Computer Science through Concurrent Enrollment: Reflections and Lessons Learned Offering Mobile CSP as a Concurrent Enrollment Course

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Abstract

Concurrent enrollment enables high school teachers approved by a partnering college or university to teach college-level coursework to their students. The collaborative research-practice partnership project CS-through-CE examines if and how concurrent enrollment (CE) programs can effectively broaden participation in computing for secondary students. In the CS-through-CE project two participating higher education institutions – Capital Community College (CCC) in Hartford, CT, and Southwest Minnesota State University (SMSU) in Marshall, MN – collaborated with the Mobile Computer Science Principles (CSP) team to train secondary teachers to teach the Mobile CSP course, and then offer the Mobile CSP course as a CE course. In this experience paper, faculty from CCC and SMSU detail their experiences recruiting secondary partners to teach Mobile CSP as a CE course, including the barriers and challenges encountered and the strategies identified for overcoming them. Additionally, participating secondary instructors from Hartford Trinity Magnet College Academy in Hartford, CT and Northeast Range School in Babbit, MN detail their experiences teaching Mobile CSP as a CE course in their high schools. They share their experiences teaching Mobile CSP as a CE course, contrast this experience to teaching the course in an Advanced Placement (AP) format, and detail the benefits they see in each modality. The experiences of the college faculty and secondary instructors in this paper are informative for any secondary or post-secondary educator interested in cultivating or expanding pathways in CS through concurrent enrollment.

CCS Concepts

• **Social and professional topics → Computing education**.

Keywords

concurrent enrollment; dual enrollment; advanced placement; computer science principles; computer science pathways

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1 Introduction

Colleges and universities nationwide offer dual enrollment (DE) programs for secondary students as a means to increase college readiness, introduce students to college-level work, and expose students to various career pathways. Students who participate in DE programs see benefits to their academic achievement both while in high school and upon transfer to post-secondary institutions [6]. Student participation in DE programs across the United States has grown over the years. Student participation in DE between 2002 and 2010 grew by more than 7%, and around 12% in rural schools and schools with majority minority enrollment [5].

Concurrent enrollment (CE), is a form of DE in which high school teachers teach college-level courses in their high schools. Participating high-school teachers must be approved by the partnering college/university to teach the CE course. CE coursework is assessed as a college course with final grades determined by student work accumulating over a semester or year. Students who successfully complete the CE course with a grade determined by the partnering college/university are guaranteed college credit. This college credit can be used at the granting university as well as transferred to other colleges and universities.

Computer science as a subject has historically not been widely offered via DE. Recently, efforts to expand college-level coursework in CS to secondary students has focused on the Advanced Placement (AP) CS Principles (CSP) course as a means to both introduce students to the study of CS and engage students underrepresented in computing [1]. AP courses have their own challenges to implementation and are not offered across all schools nor available or

deemed applicable to all students. DE also has challenges, and significant enrollment gaps due to race/ethnicity and socioeconomic status exist for both DE and AP across subject areas nationwide [3].

1.1 Mobile CSP

The Mobile Computer Science Principles (Mobile CSP) project, at The College of St. Scholastica with a faculty associate at the College of Our Lady of the Elms (Elms College), is an NSF-funded curriculum endorsed by the College Board for its alignment with the Advanced Placement (AP) CSP framework [4]. Mobile CSP has an established professional development (PD) model for teachers, with PD for teachers who have no experience in CS as well as for experienced teachers. All PD includes year-round support led by a PD facilitator in small groups as well as support forums and monthly online webinars. Since 2012, the Mobile CSP project has trained over 450 teachers to teach Mobile CSP curriculum for AP credit and CE credit.

