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RESPONSE TO PRIORITIES

Computer Science for English Learners (CSforEL): Increasing Participation and Achievement in Advanced Placement Computer Science Principles (AP CSP) for English Learners combines the content expertise and networks from Computer Science (CS) and English Learner (EL) instruction/teacher professional development (PD) to address **AP 1: Demonstrates a Rationale**, **AP 3: Field-Initiated Innovation STEM-CS**, and **CPP: Computer Science** by developing system, school, and teacher capacity to improve AP CSP access and success for students currently and formerly designated as ELs in high schools in San Diego County, California; New Mexico; and Arizona. As summarized in the table below, the target implementation areas have high numbers of underrepresented students.

Figure 1: CSforEL Demographics

	High school		SES	Race/Ethnicity				English Learners[1]	
State	**# of high schools**	**# of students**	**FRL**	**White**	**African American**	**Latinx**	**Asian**	**EL**	**Reclassified EL**
San Diego County[2,3]	181	155,106	51%	30%	4%	48%	10%	20%	16%
New Mexico[4]	184	91,897	66%	24%	2%	62%	1%	14%	Not reported
Arizona[2,3,4]	673	311,535	56%	39%	5%	45%	3%	7%	Not reported
TOTAL	**1,038**	**558,538**	**57%**	**34%**	**5%**	**49%**	**4%**	**10%**	

Expected outcomes include: (1) increased AP CSP enrollment for current and former ELs ("ever ELs"); (2) increased percentage of qualifying scores on the AP CSP exam for ever ELs; and (3) increased grades in AP CSP for ever ELs. Additionally, we hypothesize that we will see gains in ELs' scores on standardized English Language Arts (ELA) assessments.

[1] https://data1.cde.ca.gov/dataquest/
[2] https://nces.ed.gov/ccd/elsi/tableGenerator.aspx
[3] https://www.azed.gov/oelas/el-demographics-2016-2017
[4] https://www.azed.gov/oelas/el-demographics-2016-2017

INTRODUCTION

Over the last five years, the landscape for CS education has changed dramatically.[5] CS has shifted from a niche subject to the fastest growing subject in the US,[6] with thousands of new teachers placed in CS classrooms annually. Yet there is almost no pre-service teacher preparation focused on CS, and little, if any, funding provided to support in-service CS teachers, leaving many schools, districts and states scrambling to prepare and support a cadre of CS teachers to meet the demand.

Additionally, there is a profound equity gap in CS for our nation's students. Young women and students of color have long experienced low rates of participation in CS classes, which exacerbates diversity issues in the CS workforce and leaves many jobs across every sector unfilled. All students should have access to engaging and rigorous CS courses, but the reality is that students of color, those who are economically disadvantaged, and students from rural areas are less likely to attend a school that provides access to CS courses despite a growing number of local and state policies adopted in the past five years that call for the teaching of K-12 CS.

The opportunity gaps in CS for ELs are even more profound. For example, although ELs represent about 15% of New Mexico's public school population,[7] with some districts in the state serving as many 40% ELs, only 7% of students enrolled in AP courses are ELs,[8] and enrollment in AP CSP is even lower, with ELs representing 5% of students enrolled.[9] These gaps can be attributed to institutional barriers that constrict ELs' access to AP CSP as well as to inaccurate

[5] https://blogs.edweek.org/edweek/DigitalEducation/2018/10/states_adopting_k-12_computer_science_policy.html retrieved on 3/20/19.
[6] http://blogs.edweek.org/edweek/curriculum/2018/06/by_guest_blogger_sasha_jones.html retrieved on 3/20/19.
[7] https://www.migrationpolicy.org/sites/default/files/publications/EL-factsheet2018-NewMexico_Final.pdf
[8] New Mexico uses the term Limited English Proficient to designate English Learners. For purposes of this proposal, all data will be reported as English Learners.
[9] Data retrieved from New Mexico Department of Education via email correspondence on 3/29/19.

expectations about ELs' capabilities in CS, and limited teacher capacity to design CS learning environments that engage and challenge ELs.

(a) Significance

(1) The contribution of the proposed project to the increased knowledge or understanding of the educational problems, issues, or effective strategies

ELs are a heterogeneous group of students united by the dual challenge of learning English while learning academic content in English. Public schools are required to monitor EL progress on an annual basis, and do so by assessing academic achievement and English proficiency, reclassifying those who meet district and state guidelines as Fluent English Proficient (FEP). The EL subgroup is thus unique in that students are continuously entering and exiting EL classification, making it challenging to assess long-term outcomes for ELs, and to identify which districts and schools expand EL access and opportunity (Hopkins et al., 2013). Further, district and state reclassification policies vary, meaning that an EL in one district or state may not be considered an EL in another. For these reasons, our focal population includes both current and former ELs ("ever ELs") so that we can examine factors associated with EL success and struggle. If we excluded ever ELs, we would lose more successful students from our sample and bias our conclusions about factors associated with EL progress.

