The School of Interactive Arts ***at*** **Urban Arts Partnership**

presents

Game On: Teaching The AP CSP Through Game Design

The mission of Urban Arts Partnership (UAP) is to provide students from low-income communities with a quality 21st century education that is rooted in the arts and technology, preparing them for lifelong success. Founded in 1991, UAP is one of New York's largest arts and technology education organizations, currently serving over 500 schools, 30,000 students, and 1,000 teachers yearly.

In this project, ***Game On****,* UAP will partner with the Brooklyn North NYCDOE Borough Office, the North Carolina Department of Public Instruction, WestEd researchers, and our current industry partner Unity Technologies. *Game On* will serve rural and urban Title I high school students in 10th-12th grades, approximately 70% of whom will be from families with an income below the federal poverty line.

Game On is an in-school iteration of UAP's evidence-based School of Interactive Arts (SIA) program, and is designed to improve student learning in computer science (CS) through video game design. Through a blended professional learning model, CS teachers are supported in teaching the Advanced Placement Computer Science Principles (AP CSP) course using *Game On's* rigorous curriculum and evidence-based pedagogical approach. During this year-long course, students learn to design and develop their own video games, complete with original art, music, and storytelling elements; in so doing, they gain the knowledge and skills required to pass the AP CSP exam. *Game On* builds on a previously funded EIR *(School of Interactive Arts)*, leveraging knowledge and products generated in that project.

Priorities Addressed

In this proposal, we address **AP 3—Field-Initiated Innovations in STEM,** and **CPP 1: Computer Science.** *Game On* is designed to improve student achievement and attainment in computer science (CS) and expand access to and participation in rigorous CS coursework for traditionally underrepresented students; we address the priority by developing an effective, engaging, accessible, and scalable AP CSP curriculum and pedagogy, designed for and implemented in Title I schools with large percentages of high-need students. Although students who take AP CSP are at least three times as likely to study CS in college as those who do not have this course available to them (College Board, 2020b), AP CSP courses are far from universally available, especially in Title I schools. UAP's past work, including a previous SIA project funded by EIR, also suggests the need for new approaches to teaching AP CSP courses. Through researching whether using game design curriculum in introductory CS increases the likelihood that students will enroll in advanced CS courses, we found that teachers did not feel that existing AP CSP curricula were sufficiently engaging for many students, nor always accessible given schools' limited budgets and technology capabilities.

One reason for the lack of access to AP CSP courses is a lack of qualified instructors. *Game On* therefore addresses **CPP 3—Promoting Equity and Adequacy in Student Access to Educational Resources and Opportunities** by increasing students' access to fully certified, experienced, and effective CS teachers in Title I schools. *Game On* is designed to improve the preparation, recruitment, early career support, and development of CS teachers in high-need schools, through collaborative, job-embedded, and sustained professional development activities

INPUTS	ACTIVITIES	OUTPUTS	OUTCOMES
HUMAN RESOURCES • Chief Program Officer • SIA Project Director • SIA Curriculum Developer • SIA Staff • High School Teachers • District-based Administrators **SIA STUDENT CURRICULUM** • *Game On* AP CSP Curriculum **SIA TEACHER PL MATERIALS** • Hands-on activities • Synchronous and Asynchronous PL • PLC virtual meetings • Assignments • Learning assessments **TECHNOLOGY/EQUIPMENT** • C# Programming Language • Software: Streaming Unity Game Engine/ Google Suite, BandLab, Adobe Creative Suite, Discord, Twitch, Piskel, Itch.io • Hardware: Laptops, Chromebooks • WiFi connection and bandwidth **FACILITIES** • Classroom space at schools • SIA Learning Lab in Manhattan for in-person Professional Learning, Space at NC Schools for in-person PL	**RECRUITMENT** Recruit 56 new teachers in 56 schools in partnership with the Brooklyn North Borough Office and the North Carolina Department of Public Instruction	2400 students at 56 schools (50% in NYC, 50% in NC) enroll in the new AP CSP curriculum	**SHORT-TERM** • 75% of students will sit for the AP CSP exam • Students who take the AP CSP exam will pass at higher rates, compared to identified comparable schools. • 90% of students demonstrate increases in specified measures of growth mindset relating to CS and attitudes around coding. • 70% of students report an increased interest in STEM learning experiences, and a greater awareness of potential career paths in STEM fields. • 75% of participating teachers will report that PL activities adequately prepared them for in-class implementation. • 75% of participating teachers will report increased confidence in implementing *Game On* curriculum. • 100% of participating teachers will demonstrate increased knowledge of CS through benchmarks and an assessment developed by Unity Technologies. **LONG-TERM** • Students graduate and enroll in STEM disciplines at college, and will have significant pre-professional engagement with game design/development & STEM-related workplaces.
	CURRICULUM DEVELOPMENT • Align to NC K-12 Computer Science Standards • Align to NY K-12 Computer Science Standards • Align to College Board AP CSP Course Framework	AP CSP *Game On* Curriculum Guide and other instructional materials and resources completed	
	PROGRAM DELIVERY (for Students) Deliver a full-year AP CSP course taught by an in-person teacher and supported remotely by UAP staff.	• Students receive 108 hrs of classroom instruction • Students produce 1 "Create Performance Task" (i.e. a game) for the AP CSP Exam	
	PROFESSIONAL LEARNING (for HS Teachers) **Provide:** 10 hours of synchronous PL; 20 asynchronous 1-hr learning modules; 10 hours of self-guided learning projects; > 15 hours of individual/small group coaching; > 6 hours of embedded coaching; > 9 hours of PLC meetings; Remote "office hours" as needed	Teachers complete a minimum of 90 hours of PL activities over two years, or a minimum of 70 hours of PL activities over one year.	• Teachers demonstrate competency in teaching a game design-based AP CSP course. • Teachers embrace leveraging video game design as an effective strategy for engaging students in CS learning.
	DISSEMINATION Post informal updates on SIA and WestEd websites and other social media platforms	Research results presented at scholarly conferences, resulting in at least one peer-reviewed publication.	*Game On* curriculum is submitted to the College Board for endorsement.

