SMASH 3.0: Innovations in Programming Strategies that Promote Equity in Computer Science Pathways for Historically-Excluded Students

Education Innovation and Research Program – Early-Phase Grant

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A. Significance

A1. Introduction

MK Level Playing Field Institute (dba SMASH) is applying for an Early Phase Innovation and Research grant in partnership with the Kapor Foundation, American Institutes for Research (AIR), Morehouse College (GA), Spelman College (GA), University of California - Berkeley (CA), University of Michigan - Ann Arbor (MI), and Northeastern University (MA). This request covers **Absolute Priority 1** (Demonstrates a Rationale) and **Absolute Priority 3** (Field-Initiated Innovations – Promoting Equity in Student Access to Educational Resources and Opportunities: STEM) with **Competitive Preference Priority 1** (Promoting Equity in Student Access to Educational Resources and Opportunities – Implementers and Partners).

The proposed project will demonstrate promising early-phase learning strategies to promote equity in computer science (CS) pathways by integrating digital solutions to scale access to academic resourcing (focused on college and career path navigation) and CS-specific role models reflecting student populations, while building a cohort of CS-focused peers engaging in CS exposure activities and addressing the social-emotional needs of historically-excluded students on university campuses. Building upon SMASH's history of providing STEM programming for marginalized high school students, ***SMASH 3.0*** will implement, evaluate, and refine its model to focus on exposing Black, Latine, and Native students to CS and providing access to resources to navigate a path towards a CS-focused academic and career path.

SMASH 3.0 expands access to CS through opportunities to engage in student-led project-based learning; opportunities to network with CS professionals and faculty reflecting the demographics of students; building a CS-focused peer community discussing topics related to social-emotional well-being; and engagement with a digital platform to introduce students to role models in the CS field and help navigate the path towards becoming a CS major and professional. *SMASH 3.0* will reach 500 high school students each summer. In its current cycle, the program serves predominantly marginalized groups, including those identifying as Black or Latine, low-income, first-generation in college, and girls or non-binary.

An independent evaluation will be conducted to provide formative and summative evidence about the implementation and impact of the *SMASH 3.0* program. The formative evaluation will provide program staff with ongoing feedback about implementation fidelity and quality to inform adaptations and refinements to program delivery. The impact evaluation will use a student-level matched comparison quasi-experimental design (QED) to assess the impact of *SMASH 3.0* on student academic, attitudinal, and behavioral outcomes towards CS persistence.

A2. National Significance

A review of the literature shows both structural barriers and social-emotional burdens are faced by Black, Latine, and Native communities. Policies and practices across the educational, workforce, and economic systems have led to these communities being excluded from the computing pipeline. Shutting these individuals out of technology as designers, innovators, and decision-makers exacerbates wealth gaps, exposes these communities to risks through harmful technological innovations, and undermines the quality, creativity, and efficacy of new tech.

While these communities comprise 31% of the US workforce, they only hold 18% of computing jobs (Bureau of Labor Statistics, 2023). Only 19% of CS degrees conferred in 2021 were awarded to Black, Latine, and Native students (NCES, 2021). And while Black, Latine, and Native students make up 45% of public school enrollment across the nation, they only comprise 25% of AP CS course participants and were far less likely to pass the AP exam than white counterparts (College Board, 2022).

Despite the biased perceptions that students from historically-excluded communities merely lacked interest in pursuing a computing career (Koshy et al., 2021), a 2020 study found that race/ethnicity was not a determining factor in student confidence or interest in pursuing CS. Rather, CS exposure was a key correlate to student attitudes and aptitude towards CS (Gallup, 2020). These findings highlight the role that Black, Latine, and Native students' lack of access to high-quality CS courses plays in the disparities seen across the computing pipeline (Margolis, et al., 2017). As such, CS programs can be instrumental in shaping students' trajectories.

This is an urgent problem due to predictions of large-scale disruptions to occupations of the future, largely driven by the adoption of technology systems like artificial intelligence (AI), big data analytics, cybersecurity, and environmental management technologies (World Economic Forum, 2023). Disturbingly, jobs most at risk of elimination due to automation are disproportionately held by Black and Latine workers, threatening to widen already significant economic gaps (Broady et al., 2021). The creation of new technology-enabled jobs and the need to upskill a redundant workforce will require the nation to address educational inequities across racial/ethnic groups earlier in the computing pipeline to ensure US competitiveness in a global context.

A3. Programmatic Significance

To meet the needs of the future, SMASH has undergone a strategic planning process to narrow its focus from STEM to CS. *SMASH 3.0,* to be piloted in 2024, will include a 3-week summer CS exposure experience in addition to a digital platform expanding access to CS-specific college and career readiness resources serving predominantly low-income and first-generation underrepresented high school students of color. Five university sites are committed to partnering with SMASH towards this new vision (i.e., Morehouse College (GA), Spelman College (GA), University of California-Berkeley (CA), University of Michigan-Ann Arbor (MI), and Northeastern University (MA)).

