PROJECT NARRATIVE

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Section A. Project Design

A.1. Clearly specified and measurable goals, objectives, and outcomes

This **early-phase** proposal – *Extending the CS Pipeline: Enhancing Rigor and Relevance in Middle School Computer Science* – responds to **Absolute Priority 1 [AP1]**: Demonstrates a Rationale and **Absolute Priority 2 [AP2]**: Field-Initiated Innovations - Promoting STEM Education, with a Particular Focus on Computer Science (CS). Within AP2, the proposal addresses **Competitive Preference Priority 1**: Expanding access to and participation in rigorous CS coursework for traditionally underrepresented students by collaborating with local education agencies (LEAs) that serve large numbers of these students, by which we mean Black, Hispanic, and economically-disadvantaged students. Given their persistent lack of representation in the CS landscape, we also aim to encourage female students' participation in CSE.

Rutgers University (RU), *an institution of higher education with non-profit status*, in partnership with Deacon Hill Research Associates (DHRA) and seven high-need LEAs serving 38 middle schools (MSs), seeks to broaden participation of underserved student populations in computer science education (CSE) by increasing access to and engagement with rigorous and relevant CSE and motivating CS-related interest, self-efficacy, and achievement. *Rigor* – the quality of instructional content – is a necessary but insufficient condition for broadening participation in CSE. *Relevance* is also critical: CSE may be comprehensive in content, but not effectively implemented nor delivered in a way that is relevant to students, thus failing to spark interest and continued engagement in CSE (Yuen, Arreguin-Anderson, Carmona, & Gibson, 2016).

We propose to accomplish this by working with MS administrators and grade 5-8 teachers to iteratively refine and apply a comprehensive, systematic, and purposeful *CSE Technical Assistance Framework (TAF).* We also seek to assess the added value of supporting teachers and administrators via a collaborative structure, the *researcher-practitioner partnership (RPP)*, by integrating the CSE TAF with participation in an RPP. Project impacts will be assessed using an interrupted time series (ITS), a quasi-experimental design (QED), and the value added by the RPP will be examined in a cluster randomized controlled trial (RCT).

The specific goals of this project are to (1) collaboratively refine a TAF to increase rigor and relevance in MS CSE; (2) implement the CSE TAF to build capacity of MS educators to integrate and rigorously implement CSE by delivering embedded, targeted, and sustained TA inclusive of PD; (3) enhance educator engagement and collaboration in MS CSE through an RPP involving a randomly selected group of schools; (4) determine the degree to which the TA and TA+RPP conditions improve girls' and historically underrepresented MS students' attitudes, self-efficacy and academic achievement in CS; (5) assess degree to which the TA and TA+RPP conditions increase the number of girls and underserved students who take CS in MS and HS; (6) measure the added value of combining TA with an RPP using a cluster RCT design that meets What Works Clearinghouse (WWC) evidence standards (see **Exhibit 1**); and (7) ensure longevity of the project's impact beyond the funding period through dissemination of findings and pursuit of additional funding. Additional details (objectives, measures, and outcomes) related to each goal can be found in **Exhibit 1**.

MS CSE TA Framework (TAF). The TAF is an array of procedures, tools, and research-based strategies focused on increasing the rigor and relevance of CSE by addressing content knowledge (CK; e.g., programming in different languages), pedagogical content knowledge (PCK) focusing on inclusive instructional strategies (e.g., use of collaborative learning structures, unplugged activities, project-based learning), and institutional policies and culture (e.g., integration of CS into the MS curriculum; examination of policies and procedures that may inhibit access to CS). We will engage educators in the processes of reflecting on existing school-wide CSE practices and structures, gauging the current state of CSE in their school, and crafting meaningful change at the school, administrator, teacher, and student levels. The TAF includes:

(1) *MS CSE Status Assessment* – a comprehensive inventory of existing assets and opportunities, identified key challenges, and a statement of the school's vision of CSE;

(2) *MS CSE Bootcamp* – an intensive 2-day PD event for CS project teams (3 to 4 CS teachers and a minimum of one administrator within each participating school) to lay the groundwork for change and to inform their TA Action Plan. The Bootcamp, bringing together faculty and administrators, will ensure that all participants are on the same page with regards to the importance of CS and its possibilities in MS;

(3) *MS CSE TA Action Plan* – a living document that systematically translates the school's current CSE reality and vision into an actionable plan along two key dimensions – institutional and instructional practices. The CSE TA Action Plan lays out the PD tailored to each school and delivered during the course of five site visits per year (see **Appendix I.IV**);

(4) *MS CSE Professional Learning Opportunities and Resources* – a suite of curated professional learning experiences and on-demand materials selected to build local capacity in CSE and expand the participation of girls and underrepresented minorities in CS. Participating teachers will receive additional PD and one on one coaching (along with a stipend for their work and time outside of the school day).

Our TAF will enable teachers and administrators to address school-specific needs while uniformly emphasizing key facets of CSE reform: (1) rigorous CS curricula should involve experiential learning; (2) CS teachers need consistent PD; and (3) teacher networks and ongoing coaching will help sustain CS in the MS curriculum (Peneul, 2020). Given that co-construction drives implementation and sustainability (Century, 2013), we will continuously refine the TAF with a subset of our participating schools during Years 1-2 of the five-year grant period (process evaluation phase).