1.2 CS-through-CE

Computer Science through Concurrent Enrollment (CS-through-CE) is an NSF-sponsored research-practice partnership project exploring the barriers and supports to offering Mobile CSP as CE and examining its potential to broaden participation in computing [2]. The CS-through-CE project involves a partnership between the Mobile CSP team and Capital Community College (CCC) and Southwest Minnesota State University (SMSU). In this partnership, CCC and SMSU added the Mobile CSP course to our course offerings and then partnered with our respective secondary schools to teach the course as a CE course. Building on the Mobile CSP model, the CS-through-CE project also includes providing summer professional development and year-round support for secondary teachers to teach Mobile CSP as a CE course at their schools. The overarching goal of the project is to examine effective ways of offering Mobile CSP as CE and to examine if offering the course as a CE can attract and engage females and under-represented minority (URM) students.

1.3 Mobile CSP Curricular Adaptations for Concurrent Enrollment

An initial component of the CS-through-CE project was to adapt the Mobile CSP curriculum to be taught as a CE course. At the outset, the project team decided to retain the focus on the seven big ideas of the CSP framework, and retain all the learning objectives and outcomes of the AP Mobile CSP course. The primary curricular adaptation was the development of new CE curriculum materials for the Create and Explore performance tasks for teachers to use instead of the College Board AP rubrics and instructions. The focus of adapting the curriculum would be to impart college-level expectations, skills, and requirements within the curriculum that align with an introductory college-level CS course. An additional goal was to provide more flexibility for teachers and alleviate some of the difficulties experienced by AP teachers related to the performance tasks. In AP, the performance task design and scoring process are necessarily detailed in the desire to achieve reliability and validity across thousands of students. The CE performance tasks could provide more flexibility for both students and teachers.

For the Create Task, where students create a mobile app using MIT AppInventor on a topic of their choice, we created CE Create Task instructions and rubric to describe the goals and steps of the Create task and measure student performance. In the CE rubric, we included new requirements and criteria for collaboration and presentation of the completed project, both of which would be required in a college course. Collaboration requires students to work with fellow classmates in one or more phases of the iterative design process of designing, developing and testing their mobile app student projects. The presentation requirement details multiple formats including live presentation or recorded video for students to present their completed mobile app to their instructor and classmates and is designed to strengthen students presentation skills. Collaboration and presentation are required components in the CE version of the Create Performance Task and optional components of the AP College Board Create Task.

For the Explore task we also created new instructions and rubric for the CE version of the course. The CE Explore task consists of students choosing and researching a computing innovation and preparing a paper, presentation, video or other artifact that details the purpose, data, and societal impacts of the innovation. The new rubric for the CE Explore Task measures how effectively students identify and communicate these components. The artifact required of students is consistent with what would be required in a college classroom. Students are also encouraged to collaborate with fellow classmates in identifying innovations and sharing feedback with one another.

Along with these curricular changes, the CE version of Mobile CSP course provides high school teachers flexibility regarding the pacing of the curriculum, by decoupling the curriculum and performance tasks from the College Board AP testing schedule. The AP exams are generally given the first or second week of May, whereas most schools in CT end a month later in June, allowing for additional time to cover the curriculum. Importantly, for participating students, the CE version of the Mobile CSP course removes the high-stakes AP exam as the sole determinant for a student's possible awarding of college credit. In the CE version of the course, students final grades and the awarding of credit is determined by the total body of student work (assignments, projects, exam grades, etc.) as in a college course.

1.4 Recruiting Secondary Teachers

Our project team identified numerous factors that helped us recruit secondary teachers to participate in our CS-through-CE project. Secondary teachers appreciated being provided a complete Mobile CSP curriculum with lesson plans that they could use to teach their class. They also appreciated having the year-long PD and support by the Mobile CSP Facilitator and college/university faculty. Through the NSF grant, teachers were also provide a stipend for completing the summer PD, and a stipend for participating in the project activities throughout the school year.

1.5 Support for Student Recruiting

Another key component of the CS-through-CE project is the support for CE teachers to recruit students – specifically female and URM minority students – for course participation. The project team instituted a series of strategies to support participating schools in student recruitment, including sharing existing Mobile CSP student recruitment resources, supporting participating teachers in creating student recruitment plans, and partnering with National Center for Women in Computing (NCWIT) to sponsor and host Counselors for Computing (C4C) events for participating school counselors. Each of these recruitment strategies highlighted broadening participation in computing as an underlying goal.