To provide foundational skills and exposure to a range of college and career pathways across the fastest growing CS fields (i.e., artificial intelligence (AI)/machine learning (ML), cybersecurity, programming), this project will engage 11th and 12th grade students in three-weeks of in-person CS and social-emotional residential programming on college campuses and allow asynchronous access to a digital platform to navigate academic and professional paths in computing. To ensure the quality programming and consistent student outcomes expected of SMASH's legacy programming (per SMASH's annual evaluation reports), the *SMASH 3.0* curriculum and pedagogical approach are key.

Project-based learning remains the core of the program, which provides students with the opportunity to tackle real-world problems relevant to them, while exposing students to realistic tech worklife. The projects undertaken by students allow for a multidisciplinary approach, while preparing them with computational thinking skills to adapt to the ever-changing computing field. The process provides students with both choice and responsibility, promoting the development of communication, collaboration, and project management skills, while simultaneously increasing engagement, participation, and access to learning (Hsu et al., 2015).

Even with access and opportunity, marginalized students are often discouraged in studying STEM due to a lack of diverse role models (Ferreira, 2001), isolation (Moses, 1993), and active exclusion and racial hostility from educators and peers (Lee et al., 2020; McGee & Bentley 2017; Dee & Gershenson, 2017). Recognizing the importance of developing protective factors within marginalized students, *SMASH 3.0* focuses on components of CS identity development that are essential to CS persistence (Hug, 2018; Mahadeo, Hazari & Potvin, 2020;

Singer, Montgomery & Schmoll, 2020; McCartney & Colon, 2023; Taheri et al., 2018; Bond-Trittipo et. al, 2022; Rollins et al., 2021; Lunn et al., 2021). *SMASH 3.0* develops: 1) students' introductory knowledge into computing, 2) awareness of computing professionals reflective of students' identities, and 3) peer relationships among students with shared experiences based on their self- and computing-identities.

To ensure high quality programming, we equip seasonal staff with a culturally-responsive pedagogy and an engaging curriculum. Promising practices in revising CS curriculum to engage a broader group of underrepresented students of color include the development of interventions drawing upon theories of culturally relevant pedagogy (Ladson-Billings & Tate, 1995; Goode & Margolis, 2011) to engage students of color in computing (Denner, Bean, & Martinez, 2009; Eisenhart & Edwards, 2004; Scott, Aist, & Hood, 2009; Zimmerman et al., 2011). Furthermore, our training is rooted in asset-based pedagogy that emphasizes learners' growth mindset and confidence building to attain new skills (González, Moll, & Amanti, 2005). These approaches ensure a holistic academic and social-emotional approach to improve academic, behavioral, and social emotional outcomes (Hulvershorn & Mulholland, 2018).

A4. Dissemination

The SMASH team's history of collaboration with the Kapor Foundation has resulted in a notable use of diverse outlets to reach a wide audience, including social media, self-published reports, peer-reviewed journal articles, and educational conferences. We will extend this collaboration with AIR evaluators to share our results and lessons learned of *SMASH 3.0* to educators and nonprofit organizations interested in similar approaches to CS education among marginalized students. Project milestones and findings will be shared broadly over the course of the grant period, with the final year focusing on dissemination and sustainability activities. We will apply lessons learned during implementation by directly communicating with staff across our sites.

B. Quality of the Project Design

B1. Conceptual Framework

SMASH 3.0 is a CS exposure program that prepares marginalized students to engage with a CS path. *SMASH 3.0* includes the following key components: (1) an introductory CS course, (2) CS project-based learning activities tied to conversations about the ethics of tech-enabled solutions, (3) social-emotional workshops, (4) networking with peers, computing professionals, and faculty, (5) access to a digital platform with resources to navigate colleges and careers in CS, and (6) culturally-responsive facilitator training. *SMASH 3.0* is intended to boost student interest and engagement in CS, motivate them to continue exploring CS, build their knowledge base and confidence to navigate college and careers in CS, and introduce them to peer and professional networks in computing. See Appendix G for the logic model.

B2. Goals, Objectives, and Outcomes:

SMASH 3.0 objectives aim to have marginalized students persist in CS by increasing their: (1) awareness about pursuing a CS major and career; (2) confidence to pursue a CS pathway; (3) motivation to explore CS beyond the program; (4) knowledge of navigating the college application process towards a CS pathway; (5) connections to peers on a CS pathway and professionals in the CS industry; and (6) enrollment in CS courses. Concurrently, we aim to improve the staff training model and digital platform engagement through conducting a pilot, refining the model, and disseminating findings of effective strategies towards replication. Table 1 presents the goals, objectives, and outcomes of this project.