RPP. We also seek to assess the added value of a collaborative structure, the *researcher-practitioner partnership (RPP)*, by integrating the aforementioned TA with participation in an RPP. Specifically, the RPP will serve as an enhancement to the TA and builds off an existing RPP that supports CSE in HS through an existing NSF-funded project (NSF Award 1837305). The HS-based RPP has shown demonstrable value to participating educators[1]; this project is an effort to extend those benefits to the MS level. RPPs of this type can enhance the delivery of high-quality TA by connecting participants with a pool of shared resources, expertise, rich instructional and pedagogical knowledge, and a dependable peer support mechanism (e.g., advice, emotional support, etc.) (Coburn & Penuel, 2016; Wei et al., 2010). The *RPP component* entails participating in (1) annual summer institute, (2) monthly virtual RPP meetings, and (3) ongoing collaboration and peer-to-peer support through an interactive virtual platform (via Mobilize.io). Being an active member of the RPP will allow for connection to the broader community of MS CS educators as they address common challenges related to improving CSE in their schools. Given the opportunity to engage in deep learning and benefit from participating in peer-sharing, we expect enhanced outcomes for participants in the TA+RPP group compared to participants in the TA-only condition.

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[1] Descriptive results from surveys of participating teachers indicate deepened understanding of CS content, greater understanding of equity, and increased confidence in integrating what was learned as part of the RPP into classroom instruction (Blitz & Duncan, unpublished manuscript).

We will assess the outcomes of our work with MSs by using an **interrupted time series design (ITS)** to examine trends in students' CS-related motivation (interest, attitudes and self-efficacy) and achievement, as well as in subsequent HS CS enrollment and the numbers of females and underrepresented minorities taking the end-of-course tests in AP Computer Science Principles (APCSP) and AP Computer Science A (APCSA). An innovative aspect of this project is the use of a **cluster RCT** to test the value of an RPP as a complement to the TA provided to MS administrators and grade 5-8 teachers (details are provided in Section C).

Exhibit 1: Project Goals, Objectives, Measures, and Outcomes (VM=validated measure)

Goal 1: *Collaboratively refine a MS CSE TAF with participating MSs to increase rigor and relevance in CS curricula and pedagogy*		
Objectives	**Measures**	**Outcomes**
1.A Refine MS CSE TAF by engaging in iterative improvement cycles	1.A.1 through 1.A.3 Versions 1-3 of the TAF	38 schools (3 pilot, 3 field test, and 32 impact evaluation) contribute to improvements of TAF and participate in the TA or TA+RPP groups
Goal 2: *Build capacity of grade 5-8 educators to integrate and rigorously implement CS content & curricula by delivering embedded, targeted, and sustained TA inclusive of PD*		
Objectives	**Measures**	**Outcomes**
2.A Deliver TA based on results of status assessment	2.A.1 TA attendance, 2.A.2 site visit notes, 2.A.3 TA plans, 2.A.4 PD agendas	114 MS CS teachers and 38 administrators receive tailored support
2.B Increase teachers' CS CK, PCK, and ability to integrate content and curricula	2.B.1 Preparedness to Use CS-Specific Instructional Strategies, 2.B.2 Preparedness to Teach CS Topics, 2.B.3 Pedagogical Beliefs about CS *all VM	ITS: 20% net increase in teachers' reports on their CS CK, PCK, and ability to integrate content and curricula
2.C Develop teachers' ability to utilize inclusive pedagogy	2.C.1 Preparedness to Implement Inclusive Strategies (VM)	ITS: 20% net increase in teachers' reports of their ability to utilize inclusive pedagogy
2.D Enhance the quality of MS CS offerings	2.D.1 & 2 Factors (and Problems) that Affect My CS Instruction (VM), 2.D.3 Administrator interviews	ITS: 20% net improvement in teachers' views of schools' CSE RCT: 75% of administrators report positive changes to the quality of their CS offerings

Goal 3*: Enhance educator engagement and collaboration in MS CSE through an RPP involving a randomly selected group of 16 schools*		
Objectives	**Measures**	**Outcomes**
3.A Engage teachers and school admins in an RPP to foster collaborative CS learning	3.A.1 Attendance on monthly RPP calls, 3.A.2 Attendance at annual summer institute, 3.A.3 End-of institute feedback	Achieve average of 80% attendance of teachers and administrators in RPP calls and summer institutes; attain average of 80% satisfaction with summer institute experience
3.B Support work of RPP through online collaborative platform	3.B.1 Platform analytics	Achieve average of 75% of teachers in TA+RPP group who use the online platform a minimum of 1 time per month
3.C Assess teachers' and administrators' RPP engagement	3.C.1 Inventory of quality of RPP experience	Achieve average of 80% of educators reporting satisfaction w/ and usefulness of RPP experience
Goal 4*:Improve underrepresented grade 5-8 students' CS-related attitudes & achievement*		
Objectives	**Measures**	**Outcomes**
4.A Improve students' attitudes re: CS and STEM (competency, interest, efficacy)	4.A.1 STEM Competency Beliefs, 4.A.2 CS Interest Scale, 4.A.3 STEM Career Interest Scale; 4.A.4 CS Self-Efficacy Scale, 4.A.5 Emerging STEM Learning Activation Scale *all measures VM	ITS: 10% net increase in student attitudes RCT: compared to Ss whose Ts are in the TA-only group, Ss whose Ts are in TA+RPP group report statistically significantly more positive attitudes re: CS or STEM
4.B Improve students' CS-related achievement	4.B.1 MS CS course grades, 4.B.2 HS CS course grades, 4.B.3 Female students' grades in APCSP and APCSA, 4.B.4 Non-White students' grades in APCSP and APAA	ITS: 10% net increase in CS achievement RCT: students whose teachers are in the TA+RPP group earn statistically significantly higher CS grades/scores
Goal 5: *Increase the number of underserved students who take CS in MS and HS*		
Objectives	**Measures**	**Outcomes**
5.A Use administrative data to track CS participation trends 4 years prior to, and up to 3 years after onset of TA or TA+RPP	5.A.1 MS students' participation in CS electives, 5.A.2 HS CS enrollments, 5.A.3 Female students' test-taking rates in APCSP and APCSA, 5.A.4 Non-White students' test-taking rates in APCSP and APCSA	ITS: 10% net increase in participation in CS RCT: students whose teachers are in the TA+RPP group participate in CS at statistically significantly higher rates