Section A: Significance

A.1. The project develops promising new strategies that build on existing strategies.

Game On curriculum and pedagogical approach are grounded in three primary principles: game design as a pathway to CS, arts-integration and creative coding, and culturally responsive teaching. The effectiveness of these strategies is supported by research in the field as well as by initial evidence from previous *School of Interactive Arts* (SIA) studies.

Initial Evidence from SIA: Initial evidence from recent iterations of SIA programs suggests that using arts-integrated game design is highly effective in helping students learn CS concepts, principles and skills, and increases their likelihood of continued participation in STEM-related fields. For example, of the students enrolled in our out-of-school SIA courses who take the AP CSP exam, in the last two years 84% have passed, compared to about 70% nationally, 60% in North Carolina, and 40% in New York City. An internal 2018 SIA study found that students (N=512) demonstrated mastery of key CS skills learned through the SIA curriculum: 90.8% successfully applied a creative development process when making a digital artifact, 81.4% mastered the skill of employing appropriate mathematical and logical concepts in programming, 80.5% mastered the skill of expressing an algorithm in a programming language, 94.1% collaborated when processing information to gain insight and knowledge, and 92.4% used models and simulations (SIA, 2018). Additionally, preliminary evidence suggests that participation in SIA may increase the likelihood that students will attend postsecondary programs in STEM fields; in the past two years, 90% of graduates of our out-of-school *SIA Mastery* course – almost all of whom were first in their families to attend college – have enrolled in STEM programs at 35 different colleges, earning almost $5 million in scholarships.

Absent national standards for CS, the AP CSP framework serves as our best proxy for advanced CS learning standards. The AP CSP course is not linked to a specific curriculum, and as its low pass-rates attest, the exam has proven difficult for instructors to teach and for students to master. Evidence from our previous EIR-funded work suggests that in-school game design instruction can increase students' knowledge of introductory CS principles and interest in pursuing further CS studies, and results from advanced out-of-school iterations of SIA show participants' improved performance on the AP CSP exam and increased likelihood of entering a STEM-related career. *Game On* will leverage this knowledge to create an in-school curriculum, pedagogical approach, and accompanying professional learning model using game design to teach advanced CS principles through an AP CSP course.

Game Design as a Pathway to Computational Thinking Skills and CS Principles: Researchers have found the study of CS through game design to be effective in helping students master computational thinking skills and CS principles at both secondary and postsecondary levels (Morrison & Preston, 2009; Ernst & Clark, 2012; Brennan, 2013; Doerschuk et al., 2013; Granic, Lobel & Engels, 2014; Fowler et al., 2016; Weintrop & Wilensky, 2016; Togashi, 2019). Representative of this growing consensus Weitze's (2017) finding that as students learned through game design, "they were challenged to become innovative and creative and were supported in their thinking and learning processes, developing knowledge about problem-based work and CT [computational thinking] competencies." In particular, there is growing evidence that the self-expressive features of game design are leading drivers of improved learning outcomes, specifically for computational thinking skills and enhanced interest in coding. Schanzer, Krishnamurthi & Fisler (2018) found this to be true for students using *Bootstrap: Algebra*, as did Hubert & Rosen (2020) for students using *BrainPOP*'s game-oriented coding curriculum.

Like others researching the use of game design to address equity, diversity and inclusion (Pinkard et al., 2020; Kafai & Burke, 2015), we find game design to be an especially powerful pathway for learners in underserved communities to develop CT skills and principles; as Kafai & Burke contend "[m]aking games…not only more genuinely introduces children to a range of technical skills but also better connects them to each other, addressing the persistent issues of access and diversity present in traditional digital gaming cultures" (Kafai & Burke, 2015). Our approach clearly aligns with a 2021 NASEM report concluding that "[l]earning experiences in computing that are designed with attention to learners' interests, identities, and background...may attract and retain more learners from underrepresented groups in computing...than learning experiences that focus solely on professional practice" (NASEM, 2021a).

Creative Coding – An Arts-Integrated Approach to Teaching and Learning: As part of UAP's long history of integrating arts activities into teaching and learning in academic study areas, we consider creative coding to be an arts-integrated teaching and learning approach that helps students learn CS skills as a means to artistic expression, and vice versa. In previous iterations of SIA, and echoing the work of fellow arts-integration researchers, we have witnessed the capacity of arts-integrated instruction to significantly increase students' engagement, motivation, and persistence in their academic work (Asbury & Rich, 2008; Perignat & Katz-Buonincontro, 2019; Wu & Rau, 2019, Hetland et al., 2013). Furthermore, both general education populations and populations defined as "at-risk" have shown significant academic and behavioral gains from arts-integrated classroom instruction (Butzlaff, 2000; Deasy & Fulbright, 2019; Bowen & Kisida, 2019; Soundy & Qiu, 2006). A study of students using EarSketch, which teaches coding via music, reported "statistically significant gains in computing attitudes and creativity," finding that the program's "creative learning environment drives improvements in students' attitudes and intent to persist in computing" (Engelmann et al., 2017).