Critically, we recognize that both current and ever ELs may have reduced chances to take college preparatory coursework due to time in English Language Development (ELD) classes, or other non credit-bearing courses, while designated as ELs (Callahan, 2005). Although ELD coursework can shape a range of linguistic and academic outcomes (Hill et al., 2018), it can severely limit ELs' schedules and risks slowing progress toward high school graduation and entry into postsecondary education. As noted in the 2018 National Academies of Science Engineering, and Medicine (NASEM) study focused on transforming learning for ELs in STEM,

ELs are often systematically excluded from rigorous or advanced STEM coursework at the secondary level, often due to misconceptions that English proficiency must precede enrollment in content area classes (Callahan & Muller, 2013; Hopstock & Stevenson, 2003; Kanno & Cromley, 2015; Umansky et al., 2015; Umansky, 2016). This exclusion has had severe consequences on ELs' opportunities, and has been referred to as a form of linguistic apartheid (Combs, Iddings, & Moll, 2014). For instance, in the San Diego Unified School District, for the classes of 2005-06 through 2015-16, 63.5% of current and former ELs graduated on time, compared to 76.8% of other students. This rate for ever ELs is similar to the lowest rate observed by racial or ethnic group (63.1% for Hispanics) and by parental education level (64.4% for students whose parents have less than a high school diploma).

Research demonstrates that ELs fare better linguistically and academically, as well as with respect to high school graduation and college admission, when they have opportunities to engage with rigorous academic content, such as that found in advanced STEM courses, including AP CSP (NASEM, 2018). Such engagement, however, requires that teachers attend to disciplinary language and literacy practices (Lemke, 1990), understand that language and STEM/CS learning are reciprocal and interrelated endeavors (Stoddart et al., 2002), and engage ELs' funds of knowledge and linguistic practices to facilitate language and STEM/CS learning (Garcia, 2009; Gonzalez et al., 2005).

Although recognition of the fundamental and synergistic relationship among language, literacy, and STEM/CS learning is important for fostering access and equity for ELs in CS classes, few CS teachers are supported to design classroom environments in ways that foster such synergies. Nationwide, fewer than 30% of certified teachers have received more than one day of PD related to EL education. The result is, too often, sub-par approaches to teaching ELs, particularly in STEM/CS(Lee & Buxton, 2013). An additional challenge is that many schools

limit responsibility for EL instruction to English as a Second Language (ESL) teachers (Hopkins et al., 2015), such that CS teachers are denied opportunities to learn about EL instruction, and/or remain unmotivated to do so.

(2) The proposed project involves the development or demonstration of promising new strategies that build on, or are alternatives to, existing strategies

We propose an intervention designed to attract, retain and engage ever ELs in AP CSP via a professional development partnership of the **Computer Science Teachers Association** (CSTA), the **California Reading and Literature Project** (CRLP), and faculty members from the **UC San Diego's Education Studies Department** (EDS). CSforEL will integrate EL and CS instructional practices and leverage a strong CS network organized into multiple Professional Learning Communities (PLCs). PLCs are a collaborative approach to PD where small groups of educators meet regularly to explore new concepts, share expertise and insights from their teaching experiences, and engage in collective problem solving (Stoll et al., 2006).

CSTA is a membership organization that supports and promotes the teaching of CS by providing opportunities for K–12 teachers and students to successfully prepare themselves to teach and learn CS. Founded by the Association for Computing Machinery (ACM) in 2004, CSTA is a dynamic and vibrant professional association with a general membership of 30,000+ teachers and supporters that benefit from access to CS research, K-12 CS curriculum standards, and CS-focused PD and community building. Organized into a network of over 70 local chapters in 38 states and Puerto Rico, each regional or state CSTA chapter operates as a PLC. Chapters influence large numbers of CS teachers' mindsets and practices, and CSTA chapter leaders are generally K-12 CS teachers with 5+ years of experience. Regional CSTA's also forge strong partnerships with state departments of education, districts, universities, and corporate partners. In

the target regions, CSTA leaders come from state boards of education, local university education and CS departments, and K-12 classrooms.

We view CSTA chapters as the community that supports professional learning for CS teachers because there are not enough CS teachers in any one school to support site-based PLCs. We will work closely with a subset of CSTA PLCs to foster collegial relationships and build capacity for sustainable improvement (Hairon et al., 2015) via shared values and vision, collective responsibility, reflective professional inquiry, collaboration, and group and individual learning (Stoll et al., 2006). When learning in communities of practice, participants gradually absorb and are absorbed in a 'culture of practice', giving them exemplars, leading to shared meanings, a sense of belonging, and increased understanding (Wenger, 1998). Ni's (2011) study confirms that using collaboratively reflective inquiry within CS teachers can facilitate community learning and professional identity development.

