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RESPONSE TO PRIORITIES

Over the 5-year span of this **Early Phase** project that addresses **Absolute Priorities 1 (Demonstrates Rationale) and 3 (Field-Initiated Innovation Focusing on STEM-CS) plus the Computer Science Competitive Preference Priority**, Lone Star Advanced Placement (AP) Computer Science Principles (CSP) will expand the teacher supports in NMSI's proven College Readiness Program (CRP) from a one academic year model to a comprehensive three academic year model, complemented by CRP's standard school and student supports. Additionally, Lone Star AP CSP is partnering with NCWIT's Counselors for Computing program to provide greater support to school counselors as they identify/recruit students for AP CSP courses. All of **Lone Star AP CSP's components are designed to specifically increase access and qualifying scores on the AP Computer Science Principles (AP CSP) exam in 50 schools across Texas by 2023.** Lone Star AP CSP includes the National Math and Science Initiative (NMSI), 50 Texas-based schools, four evidence-based CS curriculum and professional development providers (The Beauty and Joy of Computing, Mobile CSP, UTeach, and NCWIT), and external evaluator American Institutes for Research (AIR). **Lone Star AP CSP represents a significant step forward in supporting AP CSP for all students, with specific goals to increase access and academic outcomes for girls and underrepresented minorities in Computer Science.**

INTRODUCTION

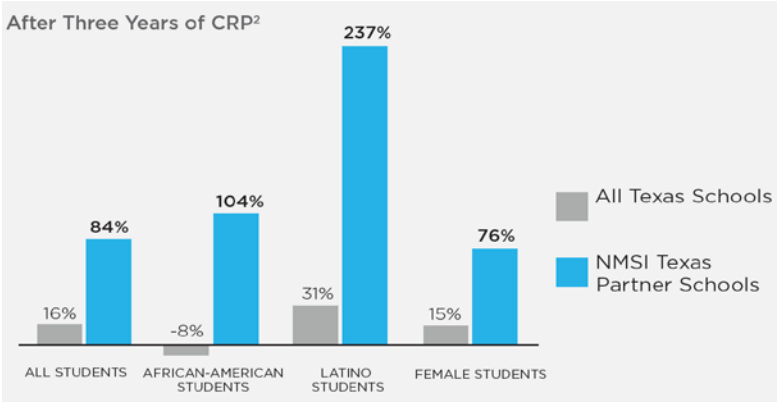
For nearly 30 years, Texas teachers and students have benefitted from training, support and resources provided by the National Math and Science Initiative (NMSI), formerly known as AP Strategies. Beginning with only nine high schools in 1991, NMSI has since partnered with 185

schools in more than 51 school districts in Texas with support from local, federal and philanthropic organizations.

In 2014, the Texas State Board of Education mandated that Computer Science (CS) be offered to every student in the state's public high schools; yet, less than 3% of Texas high school graduates have taken a computer science course due to a critical shortage of CS teachers across Texas.[1] **Lone Star AP CSP has been designed to address this teacher shortage, thus creating opportunity for increased access and achievement in CS across Texas.**

NMSI works with districts across Texas on AP content ranging from AP English to AP Calculus and beyond. In 2017-18, NMSI worked with 31 Texas districts, but only 19 of them offered AP CSP. Supporting those 19 districts, NMSI trained 21 AP CSP teachers, resulting in a 330% Year 1 year-over-year enrollment increase, and a 327% increase in year-over-year qualifying scores. While this work is not commensurate with the vast needs across the state of Texas, NMSI's impact on AP access and qualifying scores in general (see Figure 1), point to the promising results, particularly for underrepresented students that can be realized over the grant period.

Figure 1. Percentage Increase in AP Qualifying Scores in Math, Science and English at NMSI Partner Schools [1]



(a) Significance

In 2017, there were record increases in the number of female and minority students taking an

AP Computer Science exam (AP Computer Science A [CSA] and AP CSP), yet minority students still account for only 20% of those taking AP CS exams, and female students make up about 27% (College Board, 2017). Despite increases in participation in recent years, there is still a long way to go to reach equitable access and outcomes for girls and underrepresented minorities, including tackling many misconceptions about who should take CS and why all students need it. Even when schools offer CS classes, enrollment in the courses often does not match the demographics of the school, leaving many students out of this crucial discipline.

Though the number of CS students has increased exponentially, teacher recruitment and training has not followed the same pattern. In 2016, the U.S. Department of Education reported that fewer than 600 CS teachers were certified through state-approved certification pathways (U.S. Department of Education, 2016). Through the combination of professional development and state certification pathways, new CS teachers have been prepared to teach, but may eventually leave the CS discipline due to lack of support. In contrast, research affirms that supportive teacher communities positively affect teacher retention (Inman and Marlow, 2004).