Goal 6: *Test the added value of combining TA with an RPP using a cluster RCT design that meets What Works Clearinghouse (WWC) evidence standards*		
Objectives	**Measures**	**Outcomes**
6.A Randomly assign 32 MSs into TA or TA+RPP conditions	6.A.1 Lists of schools and teachers participating, 6.A.2 Demographic data about schools, teachers, students	16 schools assigned into TA and 16 schools assigned into TA+RPP; findings regarding baseline equivalence between groups
6.B Collect and analyze impact data from teachers and students.	6.B.1 Lists of participating teachers and students, 6.B.2 teacher surveys (see 2.1 and 2.2), 6.B.3 student surveys (see 4.1 and 4.2), 6.B.4 CS course grades	CONSORT diagram documenting participation and attrition rates; findings regarding group differences in teacher and student outcomes; findings on variables that mediate or moderate the impacts observed
Goal 7: *Ensure the longevity of the project's impact beyond the funding period through dissemination of findings and the pursuit of additional funding*		
Objectives	**Measures**	**Anticipated Outcomes**
7.A Disseminate project findings through presentations and publications	7.A.1 Number of presentations made, 7.A.2 Number of publications	Increased awareness among educators, researchers, and policymakers about enhancing MS CS rigor and relevance
7.B Identify and apply for an appropriate funding source and submit application by Y4	7.B.1 Verification of proposal submission	Potential for expanding support to elementary schools in our partner districts and create vertical alignment through the elementary and secondary levels

A. 2. Addressing the needs of target population

Future innovations and the prospects of a diverse and inclusive workforce depend heavily on the attainment of broad literacy and skills in CS (Council on Foreign Relations, 2018). Years of research on educational outcomes and opportunities have demonstrated that inequity in CS is profound and widespread (NCES, 2019). Despite major national and state efforts over the past 10 years, there are still low numbers of individuals from underrepresented groups enrolling in CS programs (Code.org, 2019), and the need to recruit and retain diverse students in CS is as high as ever (English, 2017; Madkins et al., 2019; Wiebe et al., 2019). In fact, the majority of public school students have not been exposed to any formal CSE prior to HS (Gallup & Google, 2016).

There are numerous reasons to provide CSE in MS. It is imperative to engage students at a time when their perceptions of gender roles and career trajectories are formed and as they actively plan for their high school and college education (Barker & Aspray, 2006; Wei et al., 2010). Additionally, research shows that improving CS curricula and cross-curricular integration of CS can help underrepresented populations recognize the intellectual and practical value of pursuing CSE (Estrada et al., 2016). Finally, without a clear CSE pathway, many traditionally underrepresented students in CS are effectively being pushed into pursuing non-technical/non-STEM career pathways (Denner, 2011).

As we move to increase rigor and relevance in CS curricula, there is a greater urgency to provide PD that equips teachers with both CS content and appropriate pedagogical approaches that are responsive to the needs, motivation, and backgrounds of specific student populations and grade levels (Ryoo, Goode, & Margolis, 2015). This includes improving the classroom experience to be more welcoming and inclusive, taking advantage of students' curiosity and communication skills, and building students' confidence to apply the knowledge and competencies they acquire (Dyer-Barr, 2013; English, 2017; Lachney, 2018; Wiebe et al., 2019). Key to these efforts is helping teachers to integrate innovative and equitable teaching strategies into their instruction, which, in turn, have been shown to increase recruitment and retention of underrepresented students (Madkins et al., 2019, Gretter et al., 2019).

Our collaborating schools serve diverse populations of students; *detailed school demographic profiles* are available in **Appendix I.II**. Based on the National Center for Education Statistics Common Core of Data (2018-19), our 38 participating schools serve a total of 12,045 students enrolled in grades 5-8. These schools serve, on average, student populations that are 48% Hispanic, 19% Black and 59% of students being eligible for free or reduced-price lunch (NCES, 2019). Overall, approximately 80% of the students reached by this project are from underrepresented minorities.[2] Additionally, less than 6% of Grade 6 to 12th public school students in New Jersey were enrolled in a CS course in 2019 (NJDOE, 2019) and performance and participation gaps in CSE are evident statewide and in our participating schools.

Efforts to improve the CS participation of girls, Black, and Hispanic students are therefore urgently needed, and our collaboration with 38 high-need New Jersey MSs is intended to help decrease those performance and participation gaps. This project responds to the needs of our participating schools, teachers, and students by refining and implementing embedded, targeted, and sustained TA (or TA paired with an RPP) designed to enhance CS pedagogy, inclusiveness, and curriculum integration. We expect students will benefit from a cohesive, engaging CS learning experience over the course of MS that can stop self-stereotypes from developing and negatively impacting student interest and the prospects of broadening participation well before they arrive at their high school years (Buffum et al., 2016; Tsan, Boyer, & Lynch, 2016).

