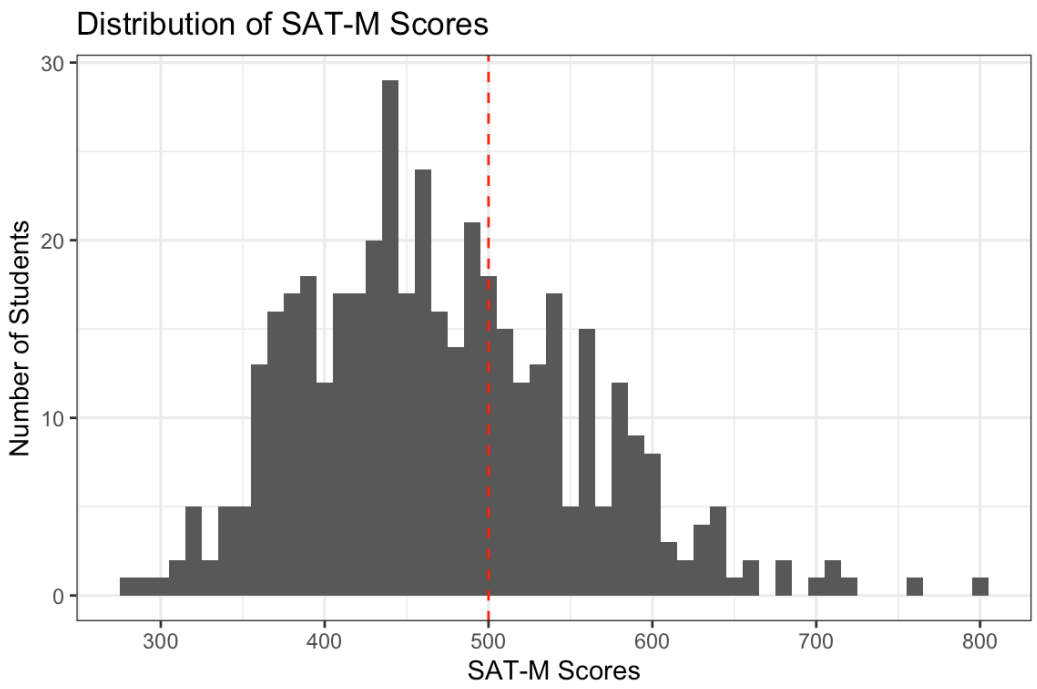


Figure C2. Distribution of SAT-EBRW scores

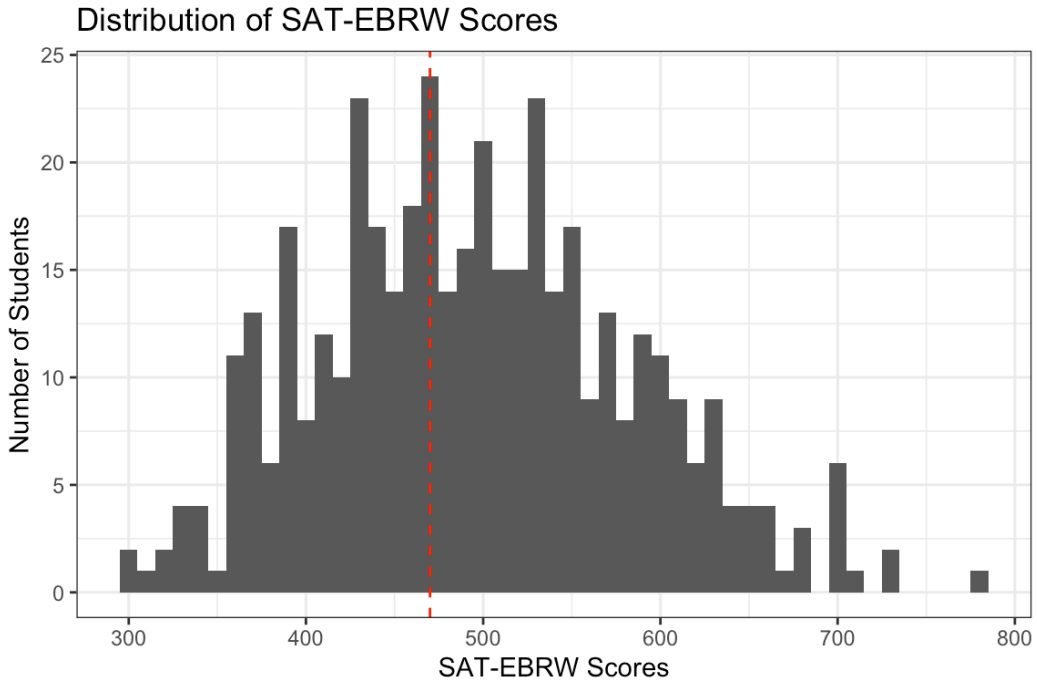
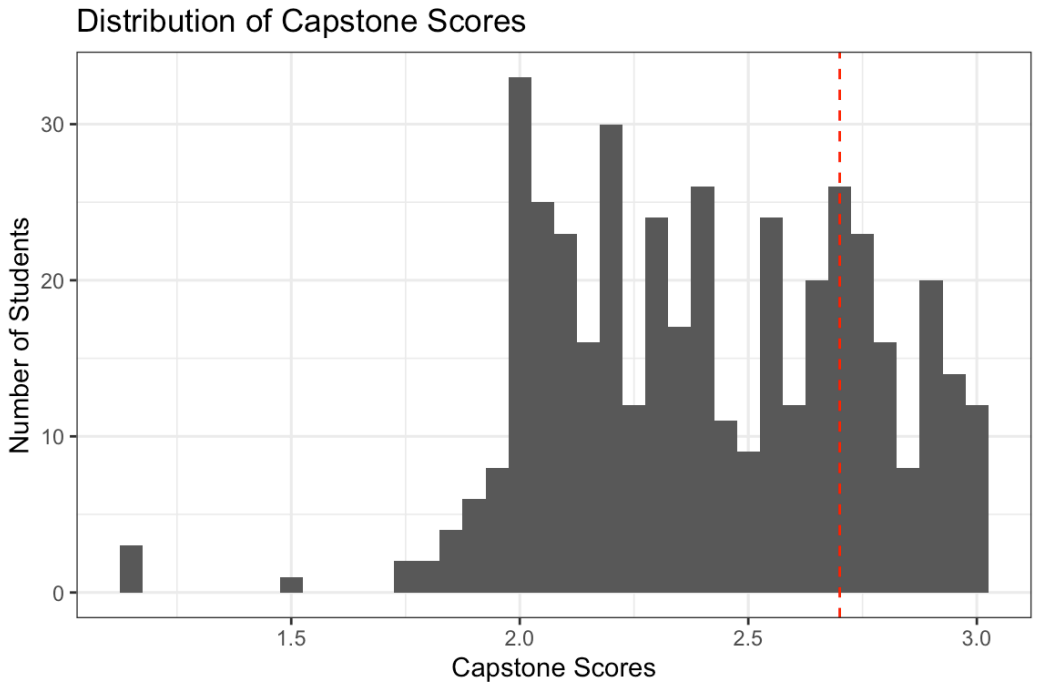


Figure C3. Distribution of capstone scores



Appendix D: Quantitative Methods Description

Addressing Research Question 2

RQ2 relies on capstone data, concurrent enrollment data, CTE certificate data, and SAT data. We first examine the extent to which demographic characteristics are predictive of capstone performance and other graduation menu options before examining the relationship between capstone performance and other outcomes.

Performance on Graduation Menu Options by Demographic Characteristics

We begin by examining the percentage of students in each cohort meeting each of the graduation menu benchmarks of interest: receiving a capstone score of two or above, passing two or more concurrent enrollment courses, receiving two or more industry certificates, and meeting both SAT benchmarks (EBRW and math). We calculate these percentages for all students and by groups of students (FRL, minority, gender). We then observe whether there are differential rates of meeting benchmarks across graduation menu options and between groups of students.