National Math and Science Initiative. NMSI's College Readiness Program (CRP) is raising the academic bar in public schools by demonstrating that more students, especially underrepresented students, can master rigorous AP coursework, with a particular emphasis on math and science, including CS, by transforming partner schools into centers of college readiness. NMSI's programs are well-documented to increase academic intensity and access to

rigorous courses, improve student achievement, and decrease the **college readiness gap,**[1] especially among underrepresented students.

CRP has been studied across several settings, and a growing body of evidence indicates that CRP not only increases the effectiveness of teachers as measured by raising the probability that students will take and earn qualifying scores on AP exams, hence increasing their achievement and college readiness, but also has significant and longer term positive postsecondary and economic impacts. The program's consistent elements produce reliably successful and sustained outcomes across settings, states, subject areas, teachers, and students, including in schools with students traditionally underrepresented in AP courses.

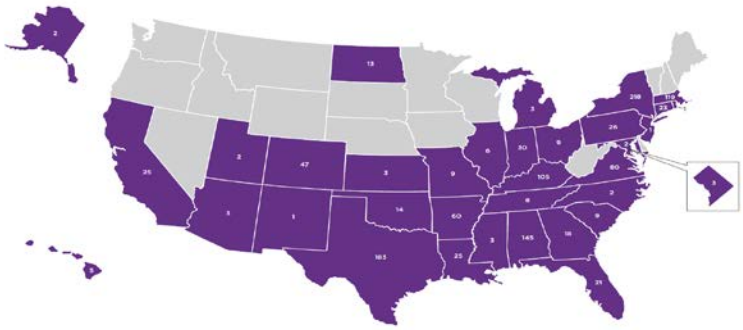
From the implementation of CRP, NMSI consistently observes that schools and districts do not utilize coherent, evidence-based curricular resources and professional development supports for teachers, administrators, and counselors, leading to low numbers of students taking CS courses. Therefore, NMSI proposes to partner with 50 schools in Texas to offer a three-year teacher training cycle for AP CSP teachers, combined with high-quality AP CSP curriculum, and counselor supports to aid in AP CSP student recruitment, all designed to increase the numbers of students, specifically underrepresented students (females, African-American, and Latinx students), participating and succeeding in AP CSP.

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

[1] For purposes of this application, the college readiness gap is measured by the number of high-need students who take and earn qualifying scores on AP exams because the AP exam is one of the few nationally accepted proxies for college readiness.

As a national entity with experience in scaling its program to impact 1.5+ million students, 50,000+ teachers, 1,000+ high schools, and 45 universities, Lone Star AP CSP's contribution to the field is both broad and deep. (See Appendix I-1 for a detailed footprint map and details within Texas.)

Figure 2: CRP Historic Footprint: 1,224 Schools Across 34 States and the District of Columbia



NMSI's model works in a variety of settings—urban and rural, disadvantaged and affluent, military connected or not, from coast to coast—and for a variety of students. For example, the U.S. average 1-year increase in qualifying scores in math, science, and English among African-American and Hispanic students is 9.7%; at NMSI partner schools, it is 81%. Over 3 years, the average national increase for minorities is 48%; among NMSI partner schools, it is 179%. Similarly, among females, the first-year increase in qualifying scores in math, science, and English is 6.5% nationally and 68% for NMSI partner schools. Over 3 years, the average national increase for females is 22% nationally; among NMSI partner schools, it is 122% (College Board, 2013).

Second, Lone Star AP CSP **dares to address the CS crisis in high schools with large populations of traditionally underrepresented students, including female, low-income, and students of color.** Lone Star AP CSP aspires to support CS teachers for three consecutive years to hone their instructional strategies and pedagogy so that both their and their students' interest

and self-efficacy in CS and related courses increases, as evidence suggests PD is most impactful when sustained and intensive (Corcoran, McVay, & Riordan, 2003; Darling-Hammond, L, 2009; Supovitz, J. & Turner, H., 2000) and ultimately, increases both enrollment and academic performance in AP CSP courses in each of the participating high schools. Additionally, NMSI will support schools in selecting between, and implementing well, the three research-based curriculum and professional development partners (The Beauty and Joy of Computing, Mobile CSP, UTeach, and NCWIT) in order to further support student learning in AP CSP.

Lastly, Lone Star AP CSP will identify mechanisms and structures for inclusive strategic planning and intra-school partnership, allowing for a comprehensive view of potential barriers and needed supports. For example, participating schools may rethink their culture by adopting open enrollment and recruiting more students, including traditionally underrepresented students, into AP courses, thereby allowing many more students to succeed at that level.

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

Lone Star AP CSP we will design, implement, and evaluate a three consecutive year teacher professional develop and support model to reach AP CSP teachers in 50 schools across Texas; this project represents the first time that the NMSI CRP model (described in the Project Design section) has focused for three consecutive years on one key component, while keeping the other two model components constant. We propose this project design because it will create a promising new strategy to deepen our proven CRP approach, providing specific supports for teachers to increase the number of underrepresented students in computer science.