CRLP has 30 years of experience successfully providing PD in reading, language development and literacy to K-12 content area teachers throughout California. CRLP is part of a network of discipline-based PD organizations sponsored by the University of California Office of the President, collectively known as California Subject Matter Projects. CRLP relies on the collective expertise of teacher-leaders who work alongside scholars and researchers to identify, develop, and test, in their own classrooms, the instructional practices and routines that drive PD content. CRLP's network provides high-quality reading/literacy and language instruction, with a special focus on meeting the needs of ELs, native speakers with low literacy, and students from economically disadvantaged communities.

CRLP PD translates the collective knowledge of teacher-leaders, scholars, and researchers into practical instructional routines that engage and challenge ELs as they develop language and literacy capacities through content specific courses. CRLP PD aims to deepen teachers'

understanding of their dual role as teachers of content *and* language. It is designed to help teachers analyze language and literacy demands of content topics/units, evaluate the needs of ELs, and plan effective instruction that proactively engages students. For this grant, CRLP's team will include teacher-leaders that create and facilitate PD designed to help secondary teachers analyze the language demands embedded in course content and plan instruction that effectively engages ELs while maintaining rigor.

CSTA and CRLP will work with two UCSD **Education Studies Department** faculty members. Dr. Beth Simon is a highly-recognized expert in computer science education with a focus on classroom practices that improve student learning; she will work with CRLP teacher-leaders and lead teacher PLCs in the integration of CS and EL standards, curricula, and practices. Dr. Simon's expertise as a College Board selected university developer of the AP CSP course, alongside eight years of experience supporting San Diego computing teacher leaders, makes her an ideal facilitator for this work. The project team also includes Dr. Megan Hopkins, an expert in systems reform and leadership for EL equity, who will collaborate with principal and counselor PLCs to build leadership capacity for ELs in CS, and to ensure ELs are placed in participating teachers' AP CSP courses.

(b) Quality of the Project Design

CSforEL brings together a team of computer science and English language development experts (program team) who will work with principals, counselors, and teachers via partnerships with districts and CSTA chapters in San Diego, Arizona, and New Mexico to (1) shift CS teachers' focus from a simplified view of language development within CS coursework to embedded use of language scaffolds to make accessible computational discourse; (2) increase awareness of CS courses, engagement in CS coursework, and belief in one's own ability to succeed in CS courses among ever EL students; (3) create a peer-led support structure for CS

teachers with EL students; (4) shift administrator and counselor mindsets around potential EL access/success in CS; and (5) develop local expertise and facilitation ability in support of EL students in CS classrooms. The program team, in collaboration with state departments or county offices of education, as well as CSTA chapters in San Diego, Arizona and New Mexico, will partner to recruit CSforEL participants across the three locales.

District and school level intervention: We will begin our work with participating districts by engaging in an equity audit process (Scott, 2001; Skrla et al., 2004), in which we collaborate with district leaders, as well as principals and counselors from a subset of schools to: (1) gather and analyze demographic, course taking, and performance data for ELs in CS; (2) observe in CS classrooms; interview CS teachers; and (3) talk to diverse groups of ELs who have taken CS courses, as well as those who have not. We will use these data to identify challenges principals and counselors face in placing ELs in CS courses, as well as the challenges teachers face in designing CS learning environments that ensure EL success, and to understand, from ELs' perspectives, what has or has not been helpful in facilitating CS course taking and engagement.

Principals and counselors from participating schools will engage in a sequence of professional development over the course of a full academic year. This professional development will leverage the results of the equity audit process to identify school and classroom practices that are hindering or generating success for ELs in CS. It will also provide a synthesis of big ideas their teachers will encounter in PD, a discussion about expectations and plans for teacher implementation of these practices, and analysis of current school structures/supports for teacher learning and leadership development. They will also share their course placement plans for ELs in CS, and make revisions based on peer feedback and discussion.

The cohort of administrators and counselors will also form a virtual PLC across all three locales to reflect on what practices are working and surface solutions across sites. This time will

provide school leaders with fresh perspectives on how other schools are implementing new policies and addressing shared challenges.

These programmatic efforts will contribute to mediators 2 and 4 above which are then tied to our program outcomes as described in our logic model (Appendix G).

Teacher focused intervention: Modeled on well-proven professional development programs for AP teachers that feature a combination of intensive summer PD[10], quarterly academic year follow ups and a closing summer experience, teachers will participate in a one week PD workshop held over the summer led by CRLP facilitators and CS education expert Beth Simon to analyze the CSP curriculum for language and literacy demands, develop the skills to evaluate the needs of their ever EL students in this context, and plan effective instruction based on leveraging SSTELLA model (Tolbert et al, 2014) for a computer science context. This model is "designed to prepare teachers to effectively integrate science, language, and literacy instruction for ELs by promoting productive use of science language in authentic contexts" (Tolbert et al, 2014). Based on an evidence-based elementary instructional model (ESTELL) that has fostered science learning and language acquisition for ELs, SSTELLA is designed around a 4-part model: **contextualizing science** around issues that engage ELs' funds of knowledge; **scientific sense-making**, **scientific discourse**, and **English language and literacy development**. SSTELLA's focus on embracing contextualized scientific activity as the doorway by which ELs can understand relationships between academic and everyday practices is especially applicable for AP CSP, which focuses on collaboration, communication, and the impact of computing on society, economy, and culture.

