Urban Arts *presents*

Creative Coders: Middle School CS Pathways Through Game Design

Urban Arts is a national nonprofit committed to teaching underrepresented students the **art and technology of game development** through computer science, coding, animation, music, and storytelling - because a quality education shouldn't depend on a child's zip code. Founded in 1991, Urban Arts (UA) has become one of New York's largest arts and technology education organizations, serving more than 260,000 students and 3,000 teachers across 300+ schools. UA currently provides high quality STEM programs in nine states (Arkansas, Florida, California, Georgia, Nebraska, New York, North Carolina, Texas, and Washington).

In the proposed project, ***Creative Coders***, UA will partner with the NYC Department of Education Community School District 6 in Washington Heights, Silicon Valley Education Foundation and their network of 65+ school districts in California, the City College of New York, WestEd researchers, and our industry partner Microsoft with the utilization of Minecraft Education. *Creative Coders* will serve Title I middle school students, approximately 70% of whom will be from families with an income below the federal poverty line.

Creative Coders is a middle school (6th-8th grade) in-school iteration of our successful high school computer science (CS) programming, teaching CS through video game design. Through a blended professional learning model, teachers are supported in teaching a middle school Intro to Computer Science course using a rigorous curriculum and evidence-based pedagogical approach. *Creative Coders* builds on previous UA research funded through the USDOE EIR and PDAE programs, leveraging practices and products generated in those projects.

In addressing **AP 3 (Field-Initiated Innovations—Promoting Equity in Student Access to Educational Resources and Opportunities: STEM),** *Creative Coders* 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, through an introductory CS curriculum and professional learning framework designed for and implemented in Title I middle schools with large percentages of high-need students. With mandatory K-12 CS being gradually adopted by states nationwide, there is a need for high-quality, engaging introductory CS curriculum and accompanying professional learning frameworks and supports. A Google and Gallup study stressed the importance of offering middle school CS courses "to build student interest and confidence before traditionally underserved populations begin to self-select out of the subject," yet across 17 states surveyed, only 3.9% of middle school students had enrolled in foundational computer science (Google and Gallup, 2020). *Creative Coders* offers an engaging, effective, affordable, and scalable path forward for middle school CS programs.

In addressing **CPP 1 (promoting partnerships with underrepresented entities),** *Creative Coders* expands Urban Arts' long-standing partnership with the City College of New York (CCNY), federally designated as both a Minority- and Hispanic-Serving Institution. Since 2020, UA has partnered with CCNY and NYC's Mayor's Office to develop and launch *Gaming Pathways* – a public/private initiative creating the city's first-ever four-year public-option undergraduate degree in Digital Game Design, creating more equitable access to pathways to tech careers for traditionally underrepresented groups. In this partnership, UA has expanded its curriculum into schools in Harlem, Upper Manhattan, and the Bronx to serve as a high-school- to-college pipeline, allowing 1000 students to study Game Design and STEM subjects and graduate with minimal to no student loan debt. In *Creative Coders*, UA will provide work-based learning experiences to CCNY's CS and Game Design undergraduate students. Selected CCNY students will be hired and trained by UA to work as virtual or in-person support staff in *Creative Coders'* classroom and professional learning environments, providing them with valuable industry-related work experience. Additionally, WestEd will hire three summer research interns from CCNY annually.

INPUTS	ACTIVITIES	OUTPUTS	OUTCOMES

HUMAN RESOURCES
• Program Director
• Learning Facilitators
• Curriculum Developers
• UA Executive Staff
• CCNY Teaching Assistants
• Middle School Teachers
• District Administrators
 	
STUDENT CURRICULUM
• CS through Game Design Curriculum
 	
TEACHER PL MATERIALS
• Hands-on activities
• In-person workshops
• Asynchronous instructional videos
• Meetings and demos
• Assignments
• Learning assessments
 	
TECHNOLOGY/EQUIPMENT
• Software: Minecraft Education, Google Suite, UA's Ghost School (website licensing), BandLab, Adobe Creative Suite, Piskel, Itch.io
• Hardware: Laptops, Chromebooks
• WiFi connection and bandwidth
 	
FACILITIES
• Classroom space at schools
• UA Learning Lab in Manhattan for in-person Professional Learning; space in other districts for PL outside of NYC
	RECRUITMENT
	• Recruit 72 new teachers and 72 schools in partnership with Silicon Valley Education Fund and NYCDOE District 6
		3,450 students at 72 schools enroll in the Introductory Computer Science (CS) curriculum	• The number of computer science classes offered by partner schools will increase, compared to peer groups.
			• Partner schools will show an increase in the % of students earning middle school computer science credit, compared to peer groups.
			• By the end of their participation year, 80% of students of treatment teachers will show statistically significant improvement with a moderate effect size on Middle Grades Computer Science Concept (MG-CSCI) Inventory Assessment scores.
			• By the end of their participation year, 80% of students report in pre- and post-surveys:
			  ○ an increased interest in STEM learning experiences
			  ○ a greater awareness of potential career paths in STEM fields.
			• By the end of their participation year, 80% of students of treatment teachers will show statistically significant improvement with a moderate effect size on the specified measures of:
			  ○ growth mindset relating to CS.
			  ○ attitudes around coding.