2 Concurrent Enrollment Programs

In this section faculty from the two partnering colleges/universities describe different facets and challenges in adding the Mobile CSP course to their course offerings and recruiting secondary schools and teachers to participate in the CS-through-CE project.

2.1 Capital Community College – Seth Freeman

Capital Community College (CCC) is a public, urban community college located in Hartford, CT. CCC is one of twelve public community colleges within the state of CT and is part of the Connecticut State Colleges and Universities (CSCU) system. CCC is a Hispanic-Serving Institution, and features one of the most diverse student populations of colleges within New England. CCC's student population is around 2500 students with 70% of students female, 80% studying part-time, and an average age of 29.

2.1.1. College Career Pathways

College Career Pathways (CCP) is a statewide concurrent enrollment program common to all twelve Connecticut community colleges that adheres to the National Alliance of Concurrent Enrollment Partnerships (NACEP) standards. CCP is partially funded through the Carl D. Perkins Career and Technical Education Improvement Act of 2006 to grant college credit free of charge to high school students. In the CCP program, students must choose a career pathway, and complete a two-course sequence within that career pathway. The program is available to 10, 11 and 12th graders, with no cost to participating students or schools. Through the CCP program students can earn up to 15 college credits while in high school. There are no eligibility requirements for participating students imposed by CCC.

2.1.2. Development of CSC 117 – Mobile CSP

In identifying where to develop Mobile CSP within our curriculum at CCC, we determined that we would offer the course as a CS course and offer it as an introductory computer science elective in our Business and Technology Department. We adopted the Mobile CSP curriculum, learning outcomes and modified performance assessments previously described, and created and added a new course – CSC 117 Mobile Computer Science Principles – to our 2019-2020 catalog. As an introductory computer science course, CSC 117 does not have any pre-requisites. As a computer science elective, the course can count towards any degree or certificate program that requires a computer science elective. These include Computer Information Systems, Computer Networking and CyberSecurity. Also, because we have a combined Business and Technology academic department at CCC, the course can also count as a Business elective, which avails the course to any student that has a Business elective.

2.1.3. Experiences Recruiting Schools and Teachers

In our first year recruiting schools to partner with Capital to teach Mobile CSP as a concurrent enrollment course, we focused on reaching out to schools within our geographic and catchment area, as well as schools we had existing CE partnerships with. Historically, much of our very limited success in teaching computer science/information technology via concurrent enrollment has been through area secondary schools in the Connecticut Technical High School system (CTECS), where we have prior agreements in place. Within the CTECS, many schools have an Information Systems (IST) pathway, where students complete a trade in information technology. With some schools having existing CE course offerings in Intro to Programming, Web Design, Digital Graphics, and Computer Applications, Mobile CSP was a strong addition to strengthen those pathways.

As we reached out to other secondary partners, we quickly identified that many high schools were currently teaching Mobile CSP as an AP course. Because the Mobile CSP project began at Trinity College in Hartford, CT, many schools in the Greater Hartford region were early adopters with many teachers trained by Mobile CSP. Our initial requests to articulate the course as a CE course were met with apprehension, due to their desire to continue to offer the course as AP. Many found the AP CS Principles course was successful in broadening participation of females and URM students, particularly compared to the AP CS A course. Additionally, their school administrations prioritized AP coursework, as the number of students taking AP coursework is a key metric for school rankings and often a measure of prestige for the schools.

From our discussions with schools, we came to understand that most of our partnering schools currently teaching AP Mobile CSP would not be able to offer both an AP version of the course and CE version. Some chose to simply stick with their existing AP version. Other schools asked to teach Mobile CSP in a dual format, i.e. to teach one course section in both AP and CE. We were initially hesitant to support this, due to the differences in performance assessments (CE vs AP), and concern that teachers teaching the course in dual formats would have difficulty differentiating the assessments to students, and the stricter AP schedule would dictate the course pacing. We did, however, support teachers in teaching in a dual format, and found teachers did manage these challenges. Of the 7 participating CT schools in Year 1, 5 of the 7 classrooms taught the Mobile CSP course in a dual format.

