SCHOOL OF INTERACTIVE ARTS

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A. Significance: *(1) The national significance of the proposed project.*

Computer programming is one of the most important skills in the 21st Century, and yet computer science (CS) education is still in its infancy due to a lack of qualified teachers, engaging curriculum, and classroom infrastructure for teaching this highly specific and complex skill. The nationally significant challenge of **building capacity for universal CS education** becomes even more complex when considering the under-representation of certain population groups in CS professions and the need for differentiation in the classroom.

Although high school students are often referred to as "digital natives," youth do not have equal opportunities to learn skills that make them creators in the digital world, rather than merely consumers.[i] Students with basic CS skills and credentials such as high school or advanced placement credit can demonstrate to institutions of higher education and employers that they have the capacity to learn more complicated programming skills, to be advanced users, and to become developers themselves.

The field of CS education is relatively young, and training programs for specialized, pre-collegiate CS educators do not yet exist. Math or technology teachers often end up teaching CS, either because they have an interest or because there is no one else who can. These teachers may have taken a CS class or two in college. However, this level of preparation does not give them the skills to help students when they run into roadblocks working in programming environments. Art and Design High School Assistant Principal Elma Reingold described the challenges of providing CS instruction at her school. "We tried for years to find a programming teacher for our school, with no success. Four years ago, we hired a computer science teacher who claimed to be able to teach Unity and C# programming. Halfway through the year, we had to end his class as he wasn't teaching programming at all - only basic computer usage."

Debugging and troubleshooting are, in some ways, the most important aspects of CS education, yet are very challenging to teach[ii]. In order for students to stretch, challenge themselves, and grow in their abilities, they need to be able to make and learn from mistakes. Some highly motivated students will sift through pages and pages of online forum comments looking for an answer, but students with less initial interest in CS become frustrated, and may decide CS just is not for them. This is especially a risk for already under-represented groups of students, who may have internalized ideas that they could never be successful in CS. The majority of women and Black people in STEM jobs experience discrimination at work.[iii]

Expert help at the right time can support students in learning and growing past the frustration. Unfortunately, there is a lack of qualified and experienced CS teachers, especially in schools serving high needs students.[iv] A successful CS curriculum must connect students to experts who give them the freedom to make and learn from mistakes with thoughtful, encouraging, and appropriate support. While secondary school students are spread throughout the country, computer experts are concentrated around universities and areas with jobs in programming.

(2) Promising new strategies that build on, or are alternatives to, existing strategies.

Urban Arts Partnership (UAP) proposes the School of Interactive Arts (SIA) in order to address the nationally significant issue of **building capacity for universal CS education** through an approach based on **personalized learning**. SIA will provide **professional development (PD) to teachers, followed by coaching** them through an engaging CS curriculum based on game design. This curriculum is delivered through a scalable, online personalized learning platform - essentially, an interactive and "gamified" virtual classroom - called Ghost School, where **classroom teachers are supported by remotely-located CS experts** to create new content (such as lectures, projects, and assignments) and provide targeted support to

students when they run into roadblocks in their programming. Through the use of game design and arts integration as an enticing and fun vehicle that encourages persistence in difficult learning, SIA uses **culturally-responsive pedagogy** to engage all students, especially under-represented groups such as students of color and girls. The original games built by students who complete the SIA curriculum are a distinguishing feature of the program. These have included: Homie O'Stasis, in which the player takes on the role of a white blood cell fighting bacteria in the human body; and Green Hero, where the player tries to save the world from the effects of climate change. Students are encouraged to represent themselves in the games they produce, with characters and situations that reflect their own personal experiences, rather than the repetitive and violent scenarios of some mainstream videogames. Using Ghost School, SIA Classroom delivers two units of CS education, aligned to the first units in the Advanced Placement (AP) CS Principles curriculum, that are appropriate in level and pace for all students. This class will allow students at participating schools to earn a half credit in CS on their high school transcripts, to understand basic concepts and foundational knowledge important for more advanced classes, and to try out CS in a supportive environment. To support **differentiation**, motivated students will be able to enroll in the SIA Advanced program, where they can pursue an additional four units of CS education in a personalized way. The SIA Advanced students can earn additional credit through their school or AP exams, and will also participate in work-based learning activities such as job shadowing and launching student-created products. Recent graduates who have completed SIA Advanced can also apply for paying jobs as Ghost School Assistant CS Instructors.