	CURRICULUM DEVELOPMENT • Align a foundational CS course to CSTA K-12 CS Standards for Middle Grades • Align to Big Ideas from College Board AP Computer Science Principles (AP CSP) Course Framework	Intro CS through Game Design curriculum completed	
	PROGRAM DELIVERY (for Students) • Deliver a full credit-bearing Intro CS course taught by an in-person teacher and supported by Teaching Assistants • Organize or support ≥1 student game showcase or esports event (e.g. Battle of the Boroughs in NYC) to highlight student work and skills	• Students receive ~108 hrs of classroom instruction + practice • Students produce digital artifacts and game portfolios • Students share at community showcase events (Game Faire)	
	PROFESSIONAL LEARNING (for Teachers) • Provide 30 hours of PL workshops to middle school teachers • Provide 5 asynchronous PL modules • Provide 5 hours self-paced PL projects • Provide 72+ hours of cohort collaboration (virtual and in-person) • Provide 12 hours of embedded coaching	Teachers will complete 40+ hours of Professional Learning and obtain relevant Continuing Teacher & Leader Education (CTLE) credits	• 80% of participating teachers will demonstrate increased knowledge of computer science through benchmarks and an assessment developed by Minecraft Education. • 80% of participating teachers will report in pre- and post-surveys increased confidence in implementing Game On curriculum.
	DISSEMINATION • Post student projects at the end of each year at showcase events • Share student projects @ community events • Post informal updates on UA and WestEd websites and social media platforms	At least two presentations of research results at scholarly conferences; at least one peer-reviewed publication.	• Students around the country are inspired by Urban Arts-produced games. Schools and teachers around the country are inspired by the power of video game design to engage students in STEM + CS / arts + tech learning.

Section A: Significance

The *Creative Coders* 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 studies of Urban Arts' (UA) existing CS programs.

Initial Evidence from UA: Initial evidence from UA's CS programs for high school students 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 studies. For example, of the students who took the AP Computer Science Principles (AP CSP) exam while enrolled in UA's after-school program, 92% of whom are students of color, 84% have passed (Casciano, 2021); this stands in contrast to the average pass rate 33.7% for Black students, 45.8% for Hispanic students, and 67% for all students nationally. An internal 2018 study found that UA students (N=512) demonstrated mastery of key CS skills:

- 90.8% successfully applied a creative development process when making a digital artifact;
- 81.4% mastered employment of 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 (Casciano, 2018).

Additionally, preliminary evidence suggests that participation in UA programs may increase the likelihood that students will attend postsecondary programs in STEM fields; in the past four years, 100% of graduates of our out-of-school *Mastery* course have enrolled in programs at more than 50 different colleges, earning in excess of $16 million in scholarships – almost all of whom were the first in their families to attend college.

UA's in-class programs also result in statistically significant increases in students' confidence in learning CS, belief that CS could be useful to them, feelings that they belong and

are being encouraged in CS. Notably, both female-identifying and male-identifying students reported comparable gains on all of the scales (Casciano, 2021, 2022).

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 (Fowler et al., 2016; Weintrop & Wilensky, 2016; Denner et al., 2019; 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 CS 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).

An Arts-Integrated Approach to CS: UA integrates arts activities into CS learning, helping students master CS skills as a means to artistic expression, and vice versa. In UA's high school game design courses, and echoing research findings, we have found that arts-integrated instruction can significantly increase students' engagement, motivation, and persistence in their academic work (Perignat & Katz-Buonincontro, 2019; Wu & Rau, 2019, Hetland et al., 2013; Asbury & Rich, 2008). Furthermore, both general education populations and populations defined as "at-risk" have shown significant academic and behavioral gains from arts-integrated classroom instruction (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). Finally, a Code.org analysis of a study by Change the Equation and C+R Research found that when students ranked subjects they liked "a lot," CS was second only to arts courses (Partovi, 2016); we posit that arts-integrated CS courses may therefore attract and engage an even wider variety of students than a conventional CS class.

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). The video game Minecraft has over 173 million users worldwide and is extremely popular with students at the middle school level; the Minecraft Education workspace we utilize in the *Creative Coders* curriculum is a familiar platform to any player of the original game. By leveraging students' personal interests and their existing "funds of knowledge" (Gonzales, Moll & Amanti, 2005), we believe *Creative Coders* is likely to increase student participation and engagement.

Dissemination: A primary program aim is to develop and field-test the *Creative Coders* curriculum and accompanying professional learning (PL) program, and submit it to the **Computer Science Teachers Association (CSTA)** for its endorsement, which signals the curriculum's alignment to CSTA K-12 CS Standards. UA 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: Creative Coders Dissemination Plan

Project Website	• Resources schools and districts can use to start their own *Creative Coders* program and request professional learning and technical support from UA • Research data showing the impact of the program on student outcomes
Social Media	• WestEd communications department and social media platforms • UA social media platforms *(e.g. 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)*
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.)*

Section B: Project Design

B.1 Conceptual framework underlying the proposed research: Based on game design as a pathway to CS, arts-integration, and culturally responsive teaching, *Creative Coders* represents an innovative approach to CS teaching and learning.