Participating teachers will reconvene throughout the year with facilitators to reflect on the efficacy of the strategies they employed and update as needed. These check points will allow

[10] Code.org impact study by Brown and Brown, 2019. NMSI impact studies including Brown and Choi, 2015.

for facilitators to respond to in the moment teacher needs and the general flow of the CSP course structure (for example a focus on writing support as key written portions of the AP CSP exam are completed in the course). In between these sessions, local CSTA chapters will support virtual and in person PLCs through bi-monthly one-hour facilitated reflections with the participating teachers. Project facilitators will join remotely to support teachers during these reflections, with a focus on honestly identifying what practices they have implemented in their classrooms and how those supported their students learning. We will create a reflective space for teachers to share challenges and learn from their peers as they engage in this new endeavor.

These programmatic efforts will lead to mediators 1, 2 and 3 above which are then tied to our program outcomes as described in our logic model (Appendix G).

Post-year reflection and knowledge sharing: To conclude the program, participating teachers will re-join the week-long summer session for a second time. This will provide additional peer support for the incoming cohort, allowing teachers to reflect on what worked from the past year and how to improve, and begin the CSTA teacher leadership identification and training to ensure local program sustainability. Similarly, prior year principals and counselors will join the incoming administrative cohort to share lessons learned and analyze the efficacy of the past year's program in partnership with participating teachers.

(1) Goals, objectives, and outcomes are clearly specified and measurable

CSforEL will accomplish three main goals; a fourth goal is exploratory, but will be included in all project activities. The objectives and measures that drive CSforEL are summarized below.

Figure 2: Goals, Objectives, Outcomes, and Measures

Objective	Measurement
Goal 1: Increase AP CSP enrollment for EL students, as measured by enrollment data from the College Board.	

1.1 Identify barriers to access for ELs / Ever ELs in CS in collaboration with principals and counselors at select schools in each district	Equity audit completed in each district of Cohort 1 by March 2020, and course placement plans developed for each district/school by June 2020, repeated annually for subsequent cohorts.
1.2 Assess EL-related PD needs of CS teachers and develop corresponding PD sequence that integrates language, literacy, and CS learning.	Workshop content is created into "toolkits" for chapter leaders to access.
1.3 EL CS course placement plans are created; plans are implemented in each school.	ELs and ever EL enrollment in CS courses rise per school, eventually approaching levels corresponding to their proportion in the school overall.
Goal 2: Increase the percentage of qualifying scores on the AP CSP exam for ever ELs, as measured by exam data from the College Board.	
2.1 Increase by X% of EL and Ever ELs enroll in AP CSP classes.	Official transcripts
2.2 Increase by X% of AP CSP students who are EL and Ever EL in the participating schools take the AP CSP exam.	AP CSP Exam enrollment, as compared to baseline year for each participating school
2.3 Increase by X% of AP CSP students who are EL and Ever EL in the participating schools earn a qualifying score on the exam.	AP CSP Exam
Goal 3: Increase grades in AP CSP.	
3.1 Increase by X% of AP CSP students who are EL and Ever EL in the participating schools earn a grade of C or better (unweighted) in the AP CSP course.	Official transcripts with statistical controls to account for differences in grading standards, e.g. ever EL's relative standing in the grade distribution for AP CSP classes in a school
Goal 4: Increase ELA proficiency in EL and ever EL populations.	
4.1 Increased performance on mandated ELA tests mandated by the state and/or district for students who are EL and Ever EL.	11th grade standardized test as required by each state's policy framework (SAT, Smarter Balanced, or other state assessment)

(2) Conceptual framework underlies project and is high quality

CSforEL's conceptual framework is described in the logic model (see Attachment G). Supporting the logic model is research on: (1) Professional Learning Communities (PLCs)

provide robust opportunities for professional learning and growth (see pg 5-6); (2) the SSTELLA - framework outlines a research- and practice-based approach to integrating language, literacy, and CS for secondary ELs; and (3) working with school leaders and/or counselors can shift school policy and practice to increase EL course access to AP CS courses. Further detail on this conceptual framework follows.

CSforEL extends frameworks on teaching effective science to ELs into the realm of CS. Specifically, we intend to build from the ESTELL (Effective Science Teaching for English Language Learners), which comes from two bodies of sociocultural research, the CREDE Five Standards for Effective Pedagogy and the integrated science, language and literacy instruction literature, and bring the framework's lessons into play within CS.