These strategies include 1) defining and deploying a three-year training arc for AP CSP teachers participating in CRP, 2) leveraging existing relationships, and building new relationships, with schools to support access to and adoption of this model, and 3) building the capacity of school counselors in schools to support student recruitment into AP CSP. Appendix I-2 summarizes the barriers we have experienced with our traditional CRP program and CS in particular, and the strategies we will deploy to ensure equitable access.

Figure 3: Three-Year Teacher Support Arc

Three Year Program	
District Recruitment and Selection	
Identify District Needs	
Year 1	Onboarding and Teacher Registration
	Summer Professional Development
	Sustained Implementations Support (Teachers, Guidance Counselors, Administrators and Students)
Year 2	Data Analysis, Goal Setting and Teacher Registration
	Summer Professional Development
	Sustained Implementations Support (Teachers, Guidance Counselors, Administrators and Students)
Year 3	Data Analysis, Goal Setting, Teacher Registration and Sustainability Planning
	Summer Professional Development
	Sustained Implementations Support (Teachers, Guidance Counselors, Administrators and Students)
Sustainability and Advocacy	

(b) Quality of the Project Design

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

After a year 1 planning period, Lone Star AP CSP partners will ensure that the 50 participating high schools' CS teachers engage in a three-year professional development arc (see Appendix I-3 for details), plus school and student supports to increase enrollment and achievement in AP CSP, and then AIR will complete the evaluation analyses in year 5. Lone Star AP CSP partners commit to the following objectives and outcomes, as summarized in Figure 4:

Figure 4: Objectives and Outcomes by Project Year

2019-20: Planning	**Objectives:** (1) Lone Star AP CSP partners solidify roles, operating mechanisms, timelines, and deliverables. (2) Finalize the 3-year teacher professional development arc. (3) Define the school counselor supports. (4) Establish the potential participating district pool; select participating schools **Outcomes:** (1) Lone Star AP CSP's supports are well-defined and ready for implementation. (2) Treatment schools are ready to participate.
2020-21: Training Year One	**Objectives:** (1) Teachers and school counselors from 50 schools participate in Summer Institute, in a specific AP CSP breakout. (2) Ongoing support is offered to both populations, resulting in strong AP CSP enrollment and instruction. **Outcomes:** (1) New AP CSP courses are offered in 50 schools. (2) Teachers report higher confidence levels in CS instruction.
2021-22: Training Year Two	**Objectives:** (1) Teachers and school counselors from 50 schools participate in Summer Institute, in a specific AP CSP breakout. (2) Ongoing support is offered to both populations, resulting in strong AP CSP enrollment and instruction. **Outcomes**: (1) We expect to see (a) increased course offerings and enrollment with demographics matching the school to ensure participation of underrepresented students; and (b) increased numbers of underrepresented students (females, African-American, and Latinx students) who can see themselves in future CS courses or careers. (2) Teachers report higher confidence levels in CS instruction.
2022-23: Training Year Three	**Objectives:** (1) Teachers and school counselors from 50 schools participate in Summer Institute, in a specific AP CSP breakout. (2) Ongoing support is offered to both populations, resulting in strong AP CSP enrollment and instruction. **Outcomes**: (1) We expect to see (a) increased course offerings and enrollment with demographics matching the school to ensure participation of underrepresented students; and (b) increased numbers of underrepresented students (females, African-American, and Latinx students) who can see themselves in future CS courses or careers. (2) Teachers report higher confidence levels in CS instruction.

(2) Conceptual framework underlies project and is high quality

In this section, we provide evidence that the rationale for this project is 1) informed by evaluation findings that **CRP itself meets or exceeds the "moderate" evidence requirement** demonstrating that the strategy will improve student outcomes; 2) informed by **research supporting the high quality AP CSP curricular choices presented to schools** demonstrating that the curricular piece of the strategy will also improve student outcomes for all students (including girls and underrepresented minorities); and 3) informed by **research that supports a multi-year professional development sequence for teachers improves their instructional**

repertoire and capacity for curriculum adaptation and development.