A.3. Proposed project is based on current research and effective practices

A major factor contributing to existing disparities is the acute shortage of stable and systematic CS course offerings and teachers who are adequately trained to deliver available CS curricula in K12 education (Cuny, 2012; Leyzberg & Moretti, 2017). It is clear that in order to successfully integrate CSE into the curriculum and broaden participation, teachers need support beyond a set curriculum and online resources, regardless of the curriculum or materials they adopt. The majority of the educators who teach CS in schools also teach other content areas,

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[2] Participating schools range from 11.6% to 96.2% Hispanic; 2.8% to 80.9% Black; and 33.7 to 95.9% eligible for free or reduced price lunch.

typically science and mathematics (Yadav et al., 2016). As a result, these teachers struggle in the classroom as they do not perceive themselves as having sufficient background or knowledge about either CS content and/or equitable practices to be able to implement a CS curriculum with confidence (English, 2017; Gal-Ezer & Stephenson, 2010; Wiebe, 2019; Margolis et al, 2014).

Research strongly indicates that the work that happens within a classroom is critical and should address all students' abilities, motivation, and cultural backgrounds. Teachers need to be particularly well-versed and skilled in the use of specific approaches and strategies that support the particular needs of their underrepresented student populations. Student-driven, inquiry-based learning is key to equitable practices, allowing all students to bring their rich backgrounds and knowledge to their education. This not only enriches the learning process of peers, but acts as a force for equity by giving all students a voice, validating their personal experiences, and fostering ownership of their education and pride in their work (Ryoo, Goode, & Margolis, 2015). Research has highlighted these practices as being successful in bolstering participation and engagement of Black students (Lachney, 2018), Hispanic students (Denner, Thiry, & Martinez, 2017), and students who are socioeconomically disadvantaged (Yuen et al., 2016). This entails a large shift in the traditional classroom environment: instead of teachers teaching content and designing projects without regard to cultural relevance, students bring their own knowledge, cultural experience, and social problems to the classroom, and educators tailor projects and assignments to encourage students to apply CS concepts to their own interests (Bennett & Eglash, 2013).

To meet this need of teachers and assist them in navigating the challenges they encounter, we propose to deliver tailored, high-quality TA in the form of TA and TA+RPP. The TAF's activities and materials, and the focus on student-driven, inquiry-based work are directly modeled on the approach we are using in our NSF-funded project with high school teachers (Blitz, Trees, & Nguyen, 2019).

A.4. Proposed project has the potential to increase knowledge or understanding of educational problems, issues, or effective strategies

The proposed project is novel and innovative in several ways. **First**, by focusing on rigorous and relevant CSE implementation and integration in grades 5-8, we are tackling an area that has not been examined closely or systematically. Attending to MSs will allow us to leverage the resources from our existing NSF-funded project, in that we are able to use our established evaluation process and procedures and the RPP structure we already have in place (see **Appendix I.IV**) to study how 5th to 8th grade teachers may or may not benefit from the intervention in the same way as high school educators. **Second**, by targeting and assessing improvements in CS curriculum integration and equitable practices across MSs in different districts, with diverse student bodies, and with varied support infrastructures in place, we will produce a deeper understanding of what aspects of the TA and/or delivery are most impactful for different types of schools (e.g., those with less experienced teachers; those with greater technology available to students). **Third**, we will be able to assess the effects of the TA or TA+RPP approaches by examining trends over time; the interrupted time series analyses will show whether our work with the MSs has improved student attitudes, achievement, and subsequent participation in HS CS. **Lastly**, with the proposed cluster RCT, we are well positioned to test the efficacy and feasibility of embedding the delivery of high-quality TA to teachers in the context of an RPP, which we hypothesize will result in improved outcomes relative to the delivery of a standalone TA. We are therefore confident that the proposed study has significant potential to produce nuanced understanding regarding how, for whom, and under what settings these two TA delivery strategies may be feasibly implemented to positively impact MS CS teachers and students.

Section B. Resources and Management Plan

B.1. Management plan

The Rutgers-led project team is composed of experienced, well-qualified education and research professionals who have and continue to effectively collaborate on similar projects, and, therefore, are poised to successfully achieve the goals of this proposed EIR grant project. In addition, the proposed project builds on ongoing, successful collaborations with each of the seven district partners (see **Appendix C** *Letters of Support*). An external team from Deacon Hill Research Associates (DHRA), led by Dr. Teresa Duncan, will conduct the independent evaluation. This project will be guided by a management plan that clearly defines responsibilities, timelines and milestones for accomplishing project tasks (see **Exhibit 2**, *Timeline, Activities, and Responsible Team Members, and,* **Exhibit 3***, Roles, Experience, and Primary Responsibilities of Key Personnel*).

Rutgers University (RU) follows and adheres to the White House of Management and Budget (OMB) OMB Uniform Guidance (UG). RU has (a) aligned the university procurement services policies and procedures with UG, (b) created checklists based on purchase amount to assist units with UG compliance and University requirements, (c) trained and tested all grant project managers on the university's aligned process for administering research and following all federal, state and university guidelines, and (d) maintained an Office of Grants Accounting that ensures that all goods, services, deliverables, and supplier payments are consistent with the requirements set forth in the related procurement contract.