The ESTELL framework currently outlines a research- and practice-based approach to integrating language, literacy, and science for secondary ELs in science (Tolbert et al. 2014). At present, researchers describe five dimensions of ESTELL (all of which could also be tested, with adjustments, in CS classroom contexts). See Attachment I for an outline of how ESTELL could be paired with CS instruction: (1) **Contextualizing Science (& CS) Activity** -- framing learning experiences in meaningful and relevant socio-scientific and/or real world issues that elicit and leverage students' funds of knowledge; (2) **Developing Scientific (& CS) Understanding** -- making explicit connections to overarching core ideas, phenomena, or driving questions while engaging students in scientific/CS practices; (3) **Scientific (& CS) Discourse** -- actively engaging students in both written and oral as well as productive (speaking/writing/ coding) and receptive (listening) forms of scientific (& CS) discourse; and (4) **Language and Literacy Development in Science (& CS)** -- ensuring that ELs are well supported to participate fully in the aforementioned dimensions, e.g., through promoting students' use of their home languages (even if/when the teacher is not proficient in these languages), purposeful grouping and

cooperative structures, student-centered learning, facilitating student understanding and use of technical vocabulary, and providing appropriate language scaffolds. (See Lyon, Tolbert, Solis, Stoddart, & Bunch, 2016, for an elaborated description of each dimension.)

Although our main focus is CS teacher PD, we will also weave the ESTELL framework into the CS PD offerings for administrators to help them understand how to support the design of more engaging classrooms and pathways that prepare ELs to participate more fully in personal and civic problem-solving (Tolbert, 2016). Conceptual frames that directly address helping administrators learn how to best support ELs in computer science are practically nonexistent. Yet, research demonstrates that school leaders are linchpins in ensuring equity and access for ELs (Menken & Solorza, 2014). They can articulate a shared vision for EL success, and implement structures and allocate resources that align with that vision. Their data-informed decisions ensure that all ELs have access to rigorous content, and that their staff are well-equipped to work with ELs (NASEM, 2018). At the secondary level, staff include counselors who make an effort to know their ELs' strengths and needs so they can place them in courses that engage and challenge them (Hopkins, Martinez-Wenzl, et al., 2013). Yet, many leaders need more information to design schools to engage and challenge ELs, and few counselors receive any EL-related preparation. When they do engage in EL-related PD, however, research suggests that these learning opportunities facilitate positive shifts in school practices (NASEM, 2018). Such shifts are necessary for ensuring EL access to and opportunity in advanced coursework like AP CSP, and thus are also attended to in our PD model.

(3) Extent to which performance feedback and continuous improvement are integral to the design of the proposed project

In Year 1, program team members (designers and evaluators) will work closely together to build a formative feedback loop with educational leaders to collect and analyze data related to

EL access to CS in high school. Program team members will engage in the equity audit process (Sklra et al., 2004) to work alongside educational leaders to examine course-taking and achievement data for their system's current and ever ELs in CS, observe in CS classrooms, interview school leaders, counselors, and CS teachers, and conduct focus groups with current and ever ELs. These data will be used to identify challenges and opportunities in each district relevant to support in access and equity for ELs in CS, which will inform PD design and implementation efforts. After initial equity audits, evaluation team members (quantitative and qualitative) will inform continuous improvement processes via monthly informal and quarterly/annual formal updates with program teams and district/school leaders.

A key component of the equity audits and the evaluation feedback loop will be the incorporation of student data and student voice participation in focusing both program designers and administrators/teachers on actionable items they can tackle to increase recruitment, engagement and success of ever ELs in CS. For instance, an improvement loop might take the form of equity audits/student focus groups informing a potentially better recruitment strategy which is then field-tested at one school/district prior to course selections. If found useful, this strategy could then be both iterated on in the following year, but could also be worked into the larger PLC CSTA community with new recruitment strategy becoming part of the larger PD and the CSTA-wide initiative. Some interventions may be time-sensitive and may need to be enacted at particular times of the year (e.g. when a particular unit is taught, master schedules are built, AP CSP test prep begins, or CS teacher hiring occurs). Whatever the interventions, the equity audits and the evaluation data will feed back into the program design such that the data and analyses enter the realm of practice, prototyping, testing and retesting in the vein of Plan, Do, Study, Act (PDSA).

(c) Adequacy of Resources and Quality of the Management Plan

(1) Management plan will achieve the stated objectives on time and within budget with clearly defined responsibilities, timelines, and milestones

Given the scope and depth of CSforEL's plan to drastically improve access to CS for English Learners, the management plan below is a brief summary of the detailed plan that the partner organizations are developing.