CRP Effectiveness: A substantial body of evidence indicates that CRP **not only increases the probability that students will take and earn qualifying scores on AP exams, hence enhancing their achievements and increasing their college readiness** (Brown R.C. 2015; Holtzman 2010), **but also has significant and longer-term positive postsecondary and economic impacts** (Jackson 2007, 2010, 2014; Sherman 2014, 2015). The program's consistent elements produce reliably successful and sustained outcomes across settings, states, subject areas, and students, including those students traditionally underrepresented in STEM. The studies upon which we focus below represent an array of well-designed, well-implemented research that presents evidence of CRP's effectiveness, from impact on immediate outcomes related to AP to postsecondary results to longer-term, lifelong impacts. Individually, we propose that each study meets the What Works Clearinghouse (WWC) standards with reservations. **As a collective group, we purport that CRP is supported by strong evidence of effectiveness that exceeds the threshold required for early-stage EIR grants.**

Curriculum Choices are Research-based: With more than a decade of research on broadening participation for underrepresented students in CS, each of the AP CSP curriculum and professional development providers is research-based, as summarized below. Programs also have publicly available evaluations that demonstrate impact of their approach and have been selected for their scale and ability to offer national professional development. Each program is housed at or affiliated with a university, allowing for continuous improvement of its model and updates to curricular materials as the research evolves, ensuring that teachers and their students benefit from

the increasing body of knowledge about CS education, specifically how to support underrepresented groups in CS.

Figure 5. Lone Star AP CSP Program Providers, Evidence, and Populations Served

Program	Evidence and Population Served
The Beauty and Joy of Computing (BJC)	BJC explores the 7 Big Ideas of CS principles, with a focus on rigorous CS, creative programming in Snap!, and critical reflection on the impacts of computing (Garcia and Barnes, 2015). From 2012 to 2015, 133 teachers joined BJC professional development, improving teachers' confidence in teaching computing with equitable, inquiry-based practices, and resulting in 89 BJC CSP courses taught in high schools (Price et al., 2016). In New York City, BJC has reached 3,766 students with nearly half female, one third Hispanic/Latinx, and one third African American, with students from all demographic groups showing similar gains in content, confidence, interest, belonging, and identity (Jume and Klein, 2019).
Mobile CS Principles (CSP)	Mobile CSP introduces students to the breadth of CS through the lens of mobile computing. The curriculum utilizes MIT App Inventor to build socially useful mobile apps, providing a low-floor, high-ceiling, and wide-walls approach to engage all students in creating apps that solve community problems. Since 2013, Mobile CSP has trained more than 600 teachers, now reaching 9,000 students annually across the United States. Both teachers and students report increased interest and confidence in CS, and students show a greater commitment to pursuing CS education after the course (Rosato et al., 2017; Hoffman et al., 2019).
NCWIT's Counselors for Computing	NCWIT Counselors for Computing (C4C) provides school counselors with information and resources they can use to support ALL students as they explore CS education and careers. Counselors are influencers and collaborators across the K-12 ecosystem, working with teachers, administrators and students. They counsel and encourage students in their education and career aspirations, advise on course selections, and expose students to occupations through career fairs and internships. If young women are to get the exposure and encouragement they need to pursue computing, it is essential that counselors get up to speed on the knowledge and resources necessary to guide effectively. In 2017, C4C staff and counselor consultants produced or presented at 52 events in 18 states, reaching 4,477 counselors for a potential reach to 1,119,250 girls. More than 95 percent of C4C participants surveyed report having a better understanding of computing and greater confidence to guide students toward computing education and careers. NCWIT will be consulting with NMSI.
UTeach Computer Science Principles	UTeach CS Principles was created in 2015 as part of an NSF grant to broaden participation in CS through the AP CS Principles course. Since then, more than 600 teachers have been trained to teach the course, and 77% of students using the curriculum have earned a qualifying AP CSP exam score, compared with 74% nationally. UTeach CS Principles was developed as a project-based learning (PBL) course because of PBL's association with higher student performance, motivation, and interest (Baran and Maskan, 2010; Han et al., 2015; and Kaldi et al., 2011). The educative and supportive curriculum includes planning guides, detailed lesson plans, an online student primer, and an AP-style test bank. After teaching using the UTeach CSP curriculum, 80–92% of teachers rated each of these components as either "very useful" or "extremely useful" (Burd, 2017).

Deep and Sustained Teacher Supports Improve Outcomes: In a review of literature on how teacher professional development affects student achievement, Yoon, Duncan, Lee, Scarloss, and

Shapley (2007) surfaced that professional development must be sustained and intensive to have an effect. Fewer than 14 hours showed no effects on student learning. In addition, the professional development arc responds to teachers' changing needs and levels of expertise over time. The underlying premise of designing with teachers' learning progressions in mind is the supposition that teachers progress on a pathway of development (Friedrichsen & Barry; 2015).

We believe curriculum can serve the purpose both of providing students with powerful and rigorous learning experiences, and developing teachers' instructional repertoire and capacity for curriculum adaptation and development. We utilize the *Educative Curricular Resources* (Davis & Krajcic; 2005) framework, which provides teachers with tools to integrate their ideas about core concepts and principles, instructional representations, and typical student ideas. These curricula will be more of a library of resources and less a scripted set of exercises. They will rely on the teacher's agency, planning, and adaptation to meet the needs of his/her students. In addition to being a vehicle for powerful student and teacher learning, we wish for NMSI curricula to embody principles of cultural responsiveness, be connected to students' daily lives, and scaffolding which will provide the means for narrowing achievement and skill gaps.