Scalable personalized learning: UAP has developed the Ghost School personalized learning platform in order to be able to offer scalable universal CS education. Ghost School has been test piloted in Academic Year (AY) 2017-18, and presented a "First Look" workshop at SXSWedu in

March 2018 to a standing-room only audience of teachers, school administrators, and industry representatives; the platform has already generated interest in schools and districts beyond NYC, in addition to the already committed group of NYC Department of Education (NYCDOE) schools and districts. The EIR Early Phase Grant will support implementation and refinement of this approach. Through Ghost School, students will be able to work on self-initiated projects at their own pace, learning essential industry- and standards-aligned programming skills, while demonstrating an understanding of the process of software development through the creation of games. The platform will lead students through content as they demonstrate mastery on built-in, AI-scored assessments. Students will be supported by a robust community of learning - unlike other online learning platforms, the Ghost School is designed to enable participants (students, teachers, and remote SIA faculty) to interact with each other, not just with a computer. The platform is built to fully adhere to COPPA compliance and data privacy laws, incorporating all best practices to ensure that students have a safe and responsible experience while learning CS. Crucially, Ghost School enables a traditional classroom to implement mastery learning - the idea that students must excel in (and not merely pass) prerequisite knowledge in order to move on to subsequent units. The SIA curriculum was designed with mastery learning as one of its key innovations, drawing from the observation that students who do not demonstrate thorough understanding of earlier CS units struggle to pass later ones, as gaps in prerequisite knowledge add up cumulatively. Although secondary school CS curricula are not typically based on the mastery approach, there is strong evidence over decades of use that this method has the best impact on students, including improvements in average GPA, school attendance and confidence, engagement and participation in class discussions and activities, and attitudes towards learning.[v][vi]

Teacher PD followed by coaching in the classroom: SIA will provide each participating teacher with 25 hours of PD each year, with PD sessions offered monthly. By year 2, PD will be delivered through Ghost School as well, allowing teachers to experience the same benefits of personalized learning, especially in terms of differentiating PD to account for differences in background knowledge, an important component of evidence-based training for adults.[vii] PD will focus on basic CS concepts and the pedagogical approach of SIA. Teachers will become familiar with Ghost School during PD workshops, prior to using it in the classroom. Then, over 8 weeks, teachers will deliver 25 hours of CS education using SIA curriculum and Ghost School, with one-on-one coaching support from SIA Faculty. This coaching will also be moved entirely to the virtual platform by year 3. This approach builds on evidence-based approaches to PD, following instruction with hands-on coaching.[viii] UAP has provided federally-funded PD following a similar model in the contexts of Special Education (Every Day Arts for Special Education) and English Language Learning (Story Studio), resulting in improvements in teacher comfort and implementation of arts integration in the classroom.[ix] [x]

Access to CS Experts: Through online avatars in Ghost School, students and teachers will have access to CS experts as guides and coaches as they progress in skill and work on independent projects. These experts include SIA Faculty, Assistant Faculty (recent graduates of SIA Advanced programming), and Adjunct Faculty drawn from graduate school programs (such as the NYU Game Center, which currently provides Faculty and Adjuncts to SIA). This is a novel approach to solving one of the key challenges in CS education – students are spread throughout the country, but experts in CS tend to be centrally located. While interested math and technology teachers are able to develop competencies to teach basic CS concepts relatively quickly, it takes time to develop the experience necessary to help students through rough spots.

Moreover, the CS world changes extremely quickly, and curriculum must be able to keep up. Experts working with Ghost School will be able to develop new content, including videos, lectures, and assignments. This content will be responsive to data drawn from Ghost School on areas where students and teachers struggle, as well as responsive to changing tools and techniques in the field. Through Ghost School, the game-design, arts-based SIA approach will provide a scalable platform to allow students anywhere to connect with a programming expert to coach them.

Culturally-responsive pedagogy: SIA is grounded in the philosophy of culturally responsive pedagogy, which taps into the power of youth culture to engage all students.[xi] SIA uses the excitement of game development to offer students ways to express themselves, solve problems, persist through challenges with "hard fun," and create products of which they are proud – through game design, SIA teaches CS as art making. The aesthetic of the gamified platform is relevant, responsive and appealing to youth, developed with focus groups from the current SIA Advanced student cohort. Ghost School offers students a comfortable and relevant learning space by providing an online environment similar to other online-only spaces where youth increasingly socialize and engage in free expression.

Differentiated CS Education: All students need the opportunity to explore CS. However, some students will want to pursue CS education further, including in higher education. In order to address the issue of under-representation in CS fields, it is important that universal CS includes options to pursue advanced work. After students complete SIA Classroom, towards the end of the school year, they are able to continue on to the next four units of study in SIA Advanced – with a group at the UAP offices in NYC, with a group at their school remotely through Ghost School, or remotely through Ghost School on their own. Just like SIA Classroom,

SIA Advanced is staffed by CS experts who create new content in response to student interests and needs, and are available to offer support as students progress through the curriculum. Differentiation is increasingly important as classrooms become more and more diverse on multiple levels, and students are asked to not only acquire skills but also meta-skills needed to employ those skills.[xii] Differentiation is enhanced through use of data on student learning as in Ghost School[xiii], and gamification allows students to interact with online learning tools in their own "style," supporting engagement among a wider variety of students.[xiv]

Work-based learning: Students participating in SIA will take part in work-based learning activities including video lectures produced by working developers, job shadowing, master classes, visiting job sites, developing games for commercial launch, crowdfunding campaigns, and gaining connections to industry experts through a system such as Nepris. Nepris is used, for example, by AT&T, a SIA funder and Partner for this project.