To evaluate the magnitude of the relationships between demographic characteristics and graduation menu options, we run a series of logistic regression models to estimate the likelihood of meeting benchmarks for students in different groups. To estimate the likelihood of meeting capstone benchmarks for FRL-eligible and FRL-ineligible students, for example, we run the following model.

$$\log\left(\frac{Capstone \geq 2}{1 - Capstone \geq 2}\right) = \beta_0 + \beta_1 FRL_i + \varepsilon_i$$

The FRL variable is equal to one for students who are eligible for FRL and zero for students who are not eligible for FRL. We estimate the likelihood of meeting benchmarks for students in both groups. We use the same model structure to estimate likelihoods across all four graduation menu options and across all three groups of interest. We then graphically display these probabilities and confidence intervals by outcome and group to easily examine differences in probabilities between groups.

To further evaluate the likelihood of students with different characteristics meeting the benchmarks on each graduation menu option, we run a series of logistic regression models that control for all demographic characteristics (FRL, minority, gender). The model to predict the likelihood of meeting capstone benchmarks, for example, is expressed as follows.

$$\log\left(\frac{Capstone \geq 2}{1 - Capstone \geq 2}\right) = \beta_0 + \beta_1 FRL_i + \beta_2 Minority_i + \beta_3 Female_i + \varepsilon_i$$

The coefficients on FRL, Minority, and Female, each provide the estimated effect of that characteristic on the likelihood of meeting the capstone benchmark of two, controlling for all other variables. We examine whether any demographic characteristics are statistically significantly predictive of outcomes when controlling for the other variables in the model.

Performance on Graduation Menu Options Relative to Performance on the Capstone

After examining the relationship between demographic characteristics and performance on graduation menu options, we move into an examination of the relationship between capstone performance and performance on other graduation menu options. We run a series of logistic regression models regressing graduation menu options on capstone score, GPA, FRL, minority, and gender. The model used to estimate the likelihood of meeting the SAT benchmarks, for example, is specified as follows.

$$\log\left(\frac{SAT}{1-SAT}\right) = \beta_0 + \beta_1 Capstone_i + \beta_2 GPA_i + \beta_3 FRL_i + \beta_4 Minority_i + \beta_5 Female_i + \varepsilon_i$$

In this model, SAT_i is equal to one for students who met the SAT benchmark and zero for students who did not, GPA is students' average GPA over the course of high school, and FRL, Minority, and Female are all indicator variables equal to one or zero. The coefficient on Capstone provides an estimate of the likelihood of meeting the SAT benchmark for each additional point earned on the capstone. Statistically significant values indicate that, controlling for GPA and demographics, capstone is predictive of the graduation menu option.

Addressing Research Question 3

In addition to examining the relationship between capstone performance and performance on other graduation menu outcome variables, we examine the relationship between capstone performance and later college enrollment to see whether capstone performance was predictive of college enrollment.

Intention to Attend College and College Enrollment Relative to Capstone Performance

We run a logistic regression model to predict post-secondary outcomes as a function of capstone performance, GPA, and demographic characteristics (FRL, minority, gender). We run this model once to predict plans to attend college and once to predict enrollment in college. The model to predict college enrollment is specified as follows.

$$\log\left(\frac{Enroll_i}{1-Enroll_i}\right) = \beta_0 + \beta_1 Capstone_i + \beta_2 GPA_i + \beta_3 FRL_i + \beta_4 Minority_i + \beta_5 Female_i + \varepsilon_i$$

In this model, Enroll is equal to one in cases where a student enrolled in college and zero if they did not enroll. The coefficients are interpreted as described in research question two. The coefficient on Capstone, for example, provides an estimate of the change in likelihood of enrolling in college based on a one unit increase in overall capstone score. A statistically significant coefficient on Capstone would indicate that capstone scores are predictive of college enrollment.