Milestones	Respon-sibility	Pre Grant	Y1 19-20	Y2 20-21	Y3 21-22	Y4 22-23	Y5 23-24
Solidify communication mechanisms between partners, participating districts, and interested schools	PD, DE, CRM						
Design and manage an application process for interested schools	PD, PM						
Hire positions needed and meet with evaluator	PD, DE						
Further refine online course equipment / finalize content support tools	DE, PM						
Order course equipment (e.g. lab materials, graphing calculators, etc.)	PC						
In each community, launch tailored teacher, staff, parent, and community event for CSforEL announcement	CRM, PM						
Finalize participating schools	CRM, PM						
Confirm data-sharing agreements and execute contracts with participating schools	PM						
Agree upon annual participation and performance goals for teachers, students, and schools	DE, PM						
Support schools in identifying potential AP instructors	PM, PC						
Teachers attend summer institute	PM, PC						
Teachers attend AP 2-day workshop	PM, PC						
Student study sessions begin	PM, PC						
Student scores received; verification of schools/ participation	PM, PC						
Collect annual feedback from students, teachers, administrators, and staff to inform continuous improvement	DE, PM, PC						
Make semi-annual updates to program to reflect feedback from key stakeholders, partners, and participants	PC, DE, PM						
Develop complete evaluation and management plans to submit to DOE	PD, PM						
Finalize data analyses	PD, PM						
Disseminate learnings to amplify impact on EL students	PD, DE						

(2) Qualifications of key personnel

CSTA is currently managing an active portfolio of over $3.5M in multi-year grants from a variety of sources and raised $2.4M in FY2018 alone from all sources. Four grantors have funded CSTA annually for programmatic and operating support and recently signed long-term commitments; these and several others also regularly sponsor CSTA's annual conference. CSTA has an annual audit and all have been clean, showing strong fiscal controls and systems. CSTA contracts with an accounting service vendor for its monthly accounting and augments and supervises this vendor's activities with internal operations staff including an Administrative Assistant, a Chief Operating Officer and the Program Director. This vendor tracks and manages accounting compliance requirements of federal grant programs and currently manages requirements for a number of active federal grants. UC San Diego, like CSTA, also has extensive control tracker protocols with oversight from the local office as well as the campus budget office and contracts and grants office with capacity to serve high volumes (UC San Diego received approximately $1B in outside grant funds in 2018-19) of external and internal budgeting.

Figure 3 summarizes the key personnel roles for CSforEL; a summary of qualifications follow. Detailed resumes/curriculum vitaes are found in Attachment B.

Figure 3: CSforEL Key Personnel and Roles

Name	Activities
Jake Baskin, CSTA (Project Director)	Overall leadership of CSforEL including convening the project team and ensuring strong grant management
CSTA Chapters	Recruit teachers, organize and host meetings, liaise with districts; assist in recruiting principals/counselors
Beth Simon, Deborah Costa Hernandez, and CRLP staff/facilitators	Design, develop, and deliver CS for EL teacher resources
Megan Hopkins	Engage district leaders, principals and counselors in an equity audit process, and design, develop, and deliver PD for principals and counselors

Jake Baskin (Project Director) is the Executive Director of CSTA, the world's leading association for K-12 CS teachers. He is a former high school CS teacher, department chair, and PD provider with the Chicago Public Schools. Prior to joining CSTA, Jake was Director of State Government Affairs for Code.org, where he worked with educators and policymakers to advocate for policies that expand access to high-quality CS education with state departments of education and governor's offices across the country. A Code.org, Jake helped build a nationwide network of more than 40 regional partners that worked with over 100 districts in the U.S. to implement comprehensive CS programs and provide PD for teachers.

Dr. Beth Simon is a Teaching Professor at the University of California, San Diego. Her research focuses on computing education, particularly introductory programming, pedagogical practices for improving student outcomes, and K-12 CS teacher preparation and PD. Dr. Simon studies the reading, writing, and debugging sub-skills supportive to teaching programming and is exploring adaptive learning models to create personalized online learning experiences for programming. She is the higher education advisor to San Diego's CSTA chapter, and chaired the California (CA) State Standards Committee that created the first-ever K12 CS Standards for CA.

Dr. Megan Hopkins is an Assistant Professor in the Department of Education Studies at UC San Diego. Motivated by her experience as a bilingual teacher in Arizona, Dr. Hopkins' research investigates how schools and school systems are organized for equity, with a particular focus on fostering equity-driven change for ELs in STEM. She has expertise in school leadership and teacher PD, and extensive experience in mixed methods collaborative research. Megan is currently co-PI of a National Professional Development project focused on fostering teacher learning for ELs in elementary science, and recently served on the NASEM review panel for the report, *English Learners in STEM Subjects*.

Dr. **Deborah Costa Hernandez** is the Statewide Executive Director of the California Reading and Literature Project (CRLP) where she oversees the development and implementation of all PD programs and directs the operations of eleven regional sites housed at public and private university campuses throughout California. Dr. Costa Hernandez has leadership experience at the school and district levels in socio-economically and culturally diverse communities, and is a leadership coach focusing on the development of instructional systems, policies, and structures that support effective instructional programming for ELs.