(3) Rationale

SIA is based on evidence-based pedagogical concepts as described above: the mastery approach, personalized learning, PD followed by coaching, culturally responsive pedagogy, and multi-faceted differentiation. SIA combines all of these elements are combined with a curriculum that itself has a growing body of evidence for its effectiveness. An internal 2018 study of SIA's effectiveness found that students in both SIA Classrooms and SIA Advanced demonstrated mastery of key CS skills, learned through the SIA curriculum. For example, 90.8% of students successfully applied a creative development process when creating an 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 language, 94.1% collaborated when processing information to gain insight and knowledge, and 92.4% used models and simulations (N=512).

SIA Advanced, especially, has had tremendous success in preparing students for college-level education. As with SIA Classroom, all students attend Title 1 public schools and over half are girls. All program graduates since 2015 have matriculated to collegiate and pre-professional game design, CS, and animation programs. Every SIA senior in 2018 was admitted to NYU's top-ranked programs in game design or CS (ranked #2 program of its kind by The Princeton Review), and two earned full-tuition scholarships. To date, SIA seniors and alumni have earned over $600,000 in merit scholarships. In 2018, SIA seniors received an average 200-point increase in their SAT scores after completing the core curriculum test tutoring programs, with gains as high as 290 points (or 35 percentile points). In 2017, SIA students were winners of the top two national awards for young game developers: the Unity prize at the National STEM Game Design Challenge and two out of three category prizes at the National Games for Change Student Challenge. In addition to competitions for students, SIA seniors have engaged in real-world marketing of their games, competing directly with work created around the world by adults. Results in this area have been impressive. In 2017 and 2018, SIA alumni raised over $7,500 in successful Kickstarters to commercialize their work; all SIA campaigns were selected as featured games, out of hundreds of competing projects by professional, adult developers.

In both SIA Classroom and Advanced, our outcomes are enabled by our six-unit curriculum, which was developed in collaboration with New York University's Game Center, currently one of the top collegiate game design programs in the country. Uniquely, this curriculum is designed to enable students to not just create programs based on specific prompts, but to go a step further by generating novel solutions to the unpredictable challenges involved in developing original games. This is fundamentally different from the way in which CS is traditionally taught, and much more in line with the professional demands of software developers. SIA seniors enrolled at

NYU and other colleges have bypassed first-year courses in programming after completing our curriculum, reflecting its genuine value as a measure of student attainment.

(4) Exceptional approach to the priorities

SIA represents an exceptional approach to addressing all of the absolute priorities and the first invitational priority. As explained in 3 above, the project **demonstrates a rationale** (Absolute priority 1) by combining multiple evidence-based pedagogical approaches with a successful curriculum for CS education.

SIA is a **field-initiated innovation** (Absolute priority 2). The SIA project will be implementing, replicating, and taking to scale an entrepreneurial, evidence-based innovation that was developed by UAP in collaboration with two NYC public high schools (Art and Design and New Design High Schools), Adobe, AT&T other private funders to meet a pressing need in the field. Schools in NYC have been clamoring to offer more CS, but many lack teachers with adequate preparation or experience. The work has been, and will continue to be, done in support of achievement among high-needs students. This includes the partnership with Art and Design High School, where teachers and students will collaborate as partners in the design process.

SIA is a **field-initiated innovation promoting science, technology, engineering, or math education** (Absolute Priority 3). The project involves implementing, replicating, and taking to scale an entrepreneurial, evidence-based, field-initiated innovation to improve student achievement among high needs students. The program will build partnerships between schools, LEAs, non-profits, institutions of higher education, and businesses to help students access opportunities for hands-on experiences in STEM. In SIA, students will work through curriculum content and assessments while also developing their own independent projects. UAP has provided current SIA students with work-based experiences in partnership with Facebook, Hearst

Media, Kate Spade, Kickstarter, Topos Design, LivePeer and AT&T, and will continue to offer these to future students. SIA students will participate in work-based learning experiences including visiting work sites, job shadowing, panel discussions with professional developers, master classes, game launches, crowdfunding campaigns, and internships. In addition to internships with external partners, internships and eventual job opportunities are built into SIA itself, as SIA Assistant Faculty. UAP currently employs six graduates as SIA Assistant Faculty.

SIA will support teachers in **personalizing learning** for all students through a flexible, project-based curriculum using Ghost School online platform, with personalization in the pace, location, and delivery method (Invitational Priority 1). Students will progress through the curriculum as they develop mastery, at their own pace. Students will initially participate in classroom groups, but as the program develops they will also be able to participate in virtual groups bringing together students from multiple schools and on their own, especially for advanced material. The delivery method will include classroom instruction, online content delivery, and online project-based learning with coaching. Students will complete a variety of assessments, including quizzes, assignments such as sample code, scaffolded mini-projects, and self-directed longer-term projects. Students participating in SIA Advanced will develop portfolios to use in college applications. Through project-based learning and work-based learning such as launching original games, the project will support students in developing meta-competencies such as planning and problem solving.