In recruiting participating schools, a secondary challenge was ensuring teachers met the criteria for teaching a CE course. In the CCP program, the requirement for teachers is that the teacher meet the same standards as an adjunct college faculty, which includes a masters degree in the subject area. Exceptions to this can be made for individuals with significant industry experience or other relevant experience. CCC exercised flexibility in reviewing teacher applications to approve teachers, by broadening the subject area

a teacher could have a masters degree in, recognizing industry experience, and requiring teachers complete the 100-hour Mobile CSP PD. Through this strategy, we were able to accept the majority of teacher applications, and only one teacher applicant was denied.

2.1.4. Results - Year 1 Teacher and Student Recruiting

The following table summarizes the teacher recruitment results for the first year CCC recruited teachers to teach Mobile CSP as CE. The Teachers Taught includes the CT Mobile CSP PD Facilitator.

Teachers Applied	Teachers Approved	Teachers Completed PD	Teachers Taught CE course
11	10	8	7

Table 1: Year 1 Teacher Recruiting - CCC

The following table summarizes the student recruiting results for the first year (2019-20) Mobile CSP was offered as a CE course for the participating CT schools. The total Mobile CSP CE course enrollment across all participating schools and percentages of females and URM students enrolled in the CE course is compared against the total school populations, female and URM student percentages. The school population data is from National Center for Education Statistics (NCES) for the 2017-18 school year, the most recent year available.

	Enrollment	% Female	%URM
Total (6 schools)	5,002	52%	51%
Total Mobile CSP CE Students	123	24%	23%

Table 2: Year 1 Student Recruiting - CCC

2.2 Southwest Minnesota State University – Dan Kaiser

Southwest Minnesota State University (SMSU) is a public, 4-year university located in Marshall, MN. SMSU is a member of the Minnesota State Colleges and Universities system and has a Carnegie classification of Masters Colleges and Universities. SMSU has a total headcount of about 6800 and an undergraduate FTE of about 3600.

2.2.1. College Now

SMSU has offered CE courses since 1984 through College Now, the longest running and largest CE program in Minnesota. College Now is accredited by NACEP and serves over one hundred, mostly rural, high schools across the state. Through College Now, university classes are taught to 11th and 12th graders at participating schools by university-approved teachers. In Minnesota, tuition for CE is paid by school districts, with a portion reimbursed to the school district by the state.

2.2.2. Development of IDST 1264 – Mobile CSP

After reviewing the Mobile CSP curriculum, we realized it aligned very closely with the first course in our computer science major. The first challenge was condensing the curriculum from a full-year high-school course into a one-semester college course. This was accomplished by moving much of the in-the-classroom activities to assignments for students to complete outside of class. With this change, we were able to keep all the topics of the Mobile CSP curriculum while also keeping topics in digital circuits and the UNIX operating system that were part of our original course.

SMSU's accrediting body, the Higher Learning Commission, mandates that anyone teaching a college course must have a master's degree with 18 graduate credits in the discipline of the course. Finding teachers in rural Minnesota high schools with 18 graduate credits in computer science is nigh impossible. Thinking about our course, we realized that it concentrates less on the formal aspects of computer science but more on the applications of computing in all of society. Additionally, many experts in computer science education are advocating that if we expect to broaden participation from diverse groups, introductory computing courses should be taught with a more interdisciplinary lens. This requires a set of teachers with more diverse expertise. To this end, we gave the new course an interdisciplinary prefix. This allows us to recruit teachers with a master's degree in any discipline. In addition to their master's degree, prior to teaching the course, the high-school teachers must participate in a 100-hour professional development workshop delivered by the SMSU computer science faculty and the Mobile CSP PD facilitator. In the first two academic years that the course has been offered as CE, the academic areas of our participating high-school teachers include English, Media Studies, Mathematics, Technology, Business, Science and even Computer Science.