As a collective group, we purport that the CRP program, the curriculum and professional development partners, and using a sustained teacher professional development cycle which responds to teachers' learning progressions over time, represent a strong conceptual framework for Lone Star AP CSP.

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

Lone Star AP CSP participants will engage in Plan, Do, Study, Act (PDSA) cycles throughout the grant period. The goal for PDSA cycles is to identify ways to optimize the strategies that participants use to address the problem of practice and undertake participatory action research to examine these focal issues using identified and shared measures. The four steps of the PDSA cycles will be implemented as follows:

- *Plan:* The initial kickoff meeting described below describes the "Plan" phase of the first PDSA cycle. The group will analyze their current AP CSP data, identify successes and gaps, and ultimately select which curriculum provider they want to use for the three-year project and define teacher supports needed to improve student outcomes. In addition, they will define success metrics and plan to test any proposed solution to the problem.
- *Do:* Participants will go back to their schools and implement the proposed solution in partnership with NMSI supports.
- *Study:* Participants will collect data to examine whether they were able to implement the solution and, if so, whether it worked in their context. Teachers, NMSI staff, and at times, curriculum partners, will reconvene to discuss the data, review measures, and share learnings.
- *Act:* As a group, participants will draw conclusions about whether and in what respects the solution appeared to be effective and should be integrated into current practice. NMSI, curriculum partners, and schools/teachers will then adapt the approach to reflect learnings.

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

NMSI has overseen $300 million in public-private funds since 2007 and had an annual operating budget of $44.7 million in 2017. NMSI has successfully administered federal grants

since 2011 and is familiar with reporting and accountability standards at the federal level, with active grants from the Department of Education and the Department of Defense. Of particular interest when considering this project, NMSI has successfully executed a 2011 i3 validation and a 2015 i3 scale up grant and is implementing a 2017 SEED grant. For this project, NMSI has developed a robust management plan to ensure it meets its project objectives on time and within budget, consistent with previous success in implementing large-scale grants. The table below summarizes key responsibilities, timelines, and milestones for accomplishing key project tasks.

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

NMSI and the Lone Star AP CSP program providers meet monthly and have met twice in person to discuss this project and document the consistent needs they see with current district partners when implementing their programs.

Figure 5: Lone Star AP CSP Management Plan

School Selection								
Activities and Milestones	**Owner**	**Support**	**Pre Grant**	**19-20**	**20-21**	**21-22**	**22-23**	**23-24**
Solidify communication systems between partners, participating districts, and interested schools	PM Growth	CRP Team Ops	■					
Design and manage application process for interested schools	PM Growth	CRP Team Ops		■				
Finalize participating schools	COO PM Growth			■				
Confirm data-sharing agreements and execute contracts with each participating school	CRP Team D&A	Ops		■	■			
Agree upon annual participation and performance goals for teachers, students, and schools	PM PD			■	■	■	■	
Preparation								

Activities and Milestones	Owner	Support	Pre Grant	19-20	20-21	21-22	22-23	23-24
Hire positions needed and meet with evaluator	COO PD							
Assist schools with curriculum selection	PD SMCSD	T&L						
Hone teacher professional development materials	PD SMCSD	T&L						
Implementation								
Activities and Milestones	**Owner**	**Support**	**Pre Grant**	**19-20**	**20-21**	**21-22**	**22-23**	**23-24**
Assist participating schools in identifying potential AP teachers	PM SMCSD							
Further refine and finalize content support tools	PD SMCSD	T&L						
Recruit students, including underrepresented students, for AP CSP course	PM							
Promote teacher participation in summer institute	PM SMCSD							
Initiate student study sessions	PM	T&L						
Engage teachers in four-day AP workshop	PM PD SMCSD	T&L Ops						
Student scores received; verification of schools and participation confirmed	D&A PM							
Evaluation								
Activities and Milestones	**Owner**	**Support**	**Pre Grant**	**19-20**	**20-21**	**21-22**	**22-23**	**23-24**
Develop comprehensive evaluation plan and management plan for submission to the Department of Education	AIR	D&A PD						
Collect annual feedback from students, teachers, administrators, and staff to inform continuous improvement	AIR	D&A PM						
Make semi-annual updates to program to reflect feedback from key stakeholders, partners, and participants	PD SMCSD	T&L PM						
Finalize data analyses	AIR							