B.2. Reasonable project costs

The Center for Effective School Practices at Rutgers (RU-CESP) has a distinguished track record of more than 30 years in managing large, complex projects and completing them on time and within budget. Our past performance and ability to secure continuous external funding demonstrates our consistency in providing quality, on-time products and services as designated by the specific grantee organization or by the contractual agreement arrangements. RU-CESP has completed numerous quality control documents over the years (e.g., annual reports, fiscal reports) that have included specific details on project scheduling/milestones and our adherence to said financial forecasting and methods for controlling costs as well as our completion of all data sharing requests. Rutgers University Procurement Services follows the procedures in 2 CFR 200.317-200.326, and more detailed budgeting information and justifications are included in **Budget Narrative A**. During its five-year span, the proposed EIR project has the potential of impacting approximately 25,500 students in grades 5-8, which translates to [redacted] per student impacted.

Exhibit 2: *Project Timeline, Activities, and Responsible Team Members*

Activity	Goal	Lead	Support	Timeline				
Project Management				*2021*	*2022*	*2023*	*2024*	*2025*
Weekly Project Meetings		CB	td, ft, va, da					
Retreats; Technical Advisory Council		CB	td, ft, va, da					
Monthly and Annual reporting to EIR		VA	cb, da					
Refine and Administer TA Framework (TAF)				*2021*	*2022*	*2023*	*2024*	*2025*
Plan and Prepare	1	FT	rg, te, nn, da					
Pilot the TAF	1	CB	ft, rg, te, nn,					
Field Test the TAF	1	CB	ft, rg, te, nn					
Refine TAF	1	FT	rg, te, nn,					
Administer the TAF	1, 2	FT	rg, te, nn, da					
Continue to Refine and Evaluate TAF	1, 2	CB	td, ft, da					
Implement and Engage Educators in RPP (treatment group only)				*2021*	*2022*	*2023*	*2023*	*2025*
Hold Monthly RPP Meetings	3	CB	ft, rg, da, va					
Conduct Summer Institutes	3	VA	cb, da, ft, rg					
Engage in Online Collaboration Platform	3	DA	cb, ft, va					
Engage RPP Through Ongoing Collaboration	3	CB	da, ft, rg, va					
Collect and Analyze Evaluation Data (process and impact)				*2021*	*2022*	*2023*	*2024*	*2025*
IRB Submission and Review	1 – 4	CB	td, va, da					
Collect Surveys, Obtain Administrative Data [1]	1 – 6	TD	js	**P**	**F**		**O**	
Analyze Data/Share Results	1 – 6	TD	js					
Observe EIR TA	1 – 6	TD	js					
Dissemination and Sustainability				*2021*	*2022*	*2023*	*2024*	*2025*
Present at Conferences	7	CB	ft, td, te, va					
Prepare Publications	7	CB	ft, td, nn, da					
Apply for Other Funding	7	CB	td, ft, va, da					

CB: C. Blitz, TD: T. Duncan, FT: F. Trees, VA: V. Allen, DA: D. Amiel, [redacted]: J. Schoeneberger
[1] P = Pilot; F = Field Test; O = Operational Administration/Impact Evaluation

B.3. Qualifications of key project personnel

Project team members are highly qualified to carry out the proposed work and bring extensive and complementary expertise in methodologically sound and theoretically grounded education research; CS teaching and learning; district and school-based technical assistance; teacher PD; inclusive instruction; RCTs; dissemination; and managing large-scale collaborative research and development efforts. **Exhibit 3** details the experience and responsibilities of key personnel (additional information can be found in **Appendix B** *Resumes of Key Personnel*). Additionally, we will create a Technical Advisory Council (TAC), co-facilitated by Blitz and Duncan that will consist of CSE content experts, representatives from other CS-focused RPPs, and experts in quantitative education research.

Exhibit 3: Roles, Experience, and Primary Responsibilities of Key Personnel

Leadership Team		
Dr. Blitz will provide executive leadership for the project overall and will head the Leadership Team. The Leadership Team will be responsible for (a) facilitation of timely and effective communication between all parties including EIR and project partners; (b) oversight of all project teams; (c) ensuring all key deliverables are met in the given timeframe and within budget; (d) identifying and addressing any potential challenges that arise during the project period; and (e) dissemination and sustainability.		
Name	*Position*	*Experience*
Cindy Blitz, Ph.D. [redacted]	PI/PD	*Served as PI on numerous grants over 10 years including 3 NSF awards on broadening participation in CSE *Expertise in facilitating successful & sustainable RPPs, developing & implementing PD, curriculum development, & identifying/addressing problems of practice
Teresa Duncan, Ph.D. [redacted]	Co-PI	*Served as PI/PD on 5 RCTs funded by USDOE *Served as Director of REL MA (2012-2017), overseeing development, implementation, production of 47 analytic technical support studies and 18 applied research studies
Fran Trees, DPS [redacted]	Co-PI	*Expertise in CS curricula design & teacher support including current position as Director of Undergraduate CSE at RU *40 years as CS educator in higher ed and within K12 *Certified AP CSP trainer and exam reader