2.2.3. Recruiting Eligible Students

In order for students to be eligible to participate in SMSU's College Now program they must be seniors in the upper fifty percent, juniors in the upper third, or sophomores in the upper ten percent of their respective classes. When recruiting high schools for the program, we learned that in many of the high schools that did offer computer programming courses, many of the students in those courses are freshmen and sophomores. We also learned that in many cases students identified as having an interest in computing did not meet the class rank requirement. Fortunately, high schools may offer courses with mixed enrollments of students taking the course for college credit and students who are not, provided at least half the class is enrolled for college credit. This allows freshmen and ineligible sophomores to take the course provided the high school can get enough eligible sophomores, juniors and seniors to enroll. In addition, students who do not meet the class-rank requirement may appeal to the institution offering the CE course. With the recommendation of the student's high school teacher, the student may be granted admission into the course for college credit.

Along with eligibility requirements, the primary challenge of student recruiting is attracting and recruiting a diverse class of students at each partnering high school. High-school counselors play a major role in matching students to courses. In hopes of getting counselors to look beyond white males when suggesting this course to students, Mobile CSP held online sessions for the teachers and counselors from high schools considering whether to participate in this program and shared resources and best practices of recruiting a diverse body of students.

2.2.4. Results - Year 1 Teacher and Student Recruiting

The following table summarizes the teacher recruitment results for the first year SMSU recruited teachers to teach Mobile CSP as CE. The Teachers Taught includes the MN Mobile CSP PD Facilitator.

Teachers Applied	Teachers Approved	Teachers Completed PD	Teachers Taught CE
8	8	6	7

Table 3: Year 1 Teacher Recruiting - SMSU

The following table summarizes the student recruiting results for the first year (2019-20) Mobile CSP was offered as a CE course for the participating MN schools. The total Mobile CSP CE course enrollment across all participating schools and percentages of females and URM students enrolled in the CE course is compared against the total school populations, female and URM student percentages. The school population data is from National Center for Education Statistics (NCES) for the 2017-18 school year, the most recent year available.

	Enrollment	% Female	%URM
Total (7 schools)	2,731	49%	16%
Total Mobile CSP CE Students	56	25%	16%

Table 4: Year 1 Student Recruiting - SMSU

3 Participating Secondary Schools

In this section two high school instructors from two of the thirteen participating secondary schools in Year 1 of the CS-through-CE project describe their experiences teaching Mobile CSP as a CE course. Both teachers had prior experience teaching Mobile CSP as an AP course and both serve as Mobile CSP PD Facilitators in the CS-through-CE project and lead the Mobile CSP summer professional development and year-round support. They describe their experiences offering Mobile CSP as a CE course at their school, perceived benefits of teaching Mobile CSP as a CE course, as well as benefits to enrolled students.

3.1 Hartford Trinity Magnet College Academy - James Veseskis

Hartford Trinity Magnet College Academy (HTMCA) is a magnet school in Hartford, CT for students in grades 6-12 with a total student population of 1,000 students. HTMCA has an Early College program with Trinity College, as well as CE partnerships with numerous colleges and universities. HTMCA also offers AP coursework in over 10 subject areas.

At HTMCA, I taught AP Mobile CSP since 2014. During the 2019-2020 school year I taught Mobile CSP in both AP and CE formats for the first time to the same class of students. I found offering the course as CE attracts a more diverse background of students to explore the discipline of computer science. After this first year if someone asked me which format - AP or CE - I prefer to teach the Mobile CSP course, I would choose the CE format.

AP courses are usually taken by students with prior experience or proficiency in various subject areas who are certain they are going to attend a selective post-secondary institution. An AP CSP course has to deal with two schedules, the school schedule and the College Board AP submission and test taking schedule. However, these two schedules are never really 100% in-line with each other. Snow days, other standardized test days, school events, etc. only allow for one thing when you miss class, cutting from the curriculum. For the student whose skills are ready for college this may not affect them. However, for the student still developing their college-readiness skills it can be very harmful and frustrating, and keeping up and succeeding in the course can be a challenge.