(2) Qualifications of key personnel

NMSI has deep experience managing large, complex, and rapidly growing projects. NMSI's leadership team for this grant includes: (1) the Chief Operating Officer (COO), who oversees all program implementation across the organization, including current i3 scale up grant, EIR early-phase grant, SEED grant, and Department of Defense grants; (2) the Senior Director of Curriculum and Design, **serving as the Project Director (PD) for this project, who has experience supporting the development of Computer Science teachers and of curricula and professional development for K-12 Science teachers, as well as scholarship in the K-12 STEM landscape;** (3) the Senior Manager of Computer Science Program Design, who oversees all computer science resource development and design work and has extensive experience in CS curriculum design and teacher support; (4) the Director of Data and Analytics (D D&A), who oversees all relationships with external data sources and third party evaluators; and (5) the Chief Financial Officer, who has overseen the budgets and financial compliance operations for all of NMSI's recent federal grants. The "CRP Team" includes Program Managers who will work in conjunction with NMSI's "Growth Team" to recruit and onboard participating schools and will act as the relationship manager and coach for school partners, meeting regularly with school partners in person and virtually. Operations coordinators on that team will manage all logistics related to program implementation. The "Teaching and Learning Team" includes curriculum design and trainer development responsibilities. In addition, the Grant Manager will manage all reporting requirements.

Outlined here are summaries of the team's qualifications; detailed resumes can be found in Appendix B: **1) Stacy Miles, COO:** Stacy leads program and operations for NMSI, overseeing

the program, teaching and learning, strategic initiatives, IT, and human capital teams with an overall focus on program strategy and organizational sustainability. She brings 20-plus years of education leadership experience in developing and supporting teachers and students, having previously worked at the University of Texas in student support services, Citizen Schools-Texas as executive director and chief program officer, and The New Teacher Project (TNTP) as partner. Stacy holds an M.A.Ed. from the University of Texas at Austin and a B.A. from Southwestern University. **2) Nicole Beeman-Cadwallader, Senior Director of Curriculum and Design:** She has experience supporting the development of Computer Science teachers and of curricula and professional development for K-12 Science teachers, as well as scholarship in the K-12 STEM landscape, publishing research in science education and culturally relevant pedagogy. Formerly, she led CS professional development at Project Lead The Way, mapping PLTW's AP CSP teacher learning progressions towards acquisition of CS pedagogical content knowledge. **3) Justin Cannady, Senior Manager, Computer Science Program Design:** With extensive experience in computer science curriculum design and teacher support, he was a curriculum development and teacher support specialist at the University of Texas Austin where he supported the UTeach CSP curriculum and developed online supplements and designed an online resource portal. He has served as a teacher trainer and mentor supporting teachers in implementing computer science and math coursework. Justin is a National Board-Certified math and computer science teacher. **4: Gina DelCorazon, Director, Data and Analytics:** As director of data and analytics, Gina leads all internal organizational data and analytics strategy as well as evaluation of NMSI's nationwide programs. She brings experience coordinating external

evaluations of program effectiveness. Gina previously worked as a site manager for TNTP programs; as such, she is highly familiar with program implementation and operations. She has an M.A. in economics from the University of California and a B.A. in government from Smith College, and she is a Ph.D. candidate at Princeton University. **5) Tammy Knapp, Chief Financial Officer:** Tammy has extensive grant administration experience, including leading NMSI's successful 2010 and 2015 i3 grant compliance. She is responsible for all financial matters at NMSI, including budget development oversight and financial reporting and compliance related to numerous public and private grants.

(3) Continued support after the grant period

NMSI's long track record of Texas impact highlights both the ongoing need for support, as well as the ongoing appetite for funders to offer financial support. That said, the very essence of Lone Star AP CSP is to build mechanisms, systems, and supportive environments for AP CSP to thrive in schools well-beyond the grant period. Three years of deep and broad professional development for AP CSP teachers, coupled with school-level supports to remove barriers to student recruitment in AP CSP has been designed so that the AP CSP momentum and enthusiasm generated through the grant period are sustained.

(d) Quality of the Project Evaluation

As the independent evaluator of the Lone Star AP CSP, AIR will conduct rigorous studies of both impact and implementation of the program in 50 Texas high schools for the 2020–21, 2021–22, and 2022–23 school years. In accordance with NMSI's mission, NMSI will recruit schools that serve high percentages of traditionally underrepresented students. AIR will use a quasi-

experimental comparative interrupted time series (CITS) design to evaluate the program's impact on student achievement in the 50 program schools, relative to student achievement in 100 comparison high schools that are similar to the program schools at baseline. When implemented correctly, a study with a CITS design can meet WWC standards with reservations.

AIR has carefully designed the impact and implementation studies to reflect the program's goals and theory of action. We will address three research questions (RQs) related to the impact of the program and two RQs related to implementation. Figure 6 presents the RQs, along with the corresponding data sources.