In order to facilitate high quality personalized learning, the **data from Ghost School will be used in multiple ways**, including to provide feedback to remote instructors, teachers, and students, to identify areas where additional learning content is needed, and to **support teachers in adjusting their learning strategies**. Students will complete quizzes ranging from a single

multiple choice question delivered in the virtual classroom to entire problem sets requiring written responses, receiving immediate feedback from both automated and real instructors. The data collected in Ghost School, capturing every keystroke, allows for much more nuanced information as well. Students, classroom teachers, and SIA instructors will have access to a data dashboard with results of assessments, progress towards mastery, and an analysis of the readability and elegance of their code. Using techniques of meta-analysis employed by large corporations to standardize code, SIA will use Regular Expressions (regex) to automatically analyze code produced by students. Students, classroom teachers, and SIA instructors will be able to see how their code is changing over time, areas of mastery that can be leveraged for improving weaknesses, and common issues and challenges. Open-ended assignments will be graded by classroom teachers and SIA instructors, but their grading will be augmented by automated text analysis to allow for a more detailed analysis of student-generated code than feasible without use of Ghost School data. This data will support teachers in adjusting learning strategies by allowing them to see what individual students struggle with as well as patterns across their classes and in comparison with other classes using Ghost School. The dashboard will suggest content, assessments, and assignments for individual students as well as material for the teacher to go over with their class as a group.

B. Quality of the Project Design and Management Plan: *(1) Goals, Objectives, and Outcomes*

The goal of SIA is to use personalized learning, student-centered pedagogy, and partnership-building to address the lack of qualified teachers in CS. SIA will implement, expand, and improve a model whereby schools can easily offer differentiated CS to students, for credit, regardless of their ability to attract a qualified CS teacher, moving from in-person classes to a hybrid in-person/digital format, to an all digital, scalable model. The objectives of the project are

1) students demonstrate improved CS skills, 2) a greater proportion of students in partner schools earn credit at the beginner and advanced level, and 3) there is an increase in the number of CS classes offered by schools, and in the number of teachers offering CS classes.

These objectives will be measured by the following outcomes:

- Students participating in SIA will show increased CS credit accumulation and increased likelihood of taking and passing the CS AP exam, compared to a comparison group of students (objective 1).

- Partner schools will show an increase in the percentage of students earning HS and AP CS credit, compared to comparison schools (objective 2).

- The number of CS classes offered by partner schools will increase, compared to a peer group (objective 3).

- The number of teachers offering CS classes at partner schools will increase, compared to a peer group (objective 3).

In addition to these outcomes, the program evaluation (see section 3 and Appendix H) will use teacher surveys and Ghost School data to assess the effectiveness of PD. This will include analysis teacher and student data in Ghost School, changes in teacher attitudes towards game design and CS, and teacher comfort with implementing the curriculum.

During Year 1, teachers will receive 25 hours of PD to build their understanding of CS concepts and their familiarity with the Ghost School platform and SIA curriculum. In Years 2-5, PD will be offered via the Ghost School, and will be differentiated to serve the needs of experienced and new teachers. Experienced teachers will work with SIA Faculty to generate new lesson plans, videos, assessments, exercises, and other curricular assets for implementation in their CS classes. Each year, classes will run for 8 weeks, for a total of 25 hours. In the first year,

this will include a SIA Faculty member from UAP working directly in classrooms to teach the first two units of SIA's curriculum to students. As the classroom teachers' understanding of CS develops and as the the pool of curricular assets they have generated deepens, SIA Faculty will be able to step back, with teachers providing in-class instruction and SIA Faculty and Assistant Faculty providing support via Ghost School. The progression towards digital delivery and scalability is presented in the next section. ***NOTE: Please see logic model in Appendix G.***

(2) Management Plan

This project involves implementing and refining a model for differentiated, personalized CS curriculum, without relying on the physical presence of qualified CS teachers in every school. As such, it involves an evolution from implementation with intense in-person support by SIA Faculty to implementation entirely through an online platform that can reach dramatically more students. In year 1, SIA Faculty and Staff will work with two schools (Art and Design HS and New Design HS) to provide SIA hybrid, in-person/ digital method. These schools will also serve as design partners helping to move the project towards digital delivery in year 2. After SIA Classroom is completed in the 2018-2019 school year, UAP will provide SIA Advanced to 120 students drawn from partner schools and other Title 1 schools throughout NYC. In years 1 and 2, SIA Advanced will be delivered in person, while also developing the capability to provide this advanced curriculum via Ghost School. SIA Classroom will be delivered via Ghost School starting in year 2, adding new schools each year. Throughout the life of the program, SIA Faculty will deliver programming in person at Art and Design HS and to 120 students in SIA Advanced, working closely with these students and their teachers to refine and develop Ghost School and SIA curriculum. SIA Advanced will operate as a hybrid of in-person and Ghost School programming in year 1 and 2, and will add one cohort of students in Ghost School only

starting in year 3. This long initial development period will ensure high quality of Ghost School

materials for advanced students before rolling out SIA Advanced via Ghost School in year 4 and