(3) Continued support after the grant period

In order to ensure the sustainability of the program beyond the life of this grant, and to extend the reach of the intervention beyond the target sites, we will develop reusable tools and develop local capacity to lead professional development. The program team will come together annually beginning in the summer of year 2 of the grant to develop at least two local facilitators per CSTA chapter. This one day training summit will be tied to the CSTA annual conference, providing opportunities for the facilitators and program team to better engage with the larger computer science education community. These facilitators will work with CRLP to support the programs in years 3 and 4, with the goal of being able to continue the programs beyond the grants lifecycle. We chose to build around this annual event because of the strong success of past summits to develop local leadership held in partnership with Google. At the 2018 CSTA Chapter Leadership Summit, 98% of attendees felt excited about their upcoming program year and 95% felt confident that they would be successful at leading their chapter over the next year. Given this high success rate, it's a natural fit for developing local leadership for this program. The team will also create an CS equity audit tool for broader dissemination to leaders and counselors.

(d) Quality of the Project Evaluation

Dr. Susan Yonezawa, is Associate Director in the Center for Research in Educational Equity, Assessment and Teaching Excellence (CREATE) at UC San Diego and a Project Scientist. She conducts design-based research on student voice, youth engagement, and equity-minded secondary school reforms. Dr. Yonezawa has published in numerous journals including the *American Educational Research Journal, Educational Researcher, Journal of Educational Change, Teachers College Record,* and *Urban Education*. She is currently a PI of a $2M, three-year Bill and Melinda Gates Foundation continuous improvement project building networks of mathematics teachers to support low-income youth K-12, a nearly $1M National Science Foundation grant studying district implementation of CS pathways at the secondary level.

Dr. Julian Betts is a Professor and former Chair of Economics at UC San Diego. As Executive Director of the San Diego Education Research Alliance (sandera.ucsd.edu), he has devoted 19 years to evaluating many interventions designed to improve the education of disadvantaged groups, recently focusing on ELs. With Laura Hill (PPIC), Dr. Betts is co-PI of a U.S. Department of Education grant to study the causal impact of EL reclassification in the two largest school districts in California (Los Angeles and San Diego). He is the co-PI of a W.T. Grant mixed-method study that examines the correlates of academic and linguistic growth of Long Term and Late Arriving ELs in secondary schools. He is also PI of a $2.5 million Continuous Improvement grant funded by the U.S. Department of Education. Dr. Betts has served on numerous technical and grant review panels for the U.S. Department of Education.

(1) The extent to which well-implemented methods of evaluation will produce evidence of project effectiveness that meet the What Works Clearinghouse (WWC) standards with or without reservations as described in the WWC handbook

The need for a rigorous evaluation that examines outcomes, fidelity of implementation and

the role of moderators and mediators calls for a mixed-method approach. Quantitatively, we propose a quasi-experimental approach that meets the What Works Clearinghouse standards with reservations. Qualitatively, we propose a combination of observations, interviews, and surveys to gauge fidelity of program implementation, and replicability of program components. We also include student voice tools to capture ever ELs' perspectives about their in-class CS experiences.

Participating high schools will not be randomly chosen, which necessitates selecting a valid comparison group. Our quasi-experimental approach combines two methods: a comparative interrupted time series analysis (CITS, also known as difference-in-difference) with propensity score matching (Rosenbaum & Rubin, 1983). Control high schools will, like the treatment high schools, offer at least one AP CSP course in 2019-20, the project's planning year.

We will recruit roughly half of the schools offering AP CSP within each district to participate, while using the other half as control schools. We will use propensity score matching to match ever ELs at treatment schools with ever ELs at control schools within the same district. Using pre-program longitudinal student data, we will model the propensity to enroll in AP CSP as a function of middle school test scores and grades, and demographics including EL status, home language, race/ethnicity and socioeconomic status. We will then match each ever EL at the treatment schools with ever ELs at the control schools who have similar predicted propensities to take AP CSP. We will then perform CITS analyses that test for a break from trend in the outcomes described below, after controlling for baseline student and school characteristics such as the demographics of the student body. We will cluster standard errors at the school level. Outcomes include the percentage of ever ELs enrolling in AP CSP, passing the class, student's percentile rank within the class based on grades, percentage taking the AP exam, the mean AP score and the percentages scoring a 3 or better and 4 or better on the AP exam. Because redesigning AP CSP classes to engage ever-EL students could improve English language skill, a

secondary outcome is performance of ever-EL students on statewide English Language Arts exams in grade 11.

We anticipate 26 high schools will be treated, and 26 high schools will be in the control group. Power analyses were conducted using PowerUp! (Dong & Maynard, 2013). Table Quant-1 in Attachment I shows the assumptions made. We obtain a Minimum Detectable Effect Size (MDES) in year 1 of implementation of 0.189. Depending on the number of high schools that enter the program in year 1 and year 2, the MDES for the two-year cumulative impact ranges between 0.189 and 0.20. Further calculations and details appear in the Attachment I.