Teaching Introductory CS through arts-integrated game design: Of the Computer Science providers currently endorsed by the national organization CSForAll to teach the CSTA K-12 CS Standards, only one includes game design, and few bring the arts-integrated focus of *Creative Coders* or are fully accessible on inexpensive devices like Chromebooks. By using

inexpensive devices, *Creative Coders* lessens a financial barrier to broadening participation while still providing rigorous computer science coursework for traditionally underrepresented students.

Program Participation: *Creative Coders* will serve 72 teachers, with each teacher participating for 2-4 years, as well as 3,450 students (based on ~25 students per class per year.)

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

	Year 1: 2024	Year 2: 2025	Year 3: 2026	Year 4: 2027	Year 5: 2028
Teacher Cohorts (Equally distributed between CA, NY)					
Professional Learning (Jun-Aug)	Coh. A	Coh. B	Coh. C	Coh. D	
Supported Implementation (Sep-Jun)	**Cohort A** 10 teachers	**Cohort B** 10 teachers	**Cohort C** 16 teachers	**Cohort D*** 36 teachers	
Mastery Implementation (Sep-Jun)		**Cohort A** 10 teachers	**Cohorts A,B** 20 teachers	**Cohorts A,B,C** 36 teachers	
Evaluation Phase	**Feasibility Study**	**Imple-mentation Study**	**Impact Study**	**Longitudinal Study**	
Students Served (Equally distributed between CA, NY for a total of 3,450)					
~ 25 per class	**250**	**500**	**900**	**1,800**	
Teacher Served (Equally distributed between CA, NY for a total of 72)					
	10	**20**	**36**	**72**	

* Comparison teachers (Cohort D) will receive the PL and program access following the impact study. These teachers will not receive Mastery Implementation, although we will pursue alternate funding to provide this support level in 2028/29, after the grant period ends.

Curricular Content: *Creative Coders* adapts Urban Arts' (UA) highly successful high-school CS curriculum to a middle school setting. Tools include ***Ghost School***, UA's open-access platform that teaches programming basics in a game environment; a beta version of ***Game Code,*** a set of instructional resources in Minecraft Education's Lower Secondary (Grades 6-8) CS progression; UA's unique unplugged, arts-based activities; and the ***Minecraft Education*** platform, in which students will design and program their own original video games.

Creative Coders is a year-long course, organized into five units of approximately 20 hours of coursework each. Specific skills are mastered and assessed through a series of **Do It Now**

mini-projects; for example, students might learn coding skills such as how to make an object appear and move 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 utilize 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 program their own original video games** on the Minecraft platform.

Creative Coders is aligned to **Computer Science Teachers Association (CSTA) K-12 National Standards for Level 2** (grades 6-8) Computer Science. *Creative Coders* will also align with New York State Computer Science and Digital Fluency Learning Standards (NYSED, 2020) and the California Computer Science Content Standards (CDE, 2023). As a pathway to AP CS coursework, its five units correspond to the five **Big Ideas** around which **AP CSP** is organized.

Table 3: Creative Coders Curriculum Outline and CSTA Standards Addressed

UNIT	Description
Unit 1: Algorithms and Programming	Arts-integrated CS activities; basics of programming taught through *Ghost School*, Urban Arts' open-access game-based platform; debugging.
	CSTA Standards Addressed: *2-AP-10 through 2-AP-19*
Unit 2: Impact of Computing	Digital citizenship, career options, accessibility, and data privacy; exploring these ideas through student-created games design within the Minecraft platform.
	CSTA Standards Addressed: *2-IC-20 through 2-IC-23*
Unit 3: Data, Analysis, and Themes	Using both unplugged and digital tools to represent data, experiment with music and explore "themes" in games; transform a classic game to reflect an original theme.
	CSTA Standards Addressed: 2-DA-07 through 2-DA-09
Unit 4: Narratives, Networks, and the Internet	Using storytelling and improv exercises to model protocols for secure transmission of data; building networks in Minecraft platform; create original games exploring narrative elements.
	CSTA Standards Addressed: *2-NI-04 through 2-NI-06*
Unit 5: Computing Systems and Collaboration	Computing systems and hardware; benefits and limitations of AI; game development principles; collaborative creation of original video games from start to finish.
	CSTA Standards Addressed: *2-CS-01 through 2-CS-03*

Culminating Events	Students submit their completed games to *Game Faire*, in which students, educators, families, and industry experts can play student-designed games.

Professional Learning Design: *Creative Coders'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 120 hours of different types of PL activities.