5. The program will expand as follows:

Expansion plan for SIA Classroom and Advanced							
		Y1	Y2	Y3	Y4	Y5
SIA Classroom	In person	300	300	300	300	300
	Hybrid	120	0	0	0	0
	Digital	0	240	480	840	2,760
SIA Advanced	In person	120	120	120	120	120
	Digital	0	0	12	200	780

In year 5, UAP will work with schools and other partner organizations to ensure the

expansion and longevity of SIA and Ghost School. This includes setting up pilot projects

connecting new schools with UAP partners, such as graduate programs in Game Design, to

further the reach of the program. The NYU Game Center (Letter of Support Attached) has

committed to provide 10 CS content experts to be trained as SIA Adjunct Faculty, offering their

graduate students the opportunity to participate in SIA as a work-based learning experience in

their graduate program. In these partnerships, UAP would provide all of the tools necessary to

implement SIA, and would then serve as a consultant to troubleshoot any problems that arise.

This project will involve creating tools, knowledge, and experience that can be used long

after the life of the grant to provide personalized learning not only for students but also for

teachers and CS experts seeking to support high quality CS education for all. Through the five

years of the grant, SIA will be developed into a completely digitally-delivered curriculum with

interactive learning materials for students, teachers, and Ghost School instructors.

There are several factors that will help ensure the project does not go over budget. First, the development of Ghost School has been, from the beginning, done in-house by SIA Faculty and other staff. This will continue, along with collaboration and design input from stakeholders at Art and Design, meaning there will not be costs for working with an outside developer. The program will expand to serve additional youth through Ghost School, meaning that few new SIA Faculty will need to be hired. The table below provides milestones in the implementation of expansion.

Time and Sites	Milestones
Fall & Spring 2018-19: ADHS Lab School, NDHS, SIA Advanced at UAP offices Summer 2019: SIA Advanced at UAP offices	In person PD offered to teachers at both schools. SIA Classroom implemented in-person with pilot testing of Ghost School. Partnerships are confirmed for year (Y) 2 implementation. 120 Students follow SIA Classroom with SIA Advanced and prepare for AP exam. SIA is offered as hybrid in-person/digital to pilot test Ghost School for advanced material. Evaluator completes Y1 implementation study, assessing initial fidelity.
Fall & Spring 2019-20: ADHS Lab School, Ghost School at NDHS and Urban Assembly Institute of Math and Science for Young Women	Partner schools offer SIA Classroom via Ghost School with an emphasis on refinement and enhancing student experiences. PD and classroom content are delivered through Ghost School. Ghost School is used to collect extensive data on how students and teachers interact with the system to inform continuous quality improvement. Partnerships are confirmed for Y3 expansion.
Summer 2020: SIA Advanced at UAP Offices	120 students continue to SIA Advanced (as in Y1), with more extensive pilot testing of Ghost School. Program staff implement refinements in Ghost School in preparation for Y3, new content created. Evaluator prepares impact study and continues to give feedback on implementation.
Fall & Spring 2020-21: ADHS Lab School, 4 Ghost School schools	Same as above with the addition of new partner schools; Y4 partnerships confirmed.
Summer 2021: SIA Advanced UAP offices and one online cohort	Same as above, along with one cohort of SIA Advanced offered in Ghost School. Refinements made to Ghost School as needed, new content created. Evaluator continues study.
Fall & Spring 2021-22: ADHS Lab School, 7 Ghost School schools	Same as above, Y5 partnerships confirmed. Partnership building takes place with NYU and other partners to pilot test SIA Faculty training in Ghost School and plan for dissemination. Program staff

	focus on dissemination and presentations.
Summer 2022: SIA Advanced Ghost School launch	Same as above with expansion of SIA Advanced offered through Ghost School. Evaluator continues study.
Fall & Spring 2022-23: ADHS Lab School, 23 Ghost School schools	Same as above with the addition of new partner schools, SIA Faculty from partner organizations provided with Ghost School training.
Summer 2023: SIA Advanced at UAP and via Ghost School	Evaluator completes study.