As a comparison point, we also run a version of this model that regresses college outcomes on SAT performance instead of capstone performance. This model is specified the same as above, but instead of β_1 providing an estimate of the relationship between capstone performance and college outcomes, β_1 provides an estimate of the relationship between SAT performance and college outcomes. We compare these coefficients to one another to understand whether capstone performance is more or less predictive of college outcomes than is SAT performance.

Appendix E: Percentages of Students Meeting Graduation Benchmarks by Year and Group

Year	Group	Total students (N)	Capstone Benchmark (2 or above)	Pass 2 or more concurrent enrollment	Receive 2 or more industry certifications	Pass SAT benchmarks in ELA and Math
2020-21	Non-FRL	75	89%	72%	40%	40%
2020-21	FRL	55	91%	55%	25%	24%
2021-22	Non-FRL	71	96%	92%	48%	37%
2021-22	FRL	50	88%	82%	60%	38%
2022-23	Non-FRL	66	100%	95%	61%	35%
2022-23	FRL	68	97%	90%	54%	16%
2020-21	Non-minority	109	91%	67%	36%	32%
2020-21	Minority	21	86%	52%	24%	38%
2021-22	Non-minority	95	92%	88%	54%	38%
2021-22	Minority	26	96%	85%	50%	35%
2022-23	Non-minority	99	100%	93%	59%	22%
2022-23	Minority	35	94%	91%	54%	34%
2020-21	Male	57	88%	58%	49%	37%
2020-21	Female	73	92%	70%	22%	30%
2021-22	Male	55	98%	85%	60%	44%
2021-22	Female	66	88%	89%	47%	32%
2022-23	Male	64	98%	91%	64%	25%
2022-23	Female	70	99%	94%	51%	26%

Appendix F: Graduation Menu Benchmarks Relative to Demographic Characteristics

	Meet capstone benchmark of two	Pass two concurrent courses	Receive two industry certificates	Meet both SAT benchmarks
Intercept	2.04e+17	16.68**	2.02*	0.40**
FRL	0.00	0.39	0.83	0.30**
Minority	0.00	0.90	0.86	2.37
Female	2.33	1.90	0.61	1.24
R2	0.37	0.04	0.01	0.06
N	134	134	134	134

*Note. '**' 0.01 '*' 0.05*

Appendix G: Scatterplots of the Relationship between Capstone Scores and Other Outcomes

Figure G1. Capstone scores and SAT composite scores for the 2020-21, 2021-22, and 2022-23 cohorts

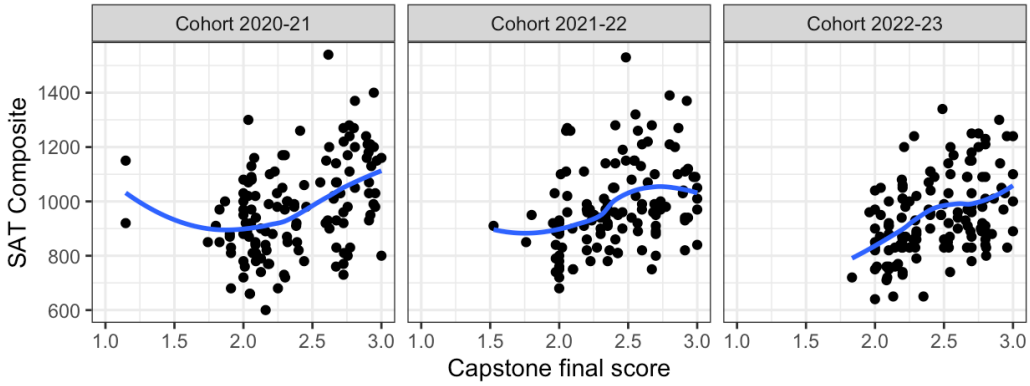


Figure G2. Capstone scores and the number of concurrent enrollment courses passed for the 2020-21, 2021-22, and 2022-23 cohorts