Table 4: Creative Coders Blended PL Component Descriptions

Component	Description
PL Workshops	Program staff lead 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 will be required of their students.
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	Quarterly 1-hour meetings between teachers and learning facilitators during the school year to discuss, plan, and troubleshoot in-class implementation of *Creative Coders* curriculum.
Embedded Support	Convening virtually and in-person, UA Teaching Assistants (from CCNY) co-lead the in-school sessions with students in which each of the program's five units is introduced.
Professional Learning Communities	PLC cohorts meet virtually to discuss effective CS/*Creative Coders* practice. Initially facilitated by UA staff, PLC meetings will eventually be led by returning teachers.
Virtual Drop-In Office Hours	UA hosts weekly virtual drop-in office hours for teachers needing support.

Table 5: Treatment Amounts of Creative Coders Blended PL at Each Level

	Synchronous Learning	Asynchronous Learning	Self-Paced Projects	
Professional Learning (summer)	30-hour summer intensive	5 hours	5 hours	
	PLC Workshops	**Embedded Support**	**Individual / Sm. Group Coaching**	**Office Hours**
Supported Implementation	27 hours (3-hour monthly meetings)	6 co-instruction in-class sessions	18 hours (2 hours / month)	Weekly as needed
Mastery Implementation	18 hours (2-hour monthly meetings)	6 co-instruction in-class sessions	9 hours (1 hour / month)	Weekly as needed

B.2 Goals, objectives, and outcomes

Table 6: Creative Coders Program Goals, Objectives, and Outcomes

Access to Computer Science Education	
Goal 1: There is an increase in the number of CS classes offered by schools.	
Objective 1: Participating schools will offer an introductory computer science course for students in middle school, applying game design to teach CS.	***Outcome 1a:*** *80% of partner schools will increase the number of CS Classes offered, compared to comparison schools.* ***Outcome 1b:*** *80% of partner schools will show an increase in the percentage of students earning middle school computer science credit, compared to comparison schools.*
Student Achievement	
Goal 2: Students will demonstrate competency in CS conceptual knowledge.	
Objective 2a: Participating students will complete 108 hours of an Introductory CS course. **Objective 2b:** Participating students will create an original game by completing all course benchmark projects that incorporate computational thinking skills, arts integration, and programming.	***Outcome 2:*** *By the end of their participation year, 80% of students will show statistically significant improvement with a moderate effect size on their Middle Grades Computer Science Concept (MG-CSCI) Inventory Assessment scores.*
Goal 3: Students will demonstrate an increase in growth mindset relating to CS.	
Objective 3: 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.	***Outcomes 3a-b:*** *By the end of their participation year, 80% of students will show statistically significant improvement with a moderate effect size on the specified measures of:* • ***3a:*** *growth mindset relating to CS.* • ***3b:*** *attitudes around coding.*
Goal 4: Students will demonstrate an increased awareness of and interest in pursuing STEM-related career paths.	

Objective 4: Participating students will participate in game design activities that introduce the procedures and workflows of professional game studios.	***Outcomes 4a-b:*** *By the end of their participation year, 80% of students report in pre- and post-surveys:* • ***4a:*** *an increased interest in STEM learning experiences (e.g. pursuing advanced high school classes and post-secondary interests in the field of computer science).* • ***4b:*** *a greater awareness of potential career paths in STEM fields.*

B.3 Successfully addressing the needs of the target population or other identified needs

Increasing CS participation of underrepresented students: Women, racialized people, and those from low-income households are underrepresented in technology-related careers (Goins et al., 2022; 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 $200 billion 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 digital skills, but those requiring higher degrees of digital skill tend to pay more (Muro et al., 2018).

In order to reach students belonging to these underrepresented groups, it is essential to offer rigorous and effective CS instruction to students in Title I schools. In the schools to be served by *Creative Coders,* the vast majority of students belong to groups underrepresented in technology-related careers. NYCDOE's District 6 is located in the vibrant and culturally rich neighborhood of Washington Heights. Home to many recent immigrants, including a large Dominican population, about one in four households have limited English proficiency (CCC, 2022). Over 85% of students in the schools we serve are economically disadvantaged, 91% are Hispanic or Black, and roughly a third are not able to pass their standardized math tests (CCC, 2022). Across the country in California, we see similar need: despite the affluence of some in Silicon Valley, its wealth inequity is more than double that of the US overall; just eight families

hold more wealth than the bottom 50% of all households (Massaro, 2023). The region is also home to a high percentage of recent immigrants; 37% of its population was born outside the US (NIF, 2017), and more than one in ten young people in Silicon Valley are undocumented (Wong et al., 2016) . Silicon Valley schools served by *Creative Coders* are 45% economically disadvantaged and 59% Black and Hispanic.