Roles and Responsibilities	
Title: Name	**Responsibilities**
Chief Executive Officer: *Philip Courtney*	Oversight of programs, industry and NYCDOE partnerships, and finances
Chief Program Officer: *Katrena Perou*	Oversight of fidelity, school partnerships, and evaluation
Project Director: *Akshai Raj*	Lead all SIA program activities, interactive platform development and dissemination, SIA trainings, partnership engagements, budget adherence, evaluation logistics, USDOE reporting
Project Manager: *Stephen Colon*	Manage school-based activities, teacher supports, student supports, facilitate instruction when needed
Director of Curriculum & Training: *Clair Tunkel*	Support and codify UAP methodology with CS game design curriculum, co-lead trainings for SIA faculty and NYCDOE teachers
Director of Program Evaluation: *Lina Cherfas*	Liaise with Independent Evaluator, lead and support SIA Classroom and SIA Advanced assessments for students and teachers.
SIA Faculty: *Zijian Zhou, Yuanqing Wu, Sean Heron, and 1 TBD (Yr2).* SIA Assistant Faculty (Alumni)	Instruct students in the classroom and via Ghost School, lead teacher PDs, develop/iterate on curriculum with Project Director and Project Manager
School teachers: *Janice Edelman-Lee, Carl Landegger, Seung Lee, Gerald Rabel, Linda Waddell, and TBD*	Participate in PD (in person and/or via Ghost School), provide in-class instruction in CS concepts, introduce students to Ghost School, provide in-class support for use of Ghost School, Implement and inform iterations of the Ghost School
Evaluator: *Glass Frog (Rebecca*	Lead the evaluation, prepare reports for USDOE, support

Casciano, PhD; Erica Chutuape, PhD; Pratikshya Bohra-Mishra, PhD)	iterative development of program, secure data from schools and NYCDOE
CS Partners & School District Dissemination partners: *NYC DOE Superintendents, NYC CS4All Administrators, NYU administrators, work-based learning partners (AT&T, Hearst, NYUGame Design Center, others)*	School selection, support data collection, support dissemination of promising practices through networks of educators and administrators, provide work-based learning experiences, ensure relevance of SIA programming vis a vis ongoing development in the CS field

(3) Continuous improvement

Continuous quality improvement will be an integral aspect of this project, involving program staff, classroom teachers, students, outside partners, and the external evaluator. Because so much of the project will use Ghost School, UAP will also be able to use detailed data from this online interface to enrich the continuous quality improvement process, including not only results of assessments completed in the program, but also more nuanced data such as time spent on different tasks and text analysis of code written by participants.

As described above, UAP will partner with HS of Art and Design to serve as a lab school, where students and teachers will work with new materials and new tools and act as design partners in the development of Ghost School. This role will be built explicitly into classes, allowing students to have the work-based experience of a real design/launch/refinement process.

Input from teachers and students at all schools, but especially at Arts and Design, will be gathered in multiple ways. *(1) During PD workshops:* Participants in in-person and online PD will be asked for feedback and input into future PD. *(2) During classroom sessions:* SIA lessons are designed to include opportunities for feedback as a way of explicitly building skills related to the design process, problem solving, and collaboration. This includes asking students to identify challenges and roadblocks at the end of each session, providing space for students to support

each other through challenges, and allowing time for reflection sessions. This feedback is

recorded as classroom notes, which are then captured as text and are shared with the program

team and evaluator for use in continuous quality improvement. *(3) Directly in Ghost School:* In

addition to the feedback methods above, all of which have digital analogues in the Ghost School,

users of the platform will have access to a Suggestion Box where they can provide input as

Ghost School is further refined and developed. Additionally, all users will be directed to short

feedback surveys twice per unit.

Every keystroke is captured in Ghost School, meaning that the online platform will provide a

rich data source both for pedagogical purposes and to support continuous quality improvement.

Teachers and SIA Faculty will be able to look at a data dashboard for each student that includes

their progress through the units, their performance on assessments, their use of time in the

program, and meta-analysis of the syntax and structure of their code. UAP program leadership

will also be able to look at aggregated data to determine how students are interacting with and

using the platform. This data will be used to track aggregate and individual student progress (for

example, improvements in code readability and efficiency) and to identify common areas where

students struggle and excel in order to refine Ghost School curriculum and implementation.

External evaluator Glass Frog will be a critical partner for ensuring that data is effectively

used for continuous quality improvement. Evaluation data collected will also include interviews,

teacher surveys, information on credit accumulation from participating and peer schools, and AP

exam performance from participating and peer schools. They will work with us to collect and

analyze the data discussed above, and will facilitate monthly team calls to review

implementation challenges and successes and develop action plans based on the available data.

To ensure continuous quality improvement is grounded in empirical evidence, they will provide

reports quarterly, including an annual report that reviews all data for the year.

(4) Broadly disseminate information for development and replication.

As part of the EIR project, UAP will implement and refine a tool and curriculum that can be widely used to teach CS through game design. UAP will provide interested schools and CS partners with access to curriculum materials, the Ghost School platform itself, and PD provided directly through Ghost School. UAP will support dissemination by allocating 10% of the Project Director's time to dissemination and partnership building. The CEO and CPO support dissemination through building city, state and national partnerships to advance the development and replication of the project. This includes current alignment and partnership with New York City, as part of the mayoral initiative CS4All, a cross-agency public-private effort to provide CS education to all public school students by 2025. UAP has over 25 years of experience partnering with school districts to expand and disseminate programs. This includes several competitive USDOE grants - i3, PDAE, and AEMDD - since 2010.