Culturally Responsive Teaching (CRT): Because a large majority of children play video games regularly (NPD Group, 2019), teaching CS through video game design exemplifies CRT, which has been linked to "academic achievement, improved attendance, [and] greater interest in school" (Hammond, 2015; Muniz, 2019, Paris et al., 2017). By leveraging students' personal interests and their existing "funds of knowledge" (Gonzales, Moll & Amanti, 2005), we believe *Game On* is likely to increase student participation and engagement.

A.2 Dissemination Plan

A primary program aim is to develop and field-test the *Game On* curriculum and accompanying professional learning (PL), and submit the program to the College Board for its endorsement of UAP as a provider of AP CSP Curricula and Pedagogical Support. Upon approval, *Game On* would join only fourteen other nationally-approved curricula (College Board, 2021), thus providing a set of effective resources for educators nationwide seeking to implement effective CS programs. As one of the few College Board curricula to utilize game design, and as the only one that can be implemented exclusively on low-cost and "lightweight" hardware such as Chromebooks, *Game On* will be well-suited to those wishing to expand access to and participation in rigorous CS coursework for traditionally underrepresented students.

UAP and WestEd will use a variety of dissemination strategies to share research results, pedagogical practices, and curricular materials. Intended audiences include policy makers, funders, researchers, curriculum developers, teacher educators, and district and school personnel.

Table 1: <u>Game On</u> Dissemination Goals and Activities

Dissemination Goal 1. Share innovative resources and knowledge with end users	
Project Website	• Resources schools and districts can use to start their own *Game On* program and request professional learning and technical support from UAP • Research data showing the impact of the program on student outcomes
Dissemination Goal 2. Build broad awareness across diverse audiences	
Social Media	• WestEd communications department and social media platforms *(see below)* • UAP social media platforms *(Ex: LinkedIn, Medium)*
Research Articles	• Submit articles on research to peer-reviewed journals aimed at varied audiences (e.g., *American Educational Research Journal, Educational Researcher, Journal of Adolescent and Adult Literacy, Journal of Research on Educational Effectiveness, Journal of Research in Innovative Teaching and Learning, Journal of Research in Science Teaching, The STEAM Journal, Written Communication)*
Dissemination Goal 3. Encourage deeper knowledge exchange among stakeholders in the field	

Conferences	• Propose conference presentations to professional organizations serving diverse stakeholders such as practitioners, curriculum designers, researchers, teacher educators. *(e.g. American Educational Research Association, Association for Supervision and Curriculum Development, CS Teachers Association, CS4All and CS Teacher Association state and local chapters, Innovative Schools Summit, Learning Forward, Society for Research on Educational Effectiveness.)*

Additionally, we will leverage WestEd's existing partnerships and seek opportunities to communicate through the Regional Educational Laboratories (RELs) led by WestEd, and the National Comprehensive Center Network, disseminating project findings and products through their work with states and districts. WestEd's award-winning Communications Department will promote new materials and findings by authoring posts for WestEd.org's *Insights* blog (viewed 45,000 times in 2020) and submit findings for potential articles in WestEd's *R&D Alert Online*, which reaches a wide audience including policymakers at the state and federal levels including House and Senate members. WestEd also actively disseminates its work through its semi-monthly newsletter, regional and national association conferences, online live events and recorded webinars, and social media, which are followed by 32,600 teachers, education leaders, and other key influencers. WestEd's website (WestEd.org) averages more than 240,000 views per quarter.

Section B: Project Design

B.1 Conceptual framework underlying the proposed research

Based on game design as a pathway to CS, arts-integration and creative coding, and collaborative learning, *Game On* represents an innovative approach to CS teaching and learning.

Teaching AP CSP through arts-integrated game design : Of the fourteen providers of AP CSP Curricula and Pedagogical Support currently endorsed by the College Board to teach the AP Computer Science Principles course, only three include game design, and none are fully accessible on devices like Chromebooks or bring the arts-integrated focus of *Game On.*

[redacted]

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Program Participation: *Game On* will serve 56 high schools with one CS teacher per school (28 in NYC and 28 in NC), each participating for 2-4 years, & 2,400 students (based on ~20 students per class per year.)

Table 2: Student and Teacher Participation (Project Year does not align with school year)

<table>
<tr><th></th><th colspan="3">Year 1: 2022</th><th colspan="3">Year 2: 2023</th><th colspan="3">Year 3: 2024</th><th colspan="3">Year 4: 2025</th><th colspan="2">Year 5: 2026</th></tr>
<tr><td colspan="15">Teacher Cohorts: 50% in NYC, 50% in NC</td></tr>
<tr><td>Professional Learning (Jun-Aug)</td><td></td><td>Coh. A</td><td></td><td></td><td>Coh. B</td><td></td><td></td><td>Coh. C</td><td></td><td></td><td>Coh. D</td><td></td><td colspan="2"></td></tr>
<tr><td>Supported Implementation (Sep-Jun)</td><td colspan="2"></td><td colspan="2">Cohort A
8 teachers</td><td></td><td colspan="2">Cohort B
12 teachers</td><td></td><td colspan="2">Cohort C
16 teachers</td><td></td><td colspan="2">Cohort D*
20 teachers</td><td></td></tr>
<tr><td>Mastery Implementation (Sep-Jun)</td><td colspan="3"></td><td colspan="2"></td><td colspan="2">Cohort A
8 teachers</td><td></td><td colspan="2">Cohorts A,B
20 teachers</td><td></td><td colspan="2">Cohorts A,B,C
36 teachers</td><td></td></tr>
<tr><td colspan="15">Students Served: 50% in NYC, 50% in NC</td></tr>
<tr><td>~ 20 per class</td><td colspan="2"></td><td colspan="2">160</td><td></td><td colspan="2">400</td><td></td><td colspan="2">720</td><td></td><td colspan="2">1120</td><td></td></tr>
</table>

* Through this grant, Cohort D will not receive Mastery Implementation, although we will pursue alternate funding to provide this support level in 2026/27.