Administrative, Financial, and Field Implementation Team		
Ms. Allen will lead the Administrative, Financial, and Field Implementation Team, which will facilitate work involving the schools and the day-to-day project administration and logistics, including (a) budget management, monitoring, and reporting; (b) development and management of project timelines and deliverables; and (c) providing field implementation support to TA and Leadership Teams		
Vivian Allen [redacted]	Project Manager	*20 years of experience in project and financial management *4 years of successful management of self-funded research center regarding financial matters, including budget development, oversight, and financial reporting
David Amiel [redacted]	Project Associate	*Background in CS, math, and statistics with experience co-creating and delivering professional learning experiences in equitable CSE to educators at all levels *Administrative, budget management, fieldwork expertise
Technical Assistance Team		
Under the supervision of Co-PI Trees, the TA Team will serve as the CK and PCK leads as well as the curriculum development/sequencing/integration/articulation experts. They will be responsible for CS resource development and design work including the project's TAF. The TA Team will work closely with participating schools and teachers, providing TA and PD, conducting extensive field work, and creating feedback-based iterations of the TAF.		
[redacted]		
Independent Evaluation Team		
Co-PI Duncan will lead the Independent Evaluation Team, which is responsible for the process and impact evaluations, including study design, data collection, quantitative and qualitative analysis, and reporting. They will work closely and consistently with the Leadership and TA Teams to iteratively improve the TAF and implementation of the project		
Jason Schoeneberger Ph.D. [redacted]	Methodo-logist	*Specializes in research design and evaluation methods, multilevel modeling, statistical programming, data management and statistical simulations *21 years' experience in applied research & evaluation

B.4. Procedures for continuous feedback and improvement

There are numerous processes put in place for the project's teams to collect, analyze, and act on process evaluation data to ensure that feedback and continuous improvement are integral to this project. First, the *Leadership Team* and *Administrative, Financial, and Field Implementation Team* will meet virtually on a weekly basis throughout the project period. In addition, there will be two, 2-day face-to-face (F2F) planning retreats in Years 1 through 4, and, one 2-day F2F planning retreat in year 5 for team members to meet, share information, and work together to improve aspects of the project. These structured opportunities will allow for continued feedback and discussions regarding the efficacy of the project's implementation and for open conversations with members of the TAC. Second, the process evaluation involving the pilot and field test schools is intended to be part of the continuous improvement process (Plan-Do-Study-Act; PDSA), where the implementation of a program is monitored, documented, and feedback is obtained from participants, then data are reviewed to refine and improve the program activities and processes (Park, Hironaka, Carver, & Nordstrum, 2013). The process evaluation will generate detailed information about the implementation of the TA and the TA+RPP which will be qualitative, involving narratives and frequency counts to document and describe the potential benefit of participating in our RPP. The annual evaluation forms used to assess satisfaction with the TA or the TA+RPP experiences will also generate descriptive and comparative data that will help refine and further expand our RPP. Usage data from the online RPP platform will be reviewed monthly to make dynamic adjustments to the support, resources, level of communication, etc. These data will be compiled and analyzed by DHRA, and reported to the Rutgers-led team members during weekly project meetings and bi-annual planning retreats. Lastly, the TAC will meet biannually to be briefed and to offer feedback on project implementation and policy implications of study findings. In the end, our continuous improvement process will yield a compilation of evidence-based recommendations and best practices, as well as a set of robust strategies for replicating the TA and/or TA+RPP model in additional schools.

B.5. Dissemination and sustainability

We will reach out to educators across the country through presentations at practitioner-oriented conferences and publication in journals including those hosted by the ACM Special Interest Group on CSE (SIGCSE), and the Computer Science Teacher Association (CSTA) as well as at appropriate academic venues such as the ACM SIGCSE Technical Symposium, AERA, ISTE, and papers in peer-reviewed journals (such as Computers and Education). Research briefs will also be made available on the CESP website and other sources. Given that part of the TA will be aimed at increasing the capacity of MS educators to collect and analyze data that informs their programmatic efforts (i.e., iterative cycle of improvement), we believe that having the knowledge to do this will help them to sustain and build upon the CSE progress made through this project. Additionally, this will allow them to participate in the dissemination of the project outcomes as well as the process through leadership, peer mentoring, and interactions they have in the context of national networks, such as *CS for All Teachers* and *CS for All*.

We believe that the potential for continued support of the project after this funding ends is strong and the project team is committed to soliciting such funding prior to the end of the proposed project. All members of the research team and a number of our participating districts are part of an active professional learning community that has been in existence since 2012, beginning as a research alliance in REL Mid-Atlantic and an active RPP since then. The strong, established working relationships between all partners and their commitment to this partnership as a means to improving evidence-based educational practice (see *letters of support*, **Appendix C**) ensure that the work we are proposing will continue and expand into the future. In addition, there is strong commitment from Rutgers to support the goals of this project as evidenced in the resources provided in-kind (see **Budget Narrative B** and **Appendix G** *Demonstration of Match Contribution*). Finally, the results of this project will add to the evidence-base on CSE, particularly around the TA needed by secondary school teachers, as well as on the use of RPPs as a vehicle for providing that support. Armed with evidence that meets rigorous WWC standards, our team will be able to pursue future funding from EIR, NSF, IES, and foundations to help sustain and even expand our work with our practitioner partners.

C. Project Evaluation

C.1. Evaluation will produce evidence that will meet WWC standards

Our research plan has two main components: a process evaluation and an impact evaluation. Data collection will be conducted throughout the grant, and includes survey data from teachers, administrators, and students, interview data from administrators, and administrative data from schools (including MS and HS CS-related enrollments; AP test scores; see **Appendix I.III**).