With the CE version I have one schedule and a little more luxury in not having to cut from the curriculum. Students don't have to work at as rigorous a pace and can take time to digest and master some of the concepts of computer science. Many students are taking a CS course for the first time and this extra time allows for developing students to process the information and learn the curriculum at a pace that matches their level.

After teaching AP CSP for many year, I have found the AP performance assessments can be a deterrent to students taking the course and they are not always the most accurate reflection of students knowledge and skills. Some students have difficulty on standardized exams and perform poorly on the multiple choice exams despite having performed well throughout the course. For others, knowing they will be required to take a high-stakes exam may turn them off to taking the computer science course. The AP Create performance task also has some limitations as a comprehensive measure of a student's skills. I have had students with strong programming skills and developing English skills who have fared worse on the AP Create Task than students with weaker programming skills yet better English and writing skill.

With the CE version of the course students have more ways to show they have mastered the concepts and skills presented in the curriculum. The CE course provides students more time to develop a complete programming project, and students can present their work in multiple formats, including a paper, poster, or video. With the CE version, students who may not perform well on standardized tests, but have developed the necessary skills to be successful in the CS field may still earn credit. In teaching the Mobile CSP class this past school year during COVID-19 there were a few students who performed poorly on the AP Create Task. However, after their AP Create Task was uploaded and finalized to the College Board, three of my students learned from their mistakes and redid their programming projects. I was able to guide these students whose skills were not quite there on test day to improve their skills, master the course materials, and ultimately get a passing grade to obtain CE credit. Five students did not pass the AP portion of the class in May but three were able to work hard in June to get credit for the course. I believe this more accurately reflects the learning process.

The final benefit I found is in regards to transferring credit. Students who stay in the CSCU system are guaranteed credit on meeting the successful completion of the course instead of maybe getting credit from a higher education institution. For students of limited means this is a game changer. It not only saves money but time they may need to work to afford a college education. Would you not be more likely to pursue a technology career if you leave

high school with up to 15 college credits in the field? It allows more students who may not have taken a computer science course in high school because it was AP. At least now they have been exposed to computer science.

3.2 Northeast Range School – Ryan Lindsay

Northeast Range School is a small rural school in Babbit, MN with a total population of approximately 150 students in grades 7-12. Our small school benefits from small class sizes and years of contact time to get to know your students. Those opportunities differ somewhat from the benefits of larger districts, which include more course offerings and specialization of staff. Several years ago, I convinced my administration and counselor to help make AP CSP happen, as we did not offer any CS courses. While the experience was positive for the students in general, the AP system was a bit of a burden for school administration and required significant effort to follow up on deadlines as well as convince students they could succeed.

AP courses are not a part of the system in our region. CE, however, is a known entity with courses regularly scheduled for juniors and seniors and existing partnerships with several local colleges. Students are familiar with the process, know there is opportunity for college credit when registering, and are not discouraged by the single high stakes test at the end that determines credit. Our counselor and administrators already have the setup and registration process as a part of the yearly routine. For all of these reasons Mobile CSP as a CE course naturally integrated into our system.

The prior experience teaching AP Mobile CSP familiarized me with the Mobile CSP curriculum. In teaching the CE version of the course for the first time, a couple benefits for my students became apparent. One is the extra time in May on the schedule. This allowed for flexibility to extend lessons when needed and adjust time for project work or showcasing student work. Second, the Create Task had a little less pressure to score well on an AP rubric, resulting in more student creativity and projects aligned to students' interest. A final app may not have contained a procedure with multiple parameters, but seeing a group of students meet enthusiastically and design for an after school club has its merits. It felt less like an assignment that determines college credit and more like unleashing students to use new skills to make their world better. With the final projects in AP, the teacher is not really allowed to be a part of the process, and the final project is basically scored as meets minimum requirements or does not meet. With the CE projects, students work through an iterative design process, with reviews at several stages. There is always a next step available in the development of the app even when submitted. I like to think the projects gave the students a glimpse into what they could do with more CS skills and encouraged generation of ideas to change how the world works.