Curricular Content: *Game On* is a year-long course, organized into four units. Each unit is 25-29 hours of coursework, and contains specific skills that must be mastered and assessed through a series of **Do It Now** mini-projects; for example, students might learn coding skills such as how to embed an object to make it appear on the screen, how to move objects around on the screen, how to program certain keys to be user controls, etc. Each unit then culminates with the completion of a **Benchmark Project** in which students must synthesize and use the skills learned throughout the unit; for example, students may be asked to combine that unit's skills to create a *Space Invaders*-type game. In the course's final unit, students work collaboratively to put together all the skills learned in order to **design and create their own original video game**.

Unit 1: Intro to Unity & Visual Studio; programming concepts and syntax, writing scripts with C#; empathy-building exercises; intro to computational and algorithmic thinking

Unit 2: Advanced algorithms and script writing; digital citizenship and the impact of computing; visual art; debugging; data; create classic games from scratch (e.g. *Space Invaders*); Collaborative Game Jam

Unit 3: Principles of game design; game physics; narrative writing for games; music production; computer systems and networks; AP CSP practice assessments

Unit 4: Game development principles; students create their own original game; submission of the "Create Now" project; final AP CSP test preparation

In each unit of instruction, *Game On* uses our **Replicate - Modify - Create** methodology.

- **Replicate:** Students engage with a sample game exemplifying the unit content, learn how the C# code works in that game, and then are given time to study and memorize it. Students then recreate the game from memory.
- **Modify:** Students delve deeper into aspects of the code used to create the previous lesson's replication project: they are offered a 'menu' of ~5 options for modifying the game, of which they choose and implement 3-5. They also engage in debugging exercises.
- **Create:** Students create an original project from scratch that requires them to demonstrate the C# knowledge they have acquired so far. Working within the parameters of a success rubric, students use their own imagination and innovation to create an original game.

Professional Learning Design: *Game On's* professional learning design is aligned with the findings of Darling-Hammond et al. (2017), addressing all seven of their "Elements of Effective Professional Development;" we provide PL that "1) is **content focused;** 2) incorporates **active learning** utilizing adult learning theory; 3) supports **collaboration**, typically in **job-embedded contexts;** 4) uses **models and modeling** of effective practice; 5) provides **coaching and expert support;** 6) offers opportunities for **feedback and reflection**; and 7) is of **sustained duration"** (Darling-Hammond et al., 2017). Over the course of a summer and two school years, teachers engage in over 90 hours of different types of PL activities, described in the table below.

Table 3: Game On Blended PL Component Descriptions

Component	Description
Synchronous PL Workshops	SIA staff lead synchronous virtual professional learning workshops for participating teachers, consisting of hands-on activities, instruction on use of asynchronous modules, and reflective practice.
Asynchronous Learning Modules	Asynchronous learning modules include instructional videos, assignments, and learning assessments. Teachers complete the same **Do It Now** mini- projects that they will have their students carry out.
Self-Paced Project Completion	To support student learning, teachers engage in the same **Benchmark Projects** that they will have their students carry out.
Individual / Small Group Coaching	Teachers engage in regular half-hour meetings with a UAP Teaching Artist during the school year to discuss, plan, and troubleshoot in-class implementation of *Game On* curriculum and pedagogy.
Embedded Coaching	Convening virtually, UAP Teaching Artists co-lead in-school sessions with students in which key program elements are introduced.
Professional Learning Communities	PLC cohorts meet virtually on a Discord channel to discuss successes and challenges they are encountering while implementing CS/*Game On* practices. Initially facilitated by SIA staff, PLC meetings will eventually be led by returning teachers through a gradual release of responsibility.
Virtual Drop-In Office Hours	UAP hosts virtual drop-in office hours for teachers in need of support.

Table 4: Treatment Amounts of Game On Blended PL at Each Level

	Synchronous Learning	Asynchronous Learning	Self-Paced Projects	
Professional Learning	10 hours (5 two-hr sessions)	20 hours (20 one-hr modules)	10 hours	
	Individual / Sm. Group Coaching	**Embedded Coaching**	**PLC meetings**	**Office Hours**
Supported Implementation	30 half-hour sessions (biweekly)	6 co-instruction class visits	9 hours (1 hour / month)	Weekly as needed
Mastery Implementation	15 half-hour sessions (biweekly)	6 co-instruction class visits	9 hours (1 hour / month)	Weekly as needed

Table 5: Game On Program Goals, Objectives, and Outcomes

Student Achievement	
Goal 1: Students will demonstrate competency in computational thinking skills and proficiency in a programming language.	
Objective 1a: Participating students will complete 108 hours of the AP CSP course. **Objective 1b:** Participating students will create an original game by completing all course benchmark projects, using AP CSP aligned computational thinking skills and programming knowledge.	***Outcome 1a:*** *By the end of their participation year, 75% of students will sit for the AP CSP exam.* ***Outcome 1b:*** *Students who take the AP CSP exam will pass at higher rates, compared to identified comparable schools for each site. (Note: For implementation studies, WestEd will work with our partner sites to identify comparable schools to generate a benchmark pass rate.)*
Goal 2: Students will demonstrate an increase in growth mindset relating to CS.	
Objective 2: Participating students will receive 108 hours of game design instruction embedded with activities specifically designed to increase growth mindset relating to CS and attitudes around coding.	***Outcome 2:*** *90% of students demonstrate increases in specified measures of* • ***2a:*** *growth mindset relating to CS.* • ***2b:*** *attitudes around coding.*
Goal 3: Students will demonstrate an increased awareness of and interest in pursuing STEM-related career paths.	
Objective 3: Participating students will participate in game design activities that introduce the procedures and workflows of professional game studios.	***Outcomes 3a-b:*** *By the end of their participation year, 70% of students report in pre- and post-surveys:* • ***3a:*** *an increased interest in STEM learning experiences (e.g. pursuing post-secondary interests in the field of computer science).* • ***3b:*** *a greater awareness of potential career*