Process evaluation. The process evaluation is intended to be part of a continuous improvement process (Plan-Do-Study-Act; see *Section B4*) to refine the materials and services provided to schools under the two study conditions to be tested in the cluster RCT (TA and the TA+RPP). During the first two years of the proposed project, we will conduct a small pilot test with 3 schools, followed by a field test with another 3 schools to refine the TAF, including processes, strategies, and logistics. We will document the components and processes used to support educators, including the materials used (e.g., handouts, slides, guides), the nature and frequency of meetings (e.g., agendas, online/in-person, length), and participants (e.g., roles at school/district, number of attendees). We will also ask teachers and administrators to respond to annual surveys to report their satisfaction with the TA or TA+RPP experience. These data will be compiled and analyzed by DHRA and reported to the Rutgers-led project team during bi-annual planning retreats and weekly meetings. The representatives from our TAC who are in other CS-focused RPPs can also share their expertise and insights about best practices. Our continuous improvement process will yield a compilation of evidence-based recommendations and best practices, as well as a set of robust strategies for implementing the TAF in other settings. For example, one of the characteristics of an effective RPP is trust among members (Henrick, Cobb, Penuel, Jackson, & Clark, 2017); we will be able to share our methods for cultivating positive partnerships, along with lessons learned.

Impact evaluation. Our **impact evaluation** will consist of (1) an **interrupted time series design** (ITS) to assess trends in CS outcomes and (2) a **cluster RCT** in Years 3-5 to assess the potential value added by the RPP to the TA-only mode.

Interrupted Time Series. To determine the impacts of our work with participating schools, we will conduct ITS analyses within several subsets of our participating schools ("cases"), as shown in **Exhibit 4**. For administrative data (e.g., enrollments, CS-related achievement), we will have up to four years of data prior to, and up to four years after, the onset of the intervention (i.e., when the school begins to receive TA or TA+RPP). For attitudinal outcomes, we are not able to begin data collection until 2021, so the data series will be more limited.

The design depicted in Exhibit 4 was developed based on the recommendations and guidance for single-case design studies in the WWC Standards Handbook, Version 4.1. Assignment to the intervention is made by the research team; outcome variables will be measured systematically for at least three time periods; and there are multiple data points per phase (specifically, clusters of schools with multiple teachers and students within each cluster). Because the administrative outcomes involve longer series than the attitudinal outcomes, we will be better positioned to rule out threats to internal validity with the administrative outcomes. We will provide data in graphical and tabular formats, assess the consistency of levels, trends, and variability within each phase, and make visual comparisons across the seven "cases". We may also conduct **subgroup analyses** to examine trends within each of the 38 schools, student groups (i.e., girls, Black students, Hispanic students) or schools within districts. To demonstrate an intervention effect, we will document the immediacy of the impact, the consistency of data across phases, and examine external factors and anomalies (Kratochwill et al., 2010). With guidance from our TAC members, we will explore both parametric and non-parametric methods to analyze the ITS data and estimate effect sizes (cf. Parker, Vannest, & Davis, 2011).

Exhibit 4. ITS Multiple Baseline Design for Administrative and Attitudinal Outcomes

Group	2017	2018	2019	2020	2021	2022	2023	2024	2025
Administrative Outcomes									
Pilot (n=3)	O_1	O_2	O_3	O_4	**X_P**	O_5	O_6	O_7	O_8
Field Test (n=3)		O_1	O_2	O_3	O_4	**X_{FT}**	O_5	O_6	O_7
TA-Only (n=16)			O_1	O_2	O_3	O_4	**X_{TA}**	O_5	O_6
TA+RPP (n=16)			O_1	O_2	O_3	O_4	**X_{TA+RPP}**	O_5	O_6
Attitudinal Outcomes									
Field Test (n=3)					O_1	**X_{FT}**	O_2	O_3	O_4
TA-Only (n=16)					O_1	O_2	**X_{TA}**	O_3	O_4
TA+RPP (n=16)					O_1	O_2	**X_{TA+RPP}**	O_3	O_4

Note. Ns refer to numbers of schools in a group. X represents the onset of a school's receipt of TA (or TA+RPP) and delineates pre-intervention and post-intervention phases. Os refer to observations or phases within a data series.

Cluster RCT. The 32 schools in the cluster RCT will be randomly assigned to the comparison group which will receive TA only, or to the treatment group that will receive the same TA and also will participate in an RPP. Random assignment for the RCT will take place in summer 2023. At each school, we assume an average of 3 participating MS CS teachers in grades 5-8, and approximately 100 students per teacher, per year. Initial power analyses using explained variance and intraclass correlations informed by Hedges & Hedberg (2013), a sample size of 32 schools, and two-tailed tests at the conventional alpha=0.05 yielded an MDES of 0.541 for the two-level teacher outcomes model (teachers-schools) and 0.402 for the three-level student outcomes model (students-teachers-schools) (calculations were done within *PowerUp!*: Dong, Kelcey, Spybrook, & Maynard, 2017). To assess impacts in the cluster RCT, we will use three-level MLM, of students nested in teachers nested in schools. Potential mediators and moderators to be included as covariates are discussed in Section C.2, below. Depending on the levels of overall and differential attrition (see attrition discussion below), the proposed RCT will be able to meet WWC Version 4.1 standards, either fully or with reservations. The number of participating schools does limit our statistical power but as an early phase project, the data will provide us with initial effect sizes on which to base a larger, well-powered study, possibly a future EIR mid-phase grant application.