(2) Extent to which evaluation will provide guidance about effective strategies suitable for replication or testing in other settings

We define replication as going beyond increasing numbers of districts, schools or CS teachers who adopt EL-engaging practices, to include the degree to which districts, schools, and CS teachers gain deeper "knowledge and authority" (Coburn, 2003). Thus, this evaluation examines the degree to which the PD components deepen teachers' and administrators' understanding about ever-EL students' engagement in CS courses, and increases educators' skills and confidence. We aim to understand how the program components shift educators' beliefs and practices, and how the program might permeate CSTA chapter(s). We also seek EL students' self-assessment of engagement with CS.

The qualitative analysis will use surveys, observations, interviews, and focus groups to evaluate iteratively three components: 1) the program's work with administrators via equity audits; 2) the program's teacher PD; and 3) the program's impact on ELs' access to AP CSP and experiences in the AP CSP class. MAXQDA will be used for management and analysis. Coding will combine a pre-established coding dictionary and grounded theory coding to assist with the identification of themes/patterns both suspected and emergent. The combination of qualitative

tools and study participants (teachers, admin, students) will allow for triangulation of findings.

a) Teacher Surveys: Pre-and-post surveys will measure individual components of the PD and each component's relationship to: teachers' knowledge when engaging EL students in CS, teachers' belief systems about ever ELs, teachers' knowledge of/comfort with strategies as related to ELs in CS, and teachers' program uptake. Post-surveys will be conducted with teachers following summer PDs and again at the end of each academic year (spring 2020 to spring 2023) for all teachers who ever participated in the program and who taught AP CSP during the year.

b) PD and Class Observations: Observations will be conducted yearly of 1) summer PD sessions and 2) AP CSP classrooms. PD observations will provide formative feedback to designers to improve content/delivery. Observations will examine providers' roles, interactions, and teachers' questions and engagement. PD observations will also examine the program curriculum's specificity and delivery and how components assist (or not) teachers' learning. Class observations will gauge teachers' fidelity of implementation and students' in-class response. Class observations will prioritize schools and/or classes with larger numbers of ever ELs. Class observations will capture in-class dynamics, and attend to "focal students": pre-identified ever ELs to maximize equity focus. Observation tools will be calibrated teamwide.

c) Administrator interviews: District and school administrators who participate in equity audits (and potentially summer PD) will be interviewed yearly to understand potential mindset shifts and changes in district and school contexts regarding ELs within CS. CSTA leaders will be interviewed annually to document efforts to scale up the PD in chapters in Years 3 and 4.

d) Student Focus Groups: Students provide a critical equity lens through which programs can be evaluated (Yonezawa & Jones, 2007). We will gather student perspectives annually through focus groups with ever ELs from each school. The focus groups will capture students' perspectives and to generate actionable suggestions to improve their experience in AP CSP (and

inform course recruitment). Students will include those enrolled in AP CSP, as well as ever ELs who may have considered taking AP CSP, but then chose not to take the course.

(3) Extent to which methods of evaluation will provide valid and reliable performance data on relevant outcomes

The team will measure all primary outcomes using transcripts for enrollment and grades in AP CSP and College Board data for outcomes on the AP test (whether a student takes the test and the score). The secondary goal of enhancing ELA skills will be measured by each state's ELA test often given in 11th, which we will convert into district-wide Z-scores. All but one of the outcomes are objective numerical outcomes with established validity. The exception is grades in AP CSP, due to possible variation in grading standards. Thus, we will convert grades to percentile rank in the class.

All analyses, quantitative and qualitative, will be conducted with iterative improvement in mind such that quarterly and annual reports including actionable recommendations will be provided to program developers to promote continuous improvement. In addition, the program developers and evaluators will communicate regularly: via ongoing email/telephone, monthly zoom progress updates, and yearly in-person meetups to ensure that the form and features of the evaluation reports are maximally useful. We will also meet up when jointly attending PD events.

(4) Extent to which evaluation plan clearly articulates key project components, mediators, and outcomes as well as measurable threshold for acceptable implementation

Our measurable threshold for acceptable implementation is that 33% or more of AP CSP teachers in a given year at a treatment school will be participants. The data and analyses above (eval. sections 1-3) will help examine the project components, mediators, and outcomes per the logic model in Attachment G and Table Quant-3. where italicized items indicate data sources.

The moderator analysis will use the bootstrap method of Preacher and Hayes (2008), which

Zhao et al. (2010) show to have good statistical properties, and which allows for simultaneous consideration of multiple moderator variables. In addition to program-focused mediators laid out in the logic model and measured as described in Table QUANT-3 in Attachment I, we will include a measure of the proportion of a school's teachers teaching AP CSP in a given year who have had at least one experience teaching it in a prior year. The rationale is that CSP teachers will gain more from the PD if they have already had experience teaching CSP. The quantitative analysis will also account for several key moderating variables. These include student's home language, which has been shown in past work to predict strength of numerous academic outcomes, and student's baseline ELA performance at the end of grade 8.

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