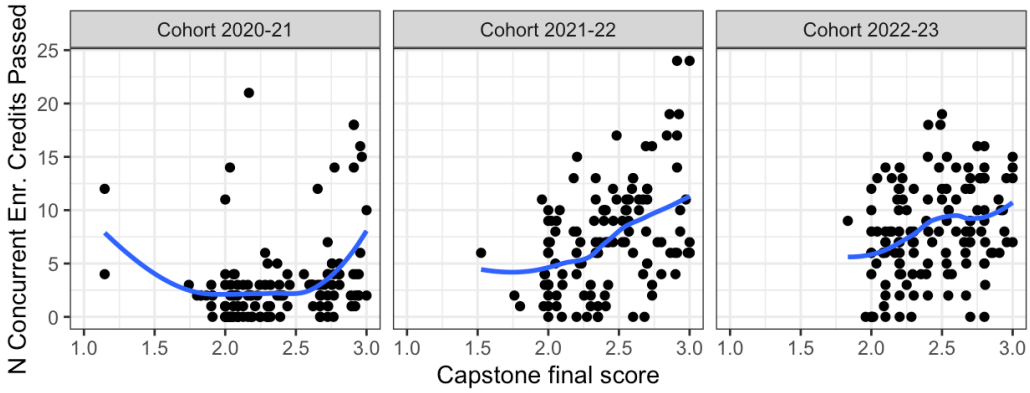
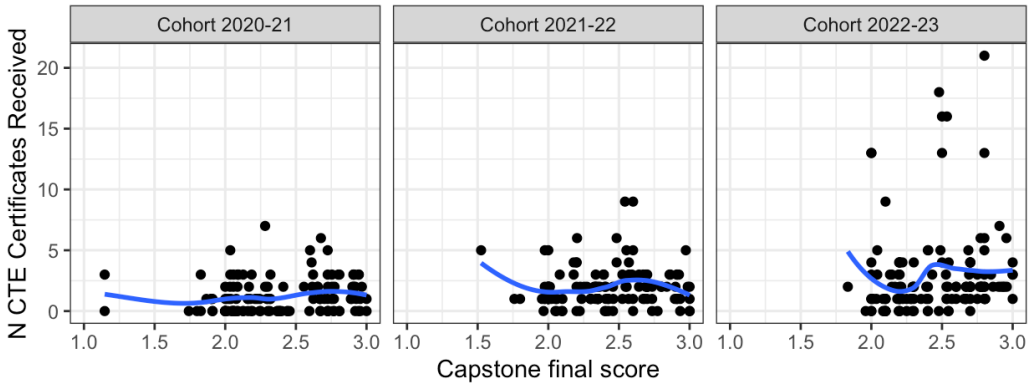


Figure G3. Capstone scores and the number of CTE certificates received for the 2020-21, 2021-22, and 2022-23 cohorts



Appendix H: Graduation Menu Benchmarks as a Function of Capstones, GPAs, and Demographics

	Pass two concurrent courses	Receive two industry certificates	Meet SAT math benchmark	Meet SAT EBRW benchmark	Meet both SAT benchmarks
Intercept	0.00	0.00**	0.00**	0.00**	0.00**
Capstone	5.08	6.67**	3.25	7.89**	8.61*
SY GPA	5.89**	1.95	6.48**	5.34**	7.30**
FRL	1.27	1.48	0.52	2.15	0.70
Minority	1.18	0.86	1.98	1.83	2.09
Female	1.18	0.43*	0.74	1.21	0.74
R2	0.23	0.11	0.22	0.23	0.26
N	134	134	134	134	134

*Note. '**' 0.01 '*' 0.05*

Appendix I: Post-Secondary Outcomes as a Function of Academic Performance and Demographics

	Plan college		Enroll in college	
Intercept	0.00**	0.03*	0.00**	0.01**
Capstone	8.17*		1.69	
SAT (both)		1.61		1.83
SY GPA	2.19	3.02**	3.40*	3.18*
FRL	0.65	0.71	1.61	1.39
Minority	1.87	1.65	0.78	0.81
Female	7.36**	6.63**	0.84	1.02
R2	0.27	0.24	0.07	0.08
N	134	134	121	121

*Note. '**' 0.01 '*' 0.05*