	paths in STEM fields.
Teachers' Professional Learning	
Goal 4: Teachers will demonstrate competency in teaching a game design-based AP CSP course.	
Objective 4a: Participating teachers will receive 40 hours of pre- implementation PL teaching how to use *Game On* curriculum, 30 hours of various PL activities in their first year of implementation, and 22.5 PL hours in their second year of implementation. **Objective 4b:** Participating teachers will create an original game project using C# on the Unity Platform.	***Outcomes 4a-b:*** *By the end of each project year, 75% of participating teachers will:* • ***4a:*** *report in surveys that PL activities adequately prepared them for in-class implementation.* • ***4b:*** *report in pre- and post-surveys increased confidence in implementing Game On curriculum.* ***Outcome 4c:*** *100% of participating teachers will demonstrate increased knowledge of CS through benchmarks and an assessment developed by Unity Technologies.*

B.3 Addressing the Needs of the Target Populations

Increasing CS participation of underrepresented students: Women, racialized people, and those from low-income households are underrepresented in technology-related careers (Muro et al., 2018; National Science Board, 2018). Yet according to the US Bureau of Labor Statistics (BLS), "Employment in computer and information technology occupations is projected to grow 11% from 2019 to 2029, much faster than the average for all occupations" (BLS, 2021). Specifically, video gaming is a multi-billion dollar industry worldwide, larger than any other entertainment sector, and is expected to grow at a similar rate (Wijman, 2019). Even for non-tech occupations, digital literacy is essential; not only do over half of all jobs require some degree of digital skills, but those requiring higher degrees of digital skill tend to pay more (Muro et al., 2018).

It is therefore essential to offer students in Title I schools rigorous and effective CS instruction. As mentioned above, prior research suggests that *Game On*'s curriculum has the potential to effectively teach AP CSP principles, and using inexpensive equipment to do so removes a financial barrier to accessibility for students attending Title I schools.

However, it can be difficult to convince high-school students to sign up for CS courses; this is especially true for students from traditionally underrepresented groups (Adair, 2020). We believe that through its culturally-responsive focus on game design, arts-integrated approach, and introduction to the procedures of professional game studios, *Game On* addresses the challenge of attracting and engaging a diverse group of students, and the need to increase students' interest in pursuing STEM-related career paths. In prior work, SIA has successfully attracted a diverse student base; 91% of our *SIA Mastery* students are from low-income communities, 92% are students of color, 50% are female-identifying, and 10-14% identify as LGBTQ+.

Building capacity for universal CS education: Computer programming is one of the most important skills in the 21st Century, and yet CS education is still in its infancy due to a lack of qualified teachers and classroom infrastructure for teaching this highly specific and complex skill. For example, only 14% of New York City high schools offered an AP CSP course last year. Math or technology teachers often end up teaching CS; these teachers may have taken a CS class or two in college, but this level of preparation does not usually give them the skills to help students when they run into roadblocks working in programming environments. Through its rigorous, detailed curricular materials, sustained and intensive PL activities, industry partnerships, inexpensive hardware requirements, and ultimately, the development of a replicable and scalable model, *Game On* is poised to help build capacity for universal CS education on the national level.

Section C: Management Plan

C.1 Responsibilities and Timeline

Table 6: <u>Game On</u> Roles and Responsibilities

Role	Project Responsibilities
Project Director	Oversees program implementation; liaises with school administrators, staff, and evaluation team; monitors progress toward all objectives; ensures program is implemented within budget; aids in dissemination efforts
Senior Leadership Team UAP CEO, COO & CPO.	Ensures that resources from across the UAP support the successful implementation of the project; provides financial and logistical oversight and support to ensure that the goals and objectives of the grant are met in a timely and fiscally responsible manner
Evaluation Team WestEd	Collects data for monitoring annual project objectives; prepares all required evaluation reports; provides regular evaluation updates to SIA staff for continuous quality improvement; aids in dissemination efforts
Program Team UAP	Creates curriculum guides; creates asynchronous PL resources; monitors and implements program and curriculum improvements; instructs teachers, participates in dissemination activities

Table 7: <u>Game On</u> Project Timeline

Program Team	**Year 1**		**Year 2**		**Year 3**		**Year 4**		**Year 5**	
Research & Evaluation Team										
Recruit schools & teachers (Cohort A)	•									
Modify SIA curriculum for in-school AP CSP course	•	•								
IRB approval	•									
Test and confirm research instruments	•	•								
Formative Evaluation and reporting	•	•	•	•	•	•	•	•		
Yearly research report	•	•	•	•	•	•	•	•	•	•
Usability Study	•									
Cohort A: Professional Learning		•								
Classroom Feasibility Study		•								
Cohort A: Supported Implementation		•	•							
Ongoing assessment and modification of curriculum		•	•	•	•	•	•	•	•	•
Recruit incoming schools & teachers (Cohorts B, C, D)				•		•		•		
Cohort B: Professional Learning				•						
Classroom Implementation Study (initial)				•	•					
Cohort B: Supported Implementation				•	•					
Cohort A: Mastery Implementation				•	•					
Cohort C: Professional Learning						•				

Classroom Implementation Study (final)						•	•			
Cohort C: Supported Implementation						•	•			
Cohorts A, B: Mastery Implementation						•	•			
Impact Study								•	•	
Cohort D: Professional Learning								•		
Cohort D: Supported Implementation								•	•	
Cohorts A, B, C: Mastery Implementation								•	•	
Summative Analysis and Dissemination									•	•
Final summative report										•

C.2 Key Personnel

[redacted]**, *Project Director:*** [redacted] is Director of the School of Interactive Arts (SIA), UAP's flagship arts and technology program. Since joining UAP in 2015, [redacted] has directed UAP's large-scale educational technology research initiatives, including federally funded projects (EIR, PDAE). [redacted] holds a Bachelor of Science in Physics and Neurobiology degree from the University of Connecticut.