In order to ensure further development and replication of this project, UAP will disseminate information about the challenges and successes of the program, technical information on Ghost School, and lessons learned from refinement of game design curriculum materials for high school students. Staff from UAP and Glass Frog will present at conferences such as SXSWedu, SXSWInteractive, Adobe CS Education Roundtable, EdSurge, and the American Evaluation Association Conference. UAP will also support staff in writing further white papers on CS education, building on the most recent white paper by Project Director Akshai Raj. Dissemination is also built into the project plan for this grant. By year 4, UAP will be piloting use of Ghost School with other CS partners, such as NYU Center for Game Design, University of Southern California, AT&T Aspire initiative, and Hearst Media. By year 5, UAP will be

working with at least one additional partner to implement SIA with technical support from UAP.

C. Quality of the Project Evaluation (Up to 20 Points): Key Questions and Methods

The evaluation plan includes an analysis of implementation and outcomes and will produce evidence that **meets the What Works Clearinghouse's (WWC's) Group Design 4.0 Standards with reservations,** with the following research questions:

-RQ1: Is the program implemented with fidelity? Is the program meeting implementation milestones crucial for progress? What are the measurable thresholds for implementation and is the program meeting them? Can this program be implemented and tested at other sites? Is the program well-suited to bring the Ghost School to scale? **(Aligned with Objectives 1 to 3)**

-RQ2: Is SIA achieving its intended outcomes? **(Aligned with Objectives 1 to 3)**

-RQ3: What are the mediators and moderators of program outcomes? Does the delivery mode of the program (i.e., in person vs. remote) influence the program's effectiveness? Is the program's effectiveness affected by the teacher's background and experience teaching CS? Is the program's effectiveness influenced by school-level characteristics? **(Aligned with Objectives 1 to 3)**

Table H1 in Appendix H lists the focal outcomes and describes their data sources. In year 1, we will focus exclusively on RQ1, though we will continue to collect implementation data over the course of the study to comply with federal reporting regulations and to inform SIA's continuous improvement efforts. We will collect data to answer RQ2 and 3 in years 2 through 5.

RQ1: These questions will be answered through an expert review of the Ghost School curriculum, program and Ghost School records, and district records on CS course participation.

RQ2: A full list of sub-questions addressed under RQ2 is located in Appendix H. We will examine student, school, and teacher outcomes in this analysis. We will draw on data from the NYCDOE to examine whether the program increases students' accumulation of CS credits

during high school. This analysis will meet the WWC group design standards with reservations. We will also use NYCDOE data to examine the program's impact on students' likelihood of taking and passing the Advanced Placement (AP) CS Principles exam. We will draw on NYCDOE administrative records to measure whether the program results in an increased number of CS classes offered by participating schools, as well as an increase in the number of teachers teaching CS courses at participating schools.

RQ3: The evaluation team will use a mixed methods approach to identify potential mediators and moderators of program outcomes. The goal is to determine whether the program is equally effective in in-person versus remote settings, whether teacher characteristics influence the program's effectiveness, and whether specific school characteristics influence the program's implementation quality and efficacy. We will draw NYCDOE data, program and Ghost School records, school administrative data, and in-depth interviews with teachers and other stakeholders.

(1) WWC standards with or without reservations.

Each component of the analysis is designed to provide ongoing feedback to the program team about crucial milestones and implementation issues, and to conduct a rigorous evaluation of the program's impact. A full explanation of the research design for each set of questions is included in Appendix H. This section describes our approach to answering RQ2a (i.e., Does the program increase students' likelihood of completing credit-bearing CS courses?), as this is the analysis that will produce evidence that will comply with WWC Standards. The **sample for this analysis will overlap with the population receiving the treatment,** the sample size **will be sufficiently large** to detect significant effects, and the sample **will be drawn from multiple sites across multiple school districts** in New York City. (In Appendix H, we describe our approach to studying performance on the AP CS Principles exam, as well as school-level outcomes.)

To answer RQ2a, the evaluation team will measure the program's impact on two outcomes: CS credit accumulation by the end of 10th grade (i.e., immediately after students participate in the SIA course) and CS credit accumulation by end of 12th grade (i.e., by the end of high school). The former outcome will measure the program's immediate impact, while the latter outcome will measure whether students go on to take additional courses. **The treatment sample** will include all students in 10th grade cohorts across the 17 SIA partner high schools in NYC in years 2 through 5 (we exclude the laboratory school from this analysis). Table H2 in Appendix H shows the breakdown of schools and students by year. The sampling frame for the comparison group is 10th grade students across all other NYCDOE high schools not partnering with SIA in years 2 through 5. For each cohort served by SIA in years 2 through 5, we will use this comparison group sampling frame to identify comparison students that are equivalent on baseline characteristics. To comply with WWC guidelines, we will use data from the "pre-intervention time point closest to the introduction of the intervention to assess baseline equivalence" (WWC Standards Handbook, Version 4.0, p. 34). In this case, that time point is 9th grade.