Prior research on UA's approach suggests that *Creative Coders*' curriculum will effectively teach introductory CS, 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 youth 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 and its use of the Minecraft platform, combined with its arts-integrated approach, *Creative Coders* addresses the challenge of attracting and engaging a diverse group of students. In prior work, UA has successfully attracted a diverse student base; 91% of our *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 these highly specific and complex skills, especially at the middle school level. Code.org's 2022 State of Computer Science Education report found that across 17 states surveyed, only "3.9% of middle school students enrolled in foundational computer science." This low number is concerning from an equity perspective; the report recommends pre-high-school instruction as a "vehicle for equity":

> Foundational courses in K–8 help all students develop confidence in computer science, better preparing them for high school courses. Efforts that only focus on high school computer science courses may not achieve increased or representative enrollment: underrepresented students who experience computer science early are more likely to enroll in subsequent computer science courses. (Roberts et al, 2022)

Another national issue is the nationwide shortage of CS teachers, especially in schools serving marginalized communities. Recognizing this issue, *Creative Coders* is responsive to the recommendations of a 2022 landscape survey conducted by CSTA; specifically, to provide ongoing professional learning in CS, to provide culturally-relevant classroom resources, and to connect CS teachers to collaborative communities (Koshy et al, 2022).

By bringing UA's successful high school CS approaches to the middle school level, and by providing high-quality CS professional learning to teachers serving traditionally underrepresented populations, *Creative Coders* will create a model that can engage underrepresented students, and assist in the national push toward universal K-12 CS education.

Section C: Project Personnel

Urban Arts encourages applications for employment from persons who are members of groups that have traditionally been underrepresented based on race, color, national origin, gender, age, or disability. Our overall full-time staff demographics are currently 59% BIPOC. Additionally, our full-time game design instructors are 80% BIPOC, and 60% are female-identifying, and our part-time Teaching Assistants are 92% BIPOC and 50% female-identifying.

Program Key Personnel

[redacted] ***Project Director*** is Director of Foundations Programs at UA, directing UA's large-scale CS education research initiatives, including federally funded projects (EIR). She has over 15 years of experience in STEM education, and holds a PhD in Information Design from Clemson University, an MA from Northwestern University, a BA from Missouri Univ. of Science & Technology, and certificates in Sound, Haptics, & Wearable Technology from Univ. of Victoria's Digital Humanities program. [redacted] ***Curriculum Developer and Learning Facilitator*** is a Mojang Studios (creator of Minecraft) Tier I Content Creator. Her past work includes Lead Curriculum Writer at Cleverlike Studios developing content in Minecraft Education, and public school teacher and STEM coordinator. She received her Ed.D.

at National Louis University where her dissertation research focused on the effects of integrated STEM as a pedagogical approach in elementary schools. [redacted] ***Curriculum Developer*** is UA's Director of Mastery Programs and was previously Sr. Director of Learning Design at Mouse, where she launched a tech ed digital learning platform accessed by 15,000 youth nationally. Her "Impact Game Design" curriculum has been distributed and taught to all schools and students competing in the Games for Change Student Challenge. [redacted] holds a BA in Learning Design from the University of Massachusetts at Amherst. [redacted] ***Learning Facilitator*** has been integral to the design and launch of the UA/CCNY partnership *Gaming Pathway* through curriculum design and classroom instruction. [redacted] holds a BFA from the School of Visual Arts, NYC in Computer Arts, Computer Animation, and Visual Effects. [redacted] ***Learning Facilitator*** is an instructor in UA's Mastery and *Gaming Pathways* programs. [redacted] holds a BA from CUNY Hunter College in Media Studies - Emerging Media. [redacted] ***UA Chief Operating Officer*** has more than 20 years of experience supporting organizations that develop and create substantial opportunities for our youth, including experience overseeing logistics for previous EIR grants. [redacted] ***UA Chief Executive Officer*** has served as CEO of Urban Arts 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.

Research and Evaluation Key Personnel

[redacted] ***Co-Principal Investigator*** 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*** is a Senior Research Associate II at WestEd and is the evaluation lead of two EIR grants. He also 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] and [redacted] ***Senior Researchers in Computer Science*****,** are both Senior Research Associate in WestEd's Learning and Technology team and bring content expertise around computer science curriculum and learning. [redacted] holds a PhD in Learning Sciences from Northwestern University and [redacted] holds a PhD in Teacher Education and Learning Sciences from North Carolina State University. [redacted] ***Lead Statistician****,* is a Senior Research Associate at WestEd. He brings extensive experience in applied statistics and psychometrics and has led many research and measurement projects funded by the USDOE and NSF. He holds a PhD in Measurement, Statistics, and Evaluation, from the University of Maryland.

Section D: Management Plan

Table 7: Creative Coders 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 UA CEO, COO, CPO	Ensures that resources from across UA 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
Research and Evaluation Team WestEd	Collects data for monitoring annual project objectives; prepares all required evaluation reports; provides regular evaluation updates to staff for continuous quality improvement; aids in dissemination efforts
Program Team UA	Creates curriculum guides; creates asynchronous PL resources; monitors and implements program and curriculum improvements; instructs teachers, participates in dissemination activities

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 **Co-Principal Investigators** 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.