Figure 6: Research Questions

Research Question (RQ)		Data Sources
Impact	(1) Does the Lone Star AP CSP improve student performance on the AP CSP exam?	School-level AP CSP exam data and demographic data, springs 2018–2023
	(2) Does the Lone Star AP CSP increase student participation rates on the AP CSP exam?	School-level AP CSP exam data and public data on school enrollments and demographics, springs 2018–2023
	(3) Does the Lone Star AP CSP improve teachers' instructional practices?	Surveys of participating teachers and nonparticipating teachers, springs 2020–2023
Implementation	(4) Is the program implemented with fidelity, and if not, why not?	Records and documents provided by NMSI and curriculum providers; surveys of program participants, springs 2021–2023
	(5) To what extent do the program participants make use of the program and find it useful?	Surveys of participating teachers and counselors, springs 2021–2023

Evaluation Methods Designed to Meet WWC Evidence Standards With Reservations.

Using a CITS design, AIR's evaluation of Lone Star AP CSP's impact on student AP CSP exam achievement and participation will meet WWC standards with reservations. Although randomized controlled trials (RCTs) are the "gold standard" for evaluating intervention effects, NMSI would like to make Lone Star AP CSP available to all 50 of the schools it recruits, rather than randomizing half to a comparison group. A CITS design is a good alternative, as the

analysis will rely on extant data for the comparison schools and will not have to recruit them. Long considered one of the strongest quasi-experimental designs for causal inference (Shadish, Cook, & Campbell, 2002), recent methodological studies by AIR and others (e.g., Hallberg, Williams, & Swanlund, 2015; Jacob, Somers, Zhu, & Bloom, 2016) have demonstrated that CITS designs can produce valid inferences about the effectiveness of school-level interventions.

Our CITS design will compare AP CSP exam outcomes in the three pre-intervention cohorts (2017–18, 2018–19, and 2019–20) with outcomes in each of the three post-intervention cohorts (2020–21, 2021–22, and 2022–23) in the 50 Lone Star AP CSP high schools. The change in outcomes in the 50 Lone Star AP CSP high schools will be compared with the corresponding change in outcomes in a set of 100 matched comparison schools. (See Appendix I-4 for details of the analytic model.) To select comparison schools whose AP exam performance is equivalent at baseline to that of the program schools, we will use scaled Euclidean distance matching (Judkins, 2013). This matching approach will allow us to prioritize baseline equivalence on the outcome measures—particularly the percentages of schools' exam takers who receive a qualifying score (3 or higher) on the AP CSP exam—while also taking into account school demographics. In assessing impact, power analyses indicate that we will be able to achieve a minimum detectable effect size (MDES) of 0.125, which corresponds to a 5.6 increase in the percentage of students earning a qualifying score. (Details of the power analysis are provided in Appendix I-4.)

We will also examine whether the program has an impact on AP CSP teachers' instructional practice, which is one of the key mediators by which the program hopes to have an impact on students. We will use a difference-in-differences design to analyze the effect on instructional

practice, as measured by a CS teacher survey described in detail in the following section. Specifically, we will compare changes in particular practices—from a baseline year (2019–20) to each implementation year—between Lone Star AP CSP teachers and comparison teachers. To obtain the baseline data, we will need to survey the teachers prior to the selection of the comparison schools to be used in the student impact analysis. Therefore, AIR will identify a separate sample of comparison teachers for the study of practice. Using virtual communities, we will recruit 200 potential comparison teachers to take the baseline survey in spring 2020, at the same time as Lone Star AP CSP teachers.[2] From this initial pool of 200, we will select 100 whose CS instructional practices closely match those of the 50 Lone Star AP CSP teachers at baseline and will survey all 150 teachers in each follow-up year. AIR will provide substantial incentives and conduct intensive follow-up efforts to maximize response rates of the surveyed teachers.[3] Power analyses indicate that 50 treatment teachers and 100 comparison teachers will yield an MDES of 0.35. (See Appendix I-4 for details.)

Valid and Reliable Performance Data on Relevant Outcomes.

Our primary outcome measure is the schoolwide percentage of students earning a qualifying score on the AP CSP exam. Administered by the College Board each spring, the AP exams are well known, well established, and highly regarded. They are scored on an ordinal basis from 1 (lowest score) to 5 (highest score). According to the College Board, scores of 3 and higher are "qualified" for college credit or placement, so this outcome has clear practical and policy

[2] One virtual community we will use is *CS for All Teachers*, an NSF-funded and AIR-managed project that houses more than 7,000 teachers of CS.

[3] In previous AIR studies, these types of efforts have yielded response rates close to 100%.

relevance (College Board, n.d.). In addition, past research has found that scores of 3 or higher are predictive of college success (Dougherty, Mellor, & Jian, 2006; Morgan & Klaric, 2007).