We will match treatment and comparison students on the total number of CS credits accumulated by each at the end of 9th grade, along with other characteristics such as math test scores, socioeconomic and demographic characteristics (e.g., eligibility for free/reduced price lunch, race and ethnicity, gender, etc.), and school-level variables. We will determine baseline equivalence between the two groups by ensuring that the differences between groups on baseline measures related to the outcomes of interest (i.e., the average total number of CS credits) are not greater than 0.25 SD, and that any measures with differences between 0.05 and 0.25 SD will be adjusted for in the models, as specified by the WWC handbook (v4).

The evaluation will estimate effect sizes, looking for evidence of both statistical and

substantive significance, using the WWC 4standards for calculating and reporting effect sizes.

To measure the program's impact on students' CS credit accumulation at the end of 10th grade

using the cohort of students served in year 5, **the minimum detectable effect (MDE)** for the

sample of 4,080 students (2,040 students across 17 treatment schools in year 5, and 2,040

students across approximately 102 comparison schools in year 5) in the context of a quasi-

experimental difference-in-difference design, accounting for school level clustering, is 0.36

(assuming a power level of 0.8, an alpha of 0.05, and intra-cluster correlation of 0.21).

(2) Guidance about effective strategies suitable for replication or testing in other settings.

The evaluation will provide feedback on the extent to which it would be feasible for this

program to be replicated and tested in other settings. We will examine whether the program has

well-established protocols for creating buy-in among stakeholders; whether the proposed

teaching methods are codified and easy to apply in the classroom; whether the program

adequately addresses the needs of students with diverse learning needs; and whether the program

model (both the in-person and remote elements) is specific enough to meet the unique needs of

particular classrooms and schools but general enough to be adapted across diverse settings. The

evaluation team will carefully document the obstacles that the program team faces in creating a

replicable program, as well as the strategies they develop to address these obstacles. This

documentation will also identify factors that affect program implementation as a means of

providing information on the factors that promote program success. This effort will culminate in

a set of best practices, produced at the end of the grant period, for replicating the program.

(3) Valid and reliable performance data on relevant outcomes.

The early-phase projects are expected to use data to inform continuous improvement efforts,

both within and between program cycles. In year 1, the evaluation will focus exclusively on

collecting data to inform this process. We will collect data through program records, Ghost

School administrative data, teacher surveys, observations, NYCDOE administrative records, and

indicators of program fidelity to inform iterative program design and implementation. The

evaluation team will make this data and its related analysis available in the form of quarterly

reports, and discuss it during monthly meetings with the program team. In years 2 through 5, the

evaluation team will continue to work with the program team to collect data to provide ongoing

feedback and participate in the continuous quality improvement process. The evaluation team

will be in contact with the program team via email, phone, and in-person meetings, including

participation in monthly progress meetings. The evaluation team will also provide formal

quarterly reports regarding fidelity of implementation and progress towards outcomes, including

analysis of program and Ghost School records, in-depth interviews, and surveys. An annual

report will analyze performance of the past years' cohort(s) on outcome measures including test

scores and pre/post teacher and student surveys. Drawing on qualitative and quantitative data, the

reports will summarize data and provide recommendations for how the results can be used to

inform programmatic decisions. The evaluation team will present results in a format that informs

dialogue and problem solving among the program team and broader communities of practice.

(4) Key components, mediators, and outcomes of the intervention

   RQ3, described briefly above and in Appendix H, will focus specifically on identifying the

mediators and moderators of program outcomes. The purpose of asking these questions is to

better understand the conditions under which the program works best, so the SIA team can

replicate those conditions as the program scales. One area of inquiry is the extent to which

program outcomes differ for students engaging with the curriculum in-person versus remotely.

The program team's hypothesis is that it can build a remote program (via Ghost School) that is as

effective as the in-person version of the program. We will test this hypothesis by comparing differences between the two groups of students in their game creation and CS credit accumulation. We will further explore whether teachers' backgrounds and experiences moderate the program's effectiveness by comparing both teacher and student outcomes between treatment classrooms led by teachers with varying levels of experience with CS. We will similarly use qualitative methods, including in-depth interviews with teachers and school administrators, to study the reason why implementation fidelity varies across sites and the role that school administrations can play in influencing program adoption and fidelity.

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[i] This concept was explored by MIT Professor and Scratch co-creator Mitch Resnick (https://www.media.mit.edu/people/mres) in his TED Talk titled "Let's Teach Kids to Code (http://www.ted.com/talks/mitch_resnick_let_s_teach_kids_to_code).

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