A primary goal of Mobile CSP is to broaden participation among females and URM students. CE courses have entry requirements including class rank and GPA, which can be limiting on the participation goal. For several students, I completed an appeal process and the college was very receptive, especially in light of the goal of broadening participation. While several of those appeal students found success in the class, a couple just didn't make it. The issues were not specific to the CS course, and in fact played out across all their courses that year. Still, there is a little more drive in me to build skills to help bridge the gaps we have in our system.

In the CE partnership, I found significant benefits that come from all of us in different parts of our system having an opportunity to connect. While I had taught Mobile CSP as an AP course before and could make it work for my students, I also was aware of what I did not know, and that is a lot! The Mobile CSP PD was put on at SMSU with several of the university faculty actively involved. When the questions about logic gates moved beyond the simple diagrams I could muddle through, it was great to have the university faculty step in. I certainly had a better perspective of the curriculum in terms of what worked in a high school setting, and learned from the other teachers as well, but the experience was richer being able to connect with what is taught down the road for our future CS students. The CE model gives high school faculty an opportunity to connect with computer science at the college level, to establish a network for support and help, and to fully see our roles in offering opportunities for all of our students.

4 Conclusion

The goal of the CS-through-CE project is to both identify supports and barriers to implementing Mobile CSP as a CE course, and determine if a CE version can broaden participating in computing. This paper focuses on the experiences of the college and university faculty in offering Mobile CSP as a CE course and recruiting participating schools and teachers. For both MN and CT, participating faculty had to exercise strategies to recruit teachers and schools to address the minimum faculty requirements. In CT, offering the course in a dual AP/CE format ended up being a needed adjustment. In MN, challenges with student eligibility limited the pool of students eligible to participate in the program and realize potential benefits. As both CCC and SMSU recruit additional teachers/schools in subsequent years, each will continue to document challenges and barriers to school and student participation and identify strategies to overcome them.

Both participating secondary teachers in CT and MN sharing their experiences in this paper had prior experience teaching Mobile CSP as an AP course. They each describe benefits of teaching the course as a CE course, both for themselves and their students. For each, the flexibility of the curriculum and removal of a single high-stakes exam proved beneficial for their students. They also share individual experiences teaching Mobile CSP in a dual AP and CE format, and perceived benefits of partnering with a university through CE and participating in a year-round cohort of teachers.

As shown in the Year 1 enrollments from participating schools, much additional work is required to support participating schools in student recruitment to address and support our broadening participation in computing goals. Through the lessons from our first year, we have identified and provided additional supports and resources for Year 2 teachers and schools to support their recruiting of females and URM students. Across the United States, disparities in participation in AP and CE across race/ethnicity and income levels are not unique to CS. In this project, we will continue to seek strategies and solutions within the CE programs and partnering schools to overcome these disparities and successfully enroll and facilitate the success of diverse student populations in CS.

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References

[1] College Board. 2020. *AP Computer Science Principles Course.* https://apcentral.collegeboard.org/courses/ap-computer-science-principles/course

[2] R. Fall, B. Hoffman, J. Rosato, S. Freeman, and D. Kaiser. 2019. CS through CE: Broadening Participation and Building Pathways in Computer Science through Concurrent Enrollment. In *2019 Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT).* 1–2.

[3] John Fink. 2019. *Acceleration for All? Mapping Racial Equity in Access to AP and Dual Enrollment. The Mixed Methods Blog, CCRC.* https://ccrc.tc.columbia.edu/easyblog/mapping-racial-equity-ap-dual-enrollment.html

[4] National Center for Computer Science Education. 2020. *Mobile CSP.* http://www.mobile-csp.org

[5] National Alliance for Concurrent Enrollment Partnerships. 2017. *Fast Facts about Dual and Concurrent Enrollment.* http://www.nacep.org/research-policy/fast-facts

[6] What Works Clearing House of the Institute of Education Sciences in the U.S. Department of Education. 2017. *WWC Intervention Report: Dual Enrollment Programs.* Retrieved August 25, 2020 from https://ies.ed.gov/ncee/wwc/Docs/InterventionReports/wwc_dual_enrollment_022817.pdf