Table 8: Creative Coders Project Timeline: Tasks and Milestones

Program Team **Research & Evaluation Team**	**Year 1 2024**				**Year 2 2025**				**Year 3 2026**				**Year 4 2027**				**Year 5 2028**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
IRB approval	•																			
Recruit schools & teachers (Cohort A)	•	•																		
Develop *Creative Coders* curriculum	•	•	•																	
Test and confirm research instruments	•	•																		
Formative Evaluation and reporting			•	•	•	•	•	•	•	•										
Annual research report				•				•				•				•				•
Usability Studies			•	•																
Cohort A: Professional Learning			•																	
Recruit/train Teaching Assistants fr.CCNY			•				•				•				•					
Cohort A: Supported Implementation			•	•	•	•														
Classroom Feasibility Study					•	•														
Assess & modify curriculum (ongoing)				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Recruit incoming teachers (Coh. B, C, D)					•	•	•	•	•	•										
Cohort B: Professional Learning							•													
Classroom Implementation Study							•	•	•	•										
Cohort B: Supported Implementation							•	•	•	•										
Cohort A: Mastery Implementation							•	•	•	•										
Cohort C: Professional Learning											•									
Impact Study											•	•	•	•						

Cohort C: Supported Implementation											•	•	•	•					
Cohort A, B: Mastery Implementation											•	•	•	•					
Cohort D: Professional Learning															•				
Exploratory Longitudinal Study															•	•	•	•	
Cohort D: Supported Implementation															•	•	•	•	
Cohorts A, B, C: Mastery Implementation															•	•	•	•	
Summative Analysis and Dissemination														•	•	•	•	•	•
Final summative report																		•	•

Section E: Project Evaluation

WestEd will conduct an independent evaluation of the implementation and efficacy of *Creative Coders* on middle school computer science student outcomes (see Table 6), including an impact study designed to meet WWC standards without reservation (see E.1). The evaluation will also consider the execution of all project activities, focusing on the development and implementation of a new middle school computer science curriculum. Working collaboratively with Urban Arts during early development, WestEd will actively engage in formative evaluation studies to provide critical feedback for program development (see E.3). WestEd will then conduct an impact study (RQ 1-3), utilizing a cluster randomized controlled trial (RCT) that meets the What Works Clearinghouse standards without reservations (WWC, 2020), including a WWC acceptable measure for student outcome: Middle Grades Computer Science Concept Inventory (MG-CSCI) Assessment (see E.1). Questions 4-5 address implementation and are designed to provide both performance feedback during initial stages and to document key factors that should be considered during replication and further scaling of *Creative Coders*. Questions 6-8 explore mediating and moderating effects, which will unpack how key project components and contextual factors can influence outcomes. Questions 9 and 10 are exploratory but will provide evidence of sustaining impact of *Creative Coders* and could provide evidence of replicability, respectively.

Table 9. Evaluation Research Questions and Data Sources

Research Question	Primary Data Source(s)
Impact analyses	
1. What is the impact of *Creative Coders* on students' computer science achievement?	Middle Grades Computer Science Concept Inventory (MG-CSCI) Assessment
2. What is the impact of *Creative Coders* on students' attitudes around coding?	Elementary Student Coding Attitudes Survey
3. What is the impact of *Creative Coders* on students': ● growth mindset? ● opportunities to learn? ● awareness of STEM related fields?	Constructs on a student survey: ● Dweck's mindset scale ● Opportunities to Learn scales ● Urban Arts' previous items
Implementation analyses	
4. To what extent is *Creative Coders* implemented with fidelity? How do teachers perceive the professional learning?	Workshop sign-ins, observations, interviews, *Creative Coders* usage data, teacher logs
5. How does the implementation of *Creative Coders* differ across contexts, such as school and teacher characteristics? What factors hinder or facilitate the implementation of *Creative Coders*?	Observations, *Creative Coders* usage data, teacher logs, relevant background and demographic data
Main mediating and moderating analyses	
6. To what extent does the impact of *Creative Coders* differ across school contexts, teacher and classroom characteristics, and student characteristics?	All data for RQs 1–3, including relevant background and demographic data
7. To what extent is the impact of *Creative Coders* on student outcomes mediated by instructional activities?	All data for RQs 1-3
8. To what extent is the impact of *Creative Coders* mediated by the fidelity of implementation?	All data for RQs 1–3
Exploratory longitudinal analyses	
10. Is the impact of *Creative Coders* on student success similar the second year after PL completion?	All data for RQ 1
11. After the control teachers are trained, are their outcomes comparable to the outcomes of the original treatment group?	Same data as RQs 1-3

These research questions align with the project's objectives and strategies and will be addressed using data collected from 72 middle schools in diverse settings across the states of New York and California.

E.1 Impact Study

Summary. During the 2026-2027 academic year, WestEd will conduct an impact study, utilizing a cluster randomized controlled trial that will meet the What Works Clearinghouse (WWC, 2020) standards without reservations. Recruitment will target 72 middle schools with a

range of student demographics to promote generalization. Half of the 72 schools will be randomly assigned to teach *Creative Coders* as their introductory computer science course for 6th to 8th grade, while the other 36 schools will teach business-as-usual. This design will allow participation from approximately 1,800 students for the impact study (the control schools will be given access to use *Creative Coders* following the impact study). The proposed study is powered for a minimum detectable effect size of 0.09 to 0.10. (See Appendix J.1 for details about the power analysis and Appendix J.2 for details about the hierarchical linear models for the impact analyses.)