[redacted]**, *Curriculum Developer:*** [redacted] is an SIA faculty member. Formerly a certified game design teacher at the NYCDOE, she created New York State's first state-approved CTE program in video game design for high school students. She holds a Bachelor of Science degree from NYU Polytechnic School of Engineering in Integrated Digital Media.

[redacted], ***Co-Principal Investigator*:** [redacted] is the Senior Director for STEM Research and Entrepreneurship at WestEd and serves as the Principal Investigator of the National Science Foundation's Center for Assessment and Evaluation of Student Learning. [redacted] also directs the National Center on Cognition and Mathematics Instruction, and serves as the PI and Content Expert for the Science Review Team for the USDOE's What Works Clearinghouse. [redacted] holds a PhD in the design and evaluation of educational programs with an emphasis in science, mathematics, and technology education from Stanford University.

[redacted] ***Co-Principal Investigator*:** [redacted] is Senior Associate, Curriculum and Evaluation at WestEd, where he manages and evaluates all Carnegie Math Pathways offerings, leads instrumentation on large scale efficacy studies, and has led many evaluation and experimental research projects of educational technology programs and products. He holds a PhD in Experimental Psychology: Cognitive and Learning Sciences from the University of Louisville.

[redacted]**, *Senior Researcher***: [redacted] is an Associate Director with WestEd's Learning and Technology team. She is currently a content specialist for the 2026 National Assessment of Educational Progress (NAEP) Reading Framework Update and is co-chair for the Collaborative for Academic, Social, and Emotional Learning (CASEL) SEL Providers Council Steering Committee. [redacted] earned an MA and PhD in language, literacy, and culture from University of California, Berkeley and an MFA in Dance and Creative Practice from Saint Mary's College of California.

[redacted], ***Formative Evaluation Director***. [redacted] is the Director of Educational Technology at WestEd and has served as PI for over twenty Small Business Innovation Research (SBIR) grants funded by IES, NSF, and NIH, among many others.

[redacted]**, *UAP Chief Executive Officer***: [redacted] has served as CEO of Urban Arts Partnership since 2003 and has built one of the country's largest and most diverse arts education organizations focusing on the intersection of arts, academics, and technology.

[redacted]**, *UAP Chief Program Officer:*** As UAP's CPO, [redacted] has overseen the growth of the organization's game design programs since 2018. [redacted] has overseen UAP's work on three other federally-funded projects through EIR, AAEDD, and PDAE.

C.3 Costs are reasonable in relation to objectives, design, and significance

Over the grant funding period, the proposed project will directly serve 56 schools and 2,400 students at a cost of $78,358 per school and $1,828 per student as well as hundreds of teachers and students through our disseminations plan.

However, as an early-phase project, the bulk of the project budget will be invested in curriculum and model development, evaluation and research, and the creation of instructional assets such as a written curriculum guide, instructional videos, and asynchronous learning modules. Our intention is to 1) develop and test a rigorous game design-based AP CSP curriculum and methodology, and 2) to develop and test a PL delivery system for said curriculum that is cost-effective, replicable, and scalable. Once the curriculum and PL model are in place, and instructional assets have been created, implementation costs are greatly reduced.

C.4 Ensuring feedback and continuous improvement

To ensure feedback and continuous improvement in the operation of the project, all activities below occur at regular intervals; exceptional or pressing issues that arise outside of this plan will be addressed as needed. The **Program Team** will meet biweekly to review project progress, identify challenges, and make any necessary adjustments to implementation, sharing input from **teachers** and **students**. The Project Director will meet monthly with the **Formative Evaluation Director** to review progress toward partnership goals and objectives, problem-solve, and make adjustments to the delivery of the program. The Project Director will meet bimonthly with **district and school administrators** to review progress toward partnership goals and objectives, problem-solve, and make adjustments to the delivery of curriculum. All information will inform development and improvement of services.

Section D: Project Evaluation

WestEd will conduct an independent evaluation of *Game On* over the project's five years. The evaluation will consider the execution and ultimate impact of all project activities, focusing on students' growth mindset, attitudes, opportunities to learn, computational thinking, and AP computer science outcomes. Working collaboratively with UAP during early development, WestEd will actively engage in formative evaluation studies to provide critical feedback for program development. After the development phases, WestEd will conduct an impact study using a quasi-experimental design (QED) that meets the What Works Clearinghouse standards without reservations (WWC, 2020). To provide context for understanding student impact, WestEd will conduct two implementation studies to explore all aspects of *Game On* implementation. The implementation studies will provide a rich and contextualized understanding of factors that may mediate the program's ability to affect its targeted outcomes. Through these studies, program stakeholders will better understand the link between program implementation and impact by examining the associations between implementation measures and the outcomes of interest.

Table 8. Summary of the samples and timeline for each major evaluation component.