Attrition. The movement of teachers and students in and out of our sample will be documented in a CONSORT diagram (Campbell, Piaggio, Elbourne, & Altman, 2010). We will use several strategies to **guard against attrition**. (1) During recruitment, we will be explicit and clear in communicating expectations, to get buy-in from at least 75% of the CS teachers at each school. (2) We will conduct a commitment check among teachers and schools prior to working with a school, and particularly prior to randomization in our RCT, so that our RCT begins with intact clusters. (3) All schools in the sample will receive the benefits of the TA, so this will help with study retention (cf. Roschelle et al., 2014). (4) Through our previous work, we have developed highly effective communication and data collection strategies leading to large response rates by treatment and control participants. Should we have attrition in our RCT that exceeds WWC thresholds, we will use multiple imputation to mitigate missing data.

C.2 Key project components, mediators, moderators, and outcomes; implementation thresholds

Key project components. The project logic model is firmly grounded in theory and research on (1) principles of effective adult learning and teacher PD; (2) CS CK and PCK that improves student learning outcomes; (3) innovative equity-driven teaching methods; and (4) collaborative work and learning structures (e.g., RPPs). It also outlines the range of activities we plan to implement as part of this project and the expected short and long-term outcomes of implementation on the participating teachers and their students. Please refer to the *logic model* in **Appendix I.I** as well as **Exhibit 2** for an *overview of the project components, activities, and outcomes*.

Mediators and moderators. The teacher surveys will include measures of several key **mediators** that will be included in our multivariate analyses: teachers' perceptions of the CSE environment at their schools, such as the quality of the technology infrastructure at school, the policy environment, and the predisposition of stakeholders (i.e., principal support, parental support, student preparedness). We will also test for the potential **moderating** effects of student race, student gender, CS curriculum, and grade level; should differential impacts be found; we will include the variable(s) in our statistical models.

Outcomes. **Administrator outcomes** will be assessed descriptively, via annual interviews. The administrator interview protocol will include questions and probes regarding their: views of and satisfaction with implementation; commitment to implementation; commitment to changing school culture; degree of advocacy for external resources/support to improve CSE in the school; and perceptions of the scope and intensity of teacher and student engagement in CS. **Teacher outcomes** include: (RQ1) pedagogical beliefs about CS; (RQ2) preparedness to teach CS topics; (RQ3) preparedness to implement CS-specific instructional strategies; (RQ4) computer science instructional objectives; (RQ5) engaging students in practices of CS; and (RQ6) preparedness to implement inclusive instructional strategies. **Student outcomes** include: (RQ7) achievement in CS units/courses; (RQ8) CS self-efficacy; (RQ9) STEM competency beliefs; (RQ10) interest in computer science careers (for grades 6-8 students); and (RQ11) plans to take CS classes in high school (for grade 8 students). We will also monitor (RQ12) CS participation at the high schools (CS course offerings, CS enrollments, AP test taking and scores).

Thresholds for implementation. Because the TA condition involves more limited contact with teachers and administrators, we will require all participating teachers to contribute to the CSE Status Assessment and attend the CSE Bootcamp. We also expect that they participate in 3 of the 5 TA/PD site visits each year. For the TA+RPP condition, we will require participation in the TA as well as attendance at the annual summer institute, attendance at 80% or more of the RPP meetings, and use of the online collaboration platform a minimum of once per month.

C.3. Evaluation will provide valid and reliable performance data on relevant outcomes

Data for the process evaluation (e.g., satisfaction surveys, online platform usage data) will be used for the continuous feedback and improvement process described in **Section B4**. All changes to the implementation approach will be documented by project staff.

Survey data for the impact evaluation will be collected twice per year from teachers and students; drafts of the proposed measures are included in **Appendix I.III**. The 2018 National

Survey of Science and Mathematics Education contains several measures specific to CS teachers (NSSME+) (Banilower et al., 2018), which we will adapt and use with the 5-8 CS teachers in our study: pedagogical beliefs about CS, perceived preparedness to teach CS topics, perceived preparedness to implement CS-specific instructional strategies; CS instructional objectives; and engaging students in practices of CS (RQs1 through 5; Cronbach alphas are 0.65, 0.80, 0.89, 0.72, and 0.87, respectively). Teachers' preparedness to implement inclusive instructional strategies (RQ6) will be measured with the Culturally Responsive Teacher Preparedness Scale (Hsiao, 2015) Cronbach's alpha = 0.95. We will also include NSSME+ items that measure all teachers' demographics, educational backgrounds, and professional development related to E, so that we can compare the results from our teacher- level analyses to national statistics. We will adapt several NSSME+ items to ask technology teachers how the policy environment, stakeholders (e.g., parents, students), and school support affect the use of CS in their classrooms (Cronbach alphas are 0.73, 0.70, and 0.77, respectively).

We will measure six student-level outcomes (RQs 7-12): achievement in CS units/courses; CS self-efficacy (Blouin, 2011) Cronbach's alpha = 0.77; STEM competency beliefs (Chen, Cannady, Schunn, & Dorph, 2017) Cronbach's alpha = 0.83; interest in CS careers (grades 6-8 students only; Blouin, 2011; Cronbach's alpha = 0.93); intentions to enroll in CS classes in HS (grade 8 students only); and CS participation at the high schools (CS course offerings, CS enrollments, AP test taking and scores).

We will test the psychometric properties of each scale by using classical test theory techniques (e.g., exploratory and confirmatory factor analyses, Cronbach alpha computation) as well as item response theory (i.e., Rasch scaling). We will refine scales as needed, by revising items or adding/deleting questions.