WWC Acceptable Outcome: Student Computer Science Achievement. To measure students' outcomes for RQ1, WestEd will use the Middle Grades Computer Science Concept Inventory (MG-CSCI) assessment (Wiebe et al., 2019). The 23 item test was developed by education and computer science faculty to assess computational thinking, focal knowledge, skills, and abilities associated with the concepts of variables, loops, and algorithms among middle grades students (grades 6-8). Rachmatullah et al. (2020) showed validity and reliability of this measure using a large sample of middle grades students (Cronbach's α=0.834).

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 ($\alpha = 0.65$), coding confidence ($\alpha = 0.81$), coding interest ($\alpha = 0.93$), perception of coders ($\alpha = 0.75$), and coding utility ($\alpha = 0.82$; see Appendix J.3 for items), and showed strong validity and reliability using a large sample of 4th-6th grade students.

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

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 $\alpha = 0.84$), opportunities to

justify reasoning (α = 0.82), opportunities to solve challenging problems (α = 0.78), and opportunities to demonstrate conceptual understanding (α = 0.80) (see Appendix J.3 for items).

Student Awareness of and Interest in a STEM-related Field. We will use items UA has used in other studies (developed in-house) to gauge students' awareness of and interest in attending college for a STEM-related field.

Covariates. WestEd will work with local district staff to collect data about individual students, teachers, and schools, to be used in the moderation analyses (see Appendix J.2).

Fidelity Measures. To provide further context for the impact results, and for mediation analyses (see Appendix J.2), WestEd will interview a sample of at least 20 participating teachers (12 treatment, 8 control). The interviews will explore teaching approaches, resources, and, when applicable, implementation of *Creative Coders*. A variety of course artifacts, including syllabi, in-class activities, homework assignments, and exams, will be collected from both treatment and control teachers, in order to understand the nature of course instruction. WestEd will also analyze ***Creative Coders* usage data** to better estimate use and engagement throughout the year.

Meeting WWC Standards Without Reservations: Further Details. Participating schools will be assigned to the treatment or control condition using blocked random assignment. Blocks will consist of school-level demographic information and prior computer science outcomes (see Appendix J.2). After randomization, Urban Arts will begin enrolling teachers in the treatment group into the *Creative Coders'* PL sequence. All teachers in the treatment schools who plan to teach 6th-8th grade computer science in the coming year will be included. Treatment schools will receive the PL sequence and will have full access to all *Creative Coders* materials.

The control schools will administer business-as-usual computer sciences classes and will not have training with or access to *Creative Coders*. School-level random assignment was selected to account for cases where there was more than one teacher per school, since teacher-level assignment would raise the threat of contamination, as teachers in a school may

discuss, view, and share instructional materials and strategies. Also, based on prior school-level randomized studies (Davenport et al., 2019), particularly with ALSDE's support, we expect minimal school-level attrition during the impact study.

The analysis of the intervention's impact will use an intent-to-treat (ITT) approach – schools and their teachers and students will be retained in their originally-assigned groups. Student rosters will be collected at the start of the 2026-27 school year to identify students in the ITT student impact sample. Students who join the school after randomization will not be included in the analytic sample. Given that the proposed evaluation is based on a school-level RCT that is expected to have low cluster-level attrition and a student analytic sample where joiner bias is not a threat, the evaluation has the potential to produce strong evidence about the impact of *Creative Coders*. In addition, based on research (Kim et al., 2020; Taylor & West, 2020) and WestEd's prior RCT experience, we anticipate manageable levels of student attrition during the study (i.e., less than 20%) and minimal differential student attrition across conditions (i.e., less than 5 percentage points), so the student impact analyses will likely meet WWC standards without reservations (WWC, 2017).

Attrition and Baseline Equivalence. WestEd will conduct an attrition analysis using WWC guidelines. WestEd defines attrition as randomly assigned schools and teachers who do not submit requested data. We will compare the treatment and control groups within the complete case analytic sample to determine whether the groups are equivalent at baseline, including all covariates, or whether 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 and .25 will be considered within the range of statistical correction (WWC, 2020).

Data Analysis and Reporting. Analyses of both conditions will allow us to assess the achieved relative strength of the intervention–control contrast (Hulleman & Cordray, 2009), to

understand the degree to which the intervention model differs from the pedagogical model(s) underlying the comparison condition. Implementation data from interviews, logs, and *Creative Coders* usage will also be analyzed, both quantitatively and qualitatively, to develop narratives of *Creative Coders* implementation across treatment classrooms. The overall end result will be a clear understanding of the impact of *Creative Coders*, how the impact varies across student populations, and how implementation is actualized in the classroom. The mix of qualitative and quantitative findings will lead to insights and recommendations for implementing *Creative Coders* to support 6th to 8th grade computer science learning and success.