	Usability Study	Feasibility Study	Implementation Study (initial)	Implementation Study (final)	Impact Study
Study Years	1	1	2-3	3-4	4-5
Teachers	3	5	10	20	72
Students	6	100	200	400	1440

D.1 Data Sources

Throughout the evaluation, various instruments will be used to gather appropriate data for the corresponding stage of the project. In addition to interviews, observations, and logs specific to evaluation components, described below and in Appendix J.1, the following are included in multiple evaluation phases:

Growth Mindset. We will use Dweck's 3-item growth mindset scale (Dweck 1999; 2006).

Attitudes around Coding. We will use an adapted Elementary Student Coding Attitudes Survey (Mason and Rich, 2020). Mason and Rich (2020) validated five constructs in this survey that include the following attitudes toward coding: social value, coding confidence, coding interest, perception of coders, and coding utility.

Student Interest in Attending College for a STEM-related Field. We will use items UAP has used in other studies (developed in-house) to gauge students' interest in attending college for a STEM-related field.

Computational Thinking. We will use the Computational Thinking Concepts and Skills Test (Peteranetz et al., 2020). The 18-item test was written by computer science faculty and includes CT and CS skills. Peteranetz et al. (2020) showed validity and reliability of this measure using a large sample of undergraduate students.

Student Opportunities to Learn. We will use items adapted from studies that provided evidence of sufficient validity and reliability for these measures (Rickles, et al., 2019; Walters et al., 2018): opportunities to make real-world connections (Cronbach's α=0.84), opportunities to justify reasoning using computer science (α=0.82), opportunities to solve challenging problems in computer science (α=0.78), and opportunities to demonstrate conceptual understanding (α=0.80).

D.2 Formative Evaluation

During the first three years of the evaluation, periodic assessment of progress will be addressed through formative evaluation questions (Patton, 2008), such as: What are the strengths and weaknesses of *Game On*? What types of implementation problems are occurring and how can they be corrected? What do participants want to change? Interviews, logs, observations, a usability study, and a classroom feasibility study will be used to answer these and other questions. Additionally, formative evaluation activities around the PL program will occur in Years 1-4. This will include observations of PL activities, participation logs, teacher interviews and focus groups, and surveys to gauge engagement with and perceived usefulness of all PL activities.

D.3 Usability Study

In May 2022, WestEd will conduct a usability study on the *Game On* prototype, tailored to the developer's needs, testing both the overall prototype, platform, and related materials, while focusing on key features that require user testing and feedback. The study will focus on whether they: 1) function as intended, 2) provide an engaging experience for students, and 3) can be improved. See Appendix J.2 for the full set of guiding questions.

Study Implementation. Three high school teachers and six students will participate in the usability study. Research has shown that this is a sufficient number of testers to identify major issues in a prototype, and that testing with additional users provides diminishing returns (Nielsen, 2000). The sample will be intentionally balanced with respect to demographics.

Data Collection. During usability testing, teachers and students will engage with identified components of *Game On's* platform and curriculum to provide feedback. They will be invited to participate in one-on-one testing sessions lasting 60 minutes. WestEd researchers will guide them through the prototype's core features, asking them to "think aloud" and explain their thought processes as they go. A facilitator will guide users and a trained observer will record user actions, reactions, and feedback. At the end of each session, WestEd will interview them about their overall experience, the ease of use, and their understanding of the content presented.

Data Analysis & Reporting. User sessions and interviews will be audio recorded, transcribed, and analyzed using the grounded-theory approach (Charmaz, 2006; Corbin and Strauss, 2015) of open and axial coding, to move small bits of information into larger categories and themes. This will result in a qualitative summary of findings with actionable recommendations to UAP for revisions to the *Game On* platform and curriculum.

D.4 Classroom Feasibility Study

During Year 1, WestEd will conduct a classroom feasibility study on the refined *Game On* program. This will determine if teachers and students can use the platform and curriculum as intended in an authentic education setting, with some guidance and support at a small scale. Feasibility testing will: 1) ensure that teachers and students are able to set up and use all technical components, 2) ensure that students are able to use appropriate components to complete select tasks and activities related to the program, and 3) collect early evidence of student impact. See Appendix J.X for the full set of guiding questions.

Study Implementation. During the first three months of the school year, WestEd will conduct the study using a subset of Cohort A: five teachers and their students (n=100). This time frame allows for further refinement and testing during the remainder of the year.

Data Collection. Through interviews, focus groups, and observations, WestEd will capture data related to the implementation of *Game On* in the classroom, including barriers and technical difficulties teachers and students experience. Students will take a pre and post-survey, measuring their growth mindset, attitudes towards coding, computation thinking, and interest in pursuing STEM in college (see D.1). The post-survey will also include the items around opportunities to learn. Feedback will also be collected from teachers through a monthly log, asking a small number of open-ended items around their approach and use of the program components, and a final interview that explores the overall reflections and suggestions for improving the experience.

Data Analysis & Reporting. Data from all sources will be coded and analyzed to answer the research questions and suggest any improvements to the program or its implementation. A qualitative and quantitative summary of findings will provide actionable recommendations to UAP for revisions to *Game On*.

D.5 Classroom Implementation Studies

During Years 2 - 4, WestEd will conduct a yearlong classroom implementation study on the refined *Game On* program, using research questions from the feasibility study.

Study Implementation. WestEd will conduct a classroom implementation study involving ten teachers and their students (half from Cohort A and half from Cohort B) in Years 2 - 3 and 20 teachers and their students (half from Cohort B and half from Cohort C) in Years 3 - 4.

Data Collection. WestEd will perform at least 10 observations each year with an observation protocol that captures data related to specific design principles of *Game On*, and will note barriers to implementation and technical difficulties teachers and students experience. Students will complete the pre- and post-surveys from the feasibility study and select items to measure performance benchmarks set by UAP. Feedback from teachers will be collected using the same monthly log and interviews from the feasibility study.