The other AP-exam-related outcome measure is the schoolwide percentage of students who *take* the AP CSP exam. Research shows that just taking the AP exam—regardless of score earned—can yield positive college outcomes (Mattern, Shaw, & Xiong, 2009; Mattern, Marini, & Shaw, 2013; Murphy & Dodd, 2009). Mattern, Shaw, and Ewing (2011) found that a strong link existed between taking an CS AP exam and majoring in CS in college.[4]

To measure AP CSP teachers' instructional practice for the teacher-level impact analysis, we will draw heavily from the High School Computer Science Teacher Questionnaire used in the 2018 NSF-funded National Survey of Science and Mathematics Education (Banilower et al., 2018), which includes multiple items to gauge respondents' use of instructional practices related to CS (e.g., "create computational artifacts"); these practices are aligned with the Computer Science Teachers Association (CSTA) K–12 Computer Science Standards and thus clearly have construct validity. In the national survey, a composite of survey items titled "Engaging Students in Practices of Computer Science" had a Cronbach's alpha reliability of 0.87 (Banilower et. al, 2018, p. D-33); several other CS-related composites had similarly high alphas, indicating that they are very reliable. Appendix I-4 lists the composites, sample items, and alphas.

Clear Articulation of Components, Mediators, and Outcomes and Measurable Threshold.

As delineated in NMSI's logic model, the key program components are supports for teachers, supports for students, and supports for schools. Assuming these components are implemented

[4] We acknowledge, however, that this finding predates the introduction of the AP CSP exam.

with fidelity, we hypothesize positive student, teacher, and school outcomes. To determine whether the program is implemented with fidelity (and if not, why not), we will collect data to measure the implementation of each component and specify a threshold for satisfactory implementation of the component. Figure 6 presents the specific indicators, data sources, and thresholds that we will use to measure implementation. At the outset of the project and annually thereafter, we will work with NMSI to refine the measures and thresholds as the program evolves. We will combine the individual element scores to assess whether Lone Star AP CSP as a whole was implemented with fidelity in each year and overall.

Figure 6. Measurement of Implementation Fidelity

Program Component and Elements	**Data Sources to Assess Fidelity**	**Examples of Threshold for Acceptable Implementation**
Support Teachers • Three-year training arc • Mentorship • High-quality curricula • Supplement in-person training with virtual PLCs • Incentives	• Attendance sign-in sheets or lists from training sessions • Curriculum providers' documentation that their curricula have been provided to the participating schools • Login/usage data and snapshots of posts from virtual PLCs • NMSI records/documentation of provision of incentives • Teacher report on surveys of access to these program elements	• The AP CSP teacher(s) from each of the participating schools attended at least one day of each summer's training • All participating schools received their chosen curriculum • Each AP CSP teacher received a login to access the virtual PLC • Incentives provided to all teachers who earned them
Support Students • Study sessions/content reviews • Technology, equipment, and supplies • Exam fee subsidies and incentives	• Teacher report on surveys that study sessions/reviews are available to students • Providers' documentation that technology, equipment, and supplies are provided to the participating schools • NMSI records/documentation of provision of exam fee subsidies and incentives	• Student study sessions took place at no fewer than 75% of the participating schools • Technology/equipment/supplies needed to implement the selected curriculum were provided to 100% of the participating schools; at least 75% of participants confirmed the technology was received and usable for the intended purposes • Exam fees subsidies and incentives provided to 90% of eligible students
Support Schools • Performance analysis and technical assistance	• NMSI and/or school documentation that these supports were provided	• All participating schools had access to the promised supports

• Shared goals and accountability • Incentives • Counselor training/ online support	• NMSI records/documentation of provision of incentives • Counselor report on surveys of access to these program elements	• Counselors from all participating schools received training and had access to online support

In addition to evaluating implementation fidelity, which is focused on whether the program was delivered as planned and whether participants had *access* to its supports, AIR will also examine the extent to which participants make use of the program (i.e., uptake) and find it useful. In each year of the program, we will survey the participating teachers and counselors to gauge their levels of participation in and uptake of the program (in addition to access to it) and use of the provided resources. [5] In addition, we will ask teachers how useful they perceive each program element—and the program as a whole—to be for improving their instruction and student access to a quality CS experience. AIR will provide this information to NMSI as formative feedback in service of continuous improvement of the program.

Generation of Guidance About Effective Strategies Suitable for Replication in Other Settings.

AIR's evaluation will generate rigorous evidence on the effectiveness of the Lone Star AP CSP that can inform scale-up efforts and/or expansion to other subject areas. With 50 treatment schools, the treatment sample will be large enough to be generalizable to a broad population of schools serving high-need students. In addition, the implementation fidelity and teacher-level uptake data collected by the evaluation can inform future and broader efforts to implement (or adapt) the intervention to greatest possible effect, both by NMSI and others. The project team

[5] To minimize burden for the treatment teachers, the survey-based implementation measures will be administered, starting in spring 2021, as part of the same survey that measures their instructional practices.

will disseminate findings at relevant research and practitioner conferences such as the Special Interest Group on Computer Science Education and the CSTA conference. We will also engage in virtual means of dissemination, including Twitter chats, podcasts, webinars, and blog posts.

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