E.2 Components, Mediators, Outcomes, and Acceptable Thresholds of Implementation

The design of the proposed evaluation is informed by clearly articulated key components, mediators, and outcomes of *Creative Coders* as depicted in the conceptual framework presented in Appendix G. The impact analyses (RQ 1-3) will be based on valid and reliable measures: (1) Middle Grades Computer Science Concept Inventory Assessment; (2) Elementary Student Coding Attitudes Survey; (3) Dweck's Growth Mindset scale; (4) Opportunities to Learn scales. The evaluation will include moderator analyses (RQ5) and mediator analyses (RQ 6-7) to explore the relationships among implementation context, intermediate outcomes, and student achievement outcomes, as discussed above. Implementation context questions (RQ 3-4) will be answered with data from multiple sources, including artifacts from professional learning workshops to determine participation and coverage, observations, interviews, and monthly teacher logs describing teaching activities using *Creative Coders* and other curricular materials. Acceptable thresholds of implementation will be accounted for within PL measures, teacher logs, and observations. Thresholds will be based on **tracking the usage of the core elements *Creative Coders* per module and any substitutions of supplements made**. These thresholds will be specifically defined and tested during the formative stages (see E.3), and will be monitored to discover if the

program is implemented with fidelity and what potential effect the level of fidelity may have on outcomes.

E.3 Formative Evaluation, Performance Feedback, and Periodic Assessment of Progress

During the first two and a half years of the evaluation, performance feedback and periodic assessment of progress will be addressed through formative evaluation. Usability studies, a classroom feasibility study, and a classroom implementation study will build towards the impact study (see Table 10), and will be guided by the corresponding research questions in Appendix J.4.

Table 10. Summary of the samples and timeline for each major evaluation component.

	Usability	Feasibility	Implementation	Impact
Timeline	2024	Spring 2025	2025-2026	2026-2027
Teachers	10	10	20	72
Students	250	500	900	1,800

Usability Study. In summer and fall 2024, WestEd will conduct multiple rounds of usability research, as needed, to iteratively test new program components, features, and content that were built in winter/spring 2024 by UA for *Creative Coders*. For each round, at least 5 teachers will participate with a minimum of 10 different total teacher participants. Research has shown that this is a sufficient number of testers to identify major issues, and that testing with additional users provides diminishing returns (Nielsen, 2000). The sample of these studies will be intentionally balanced with regard to demographics and contexts. WestEd researchers will guide participants through the relevant tasks and ask them to "think aloud" and explain their thought processes as they go. At the end of each session, WestEd will interview participants about their overall experiences, the ease of use of the activities, and their understanding of the tools and content

presented. Each round of usability will result in a qualitative summary of findings **with actionable recommendations to UA.**

Feasibility Study. In spring 2025, WestEd will conduct a feasibility study to evaluate whether teachers can take the professional learning (PL) and curriculum materials, and translate them into practice, as intended in an authentic education setting. WestEd will complete the feasibility study with 10 teachers, each with one full class of students. Teachers will receive a three-hour session of PL on how to use the materials effectively in their classrooms. Teachers will substitute in materials from *Creative Coders* for one entire module of their curriculum. WestEd will perform 2 observations per classroom, using an observation protocol that captures data related to the implementation of *Creative Coders* in the classroom, including barriers to implementation and technical difficulties that teachers and students experience while using the embedded technology. WestEd will also create and test preliminary fidelity thresholds to analyze how well they reflect the envisioned implementation by UA. Feedback will also be collected from teachers through a weekly log and a final interview. Qualitative and quantitative reports of findings will provide **actionable recommendations to UA** throughout the study.

Implementation Study. In 2025-2026, WestEd will conduct a yearlong implementation study of *Creative Coders*, where teachers teach the entire *Creative Coders* curriculum. The study will involve 20 teachers, each with one full class of students. Teachers will receive the full PL support sequence. WestEd will perform two observations per classroom and teachers will complete monthly logs and a final interview. WestEd will also test and finalize fidelity thresholds for the impact study. WestEd will also administer the pre- and post-student surveys to pilot the use of the Middle Grades Computer Science Concept Inventory Assessment, the Elementary Student Coding Attitudes Survey, Dweck's growth mindset scale, opportunities to learn constructs, and awareness

of STEM survey items. The implementation study will result in a mixed qualitative and quantitative summary of findings, **with actionable recommendations to Urban Arts**.

Performance Feedback and Periodic Assessment of Progress. During this formative period, WestEd will help gather feedback to improve the curriculum and materials, professional development supports, and administration strategies, in partnership with Urban Arts, that can work best for the participating students. WestEd will also create, test, and finalize measurable thresholds for acceptable implementation in consideration of Urban Arts vision of ideal implementation, teacher feedback, and findings from the feasibility and implementation studies.

The formative evaluation will also provide structure for consistent, periodic feedback to the program officer and to Urban Arts on its development goals. All parties will participate in virtual, bi-monthly calls to discuss upcoming project goals and review progress to date on development, testing, and other project components. WestEd will be responsible for monitoring and tracking all activities and to make sure all goals stay within their scope and timeline. Any deviation or concern on progress or performance will be discussed among all stakeholders.

References

Attached, please see Appendix K.