Data Analysis & Reporting. Data from all sources will be coded and analyzed to answer the research questions and suggest any improvements to the implementation of the experience. The implementation study will result in a mixed qualitative and quantitative summary of findings with actionable recommendations to UAP prior to the QED in Year 5.

D.6 Impact Study

During the 2025-2026 academic year (Years 4 - 5), WestEd will conduct an impact study using a quasi-experimental design (QED) that meets the What Works Clearinghouse standards without reservations (WWC, 2020). The study will address the following research questions:

1) Confirmatory Research Question - What is the impact of using the *Game On* curriculum, relative to the control, on students' outcomes?
2) Exploratory Research Question - Does the impact of *Game On* on students' outcomes, relative to the control, vary across student, teacher, or school characteristics?
3) Implementation Question - To what extent is *Game On* implemented with fidelity and what impact does this have on student outcomes?

Study Implementation. This study will include the 36 teachers in Cohorts A, B, and C, and will targetedly recruit 36 comparison teachers from other schools, considering relevant school and teacher characteristics (e.g. moderators in Table J.4). The proposed study is powered for a minimum detectable effect size of 0.09 to 0.10. (See Appendix J.3 for details about the power analysis and Appendix J.4 for details about the statistical models for the impact analyses.)

Data Collection: Instructional Practices. To measure the quality of instructional activities, WestEd will administer a teacher log three times across the year to provide an accurate picture of the instructional activities over the entire school year. Prior studies of teacher logs indicate that they can be a valid and reliable measure of instruction (Rowan & Correnti, 2009). The log will include the following measures adapted from a RAND study of inquiry-based instruction (Le et al., 2006): inquiry-based practices intended to actively engage students and promote problem solving skills ($\alpha = 0.83$), inquiry-based activities intended to facilitate critical thinking ($\alpha = 0.77$), discussion ($\alpha = 0.74$), and computer sciences processes that include multiple representations and develop conceptual understanding ($\alpha = 0.58$) (see Appendix J.1). WestEd will also implement a brief monthly survey asking about teachers' use of *Game On* components, including frequency and duration. Together, these measures capture the types of instructional activities *Game On* aims to use in the classroom.

Data Collection: Student Surveys. WestEd will administer the same surveys from the implementation study.

Data Collection: Student Achievement Outcomes. WestEd will use students' Advanced

Placement (AP) test taking (took test / did not take the test) and results (1-5) as the primary student outcome. AP scores are considered valid and reliable by the WWC standards. Pass/fail status of their course will be used as a supplemental measure of student achievement.

Data Collection: Covariates. WestEd will work with local district and school staff to collect data about individual students, teachers, and schools to be used in our moderation analyses (see Appendix J.4).

Data Collection: Fidelity Measures. To provide context for the impact results and for mediation analyses (see Appendix J.4), WestEd will have a multi-faceted approach to collecting data around implementation. In addition to the instructional practices measures, WestEd will measure teacher and student activities against all benchmarks of intended implementation of *Game On.* WestEd will also interview a sample of at least 12 participating teachers (6 treatment, 6 control). The interviews will explore teaching approaches and use of resources. A variety of course artifacts from both treatment and control teachers will be collected in order to understand the nature of course instruction, including course syllabi, in class activities, homework assignments, exams, and presentation materials.

Attrition and Baseline Equivalence. An attrition analysis using WWC guidelines will be conducted. We define attrition as schools and teachers who do not participate or do not submit end-of-course grade data. We will compare the treatment and control groups within the complete case analytic sample to determine if the groups are equivalent at baseline, including all covariates, or if statistical adjustment of certain characteristics will be required. Baseline variables with baseline effect size differences greater than .25 will be considered non-equivalent, whereas baseline variables with baseline effect size differences between .05-.25 will be considered within the range of statistical correction (WWC, 2020).

Data Analysis & Reporting. The analysis of the program's impacts is discussed in Appendix J.4. Implementation data from interviews and focus groups, logs, and platform usage will be analyzed both quantitatively and qualitatively to develop narratives of *Game On* implementation across treatment classrooms. Similar analyses on the comparison will allow us to assess the achieved relative strength of the intervention-control contrast (Hulleman & Cordray, 2009) to understand the degree to which the *Game On* model differs from the pedagogical model(s) underlying the comparison condition. The overall end result will be a clear understanding of the impact of *Game On*, how the impact varies across student populations, and how implementation is actualized by teachers and students in the classroom. The mix of qualitative and quantitative findings will lead to insights and recommendations for using *Game On* to support computer science teaching and learning.

Cost Analysis. To provide information about the cost effectiveness of implementing *Game On*, the evaluation includes a cost analysis based on the Resource Cost Model (RCM; Levin & McEwan, 2002) described fully in Appendix J.5.

D.7 Contribution of Proposed Study

The *Game On* study employs rigorous methodologies to measure the success of an innovative, game design-based approach to teaching AP CSP content and principles to high school students from underrepresented groups, thereby increasing their academic success and boosting their interest in pursuing post-secondary pathways and careers in STEM-related fields. Additionally, the study will include mediating and moderating variables to explore how the program is working, for whom, and under what conditions. The proposed project is significant because it will determine whether an innovative, game-based approach can successfully improve computer science achievement in populations with a high percentage of high-need students.

This project will also examine several of the challenges found in the nation's current CS education landscape, including ensuring access to fully certified, experienced, and effective computer science teachers through effective professional learning programs, and lessening financial access barriers to CS participation for those in low-income schools. The project's findings will help *Game On* replicate and scale to reach more students across the country, improving educational outcomes and addressing access imbalances more broadly.