Table 1. SMASH 3.0 project goals, objectives, and outcomes

GOAL 1: TO BUILD THE CAPACITY OF STAFF TO IMPLEMENT *SMASH 3.0*.		
Objectives	**Outcome**	**Data Timeline**
1.1: Improve facilitators' ability to effectively engage students in culturally-relevant, hands-on project-based CS programming. 1.2: Improve facilitators' ability to effectively support students' social-emotional well-being. 1.3: Use evaluation to ensure students stay engaged in the program.	1.A.: 90% of facilitators will participate in SMASH training, coaching, and debriefing meetings. 1.B.: 85% of facilitators will feel supported in carrying out responsibilities. 1.C: 85% of facilitators will feel confident in carrying out culturally-relevant, hands-on project-based CS programming. 1.D: 85% of facilitators will feel confident in supporting students' social-emotional well-being. 1.E: 85% of *SMASH 3.0* participants will understand how CS was relevant to their future college/career plans. 1.F. 85% of *SMASH 3.0* participants will report that facilitators supported their social-emotional well being. 1.G. 85% of *SMASH 3.0* participants will report satisfaction with CS instruction. 1.H. 80% of *SMASH 3.0* participants will attend Introductory CS courses. 1.I. 100% of *SMASH 3.0* participants will attend at least 1 CS project-based design thinking workshop. 1.J. 100% of *SMASH 3.0* participants will attend at least 1 residential social-emotional workshop. 1.K. 100% of *SMASH 3.0* participants will attend at least 1 networking event and 1 speaker series event.	1.A. Y1-Y5 1.B. Y1-Y5 1.C. Y1-Y5 1.D. Y1-Y5 1.E. Y2-Y5 1.F. Y2-Y5 1.G. Y2-Y5 1.H. Y1-Y5 1.I. Y1-Y5 1.J. Y1-Y5 1.K. Y1-Y5
GOAL 2: USE AND IMPROVE A DIGITAL PLATFORM TO PROVIDE STUDENTS RESOURCES RELATED TO COLLEGE & CAREER READINESS FOR CS PATHWAYS.		
Objectives	**Outcome**	**Data Timeline**
2.1: Refine digital platform content related to role models in CS.	2.A.: 85% of *SMASH 3.0* participants report CS role model content is engaging. 2.B.: 80% of *SMASH 3.0* participants access information	2.A. Y2-Y5 2.B. Y2-Y5

2.2: Develop digital platform content related to CS college pathways. 2.2: Refine digital platform content developed related to CS career pathways. 2.3: Improve student engagement with the digital platform.	about CS programs/courses in their community via the platform. 2.C.: 75% of *SMASH 3.0* participants in both cohorts access information about CS career paths via the platform. 2.D. 65% of *SMASH 3.0* participants in both cohorts will attend external events/programs found on the platform. 2.E.: 90% of *SMASH 3.0* participants in both cohorts create a profile on the digital platform. 2.F.: 85% of *SMASH 3.0* participants in both cohorts will watch at least 2 role model videos.	2.C. Y2-Y5 2.D. Y2-Y5 2.E. Y1-Y5 2.F. Y2-Y5
GOAL 3: TO IMPROVE STUDENT CS ENGAGEMENT, CS PERSISTENCE, AND SOCIAL-EMOTIONAL OUTCOMES.		
Objectives	**Outcome**	**Data Timeline**
3.1: Students increase their awareness about how to pursue CS major & careers. 3.2: Students increase their confidence to pursue CS. 3.3: Students increase their motivation to explore CS beyond the program. 3.4: Students increase their understanding of the college CS pathway navigation and process. 3.5: Students increase their connections to peers on a CS pathway. 3.6: Students increase their connections to professionals in the CS industry.	3.A.: 85% of *SMASH 3.0* participants report increased knowledge of community activities, academic courses, and colleges with CS programs. 3.B.: 85% of *SMASH 3.0* participants report increased knowledge of potential careers to have on a CS path. 3.C.: *SMASH 3.0* participants show 10% improvements in confidence to pursue a CS pathway. 3.D. *SMASH 3.0* participants show 10% improvements in CS engagement and aspirations. 3.E.: 85% of *SMASH 3.0* participants report intention to enroll in CS courses and/or programs beyond SMASH. 3.F.: 85% of *SMASH 3.0* participants gain knowledge of the college application process. 3.G.: 85% of *SMASH 3.0* participants report greater connections made to students also pursuing CS. 3.H.: 100% of *SMASH 3.0* participants report meeting at least 2 computing professionals and faculty. 3.I.: 80% of *SMASH 3.0* participants who have access to CS	3.A. Y3-Y4 3.B. Y3-Y4 3.C. Y3-Y4 3.D. Y3-Y4 3.E. Y3-Y5 3.F. Y3-Y5 3.G. Y3-Y5 3.H. Y1-Y5 3.I. Y3-Y5

3.7: Students increase enrollment in CS courses beyond *SMASH 3.0*.	courses in their schools and CS programs enroll. 3.J.: 75% of *SMASH 3.0* participants enroll in post-secondary institutions with the intention to major or minor in CS.	3.J. Y5
GOAL 4: TO EVALUATE, REFINE, & IMPLEMENT *SMASH 3.0* COMPONENTS.		
Objectives	**Outcome**	**Data Timeline**
4.1: Identify the fidelity of the SMASH 3.0 model across all sites. 4.2: Identify the relationship between SMASH 3.0 strategies (incl. in-person and digital components) and expected outcomes. 4.3: Adapt the SMASH 3.0 model as necessary.	4.A.: Complete a mixed-method quasi-experimental design evaluation study, including formative evaluations. 4.B.: Revised logic model of the *SMASH 3.0* program. 4.C.: Resources, publications, and presentations produced to inform replications of an effective model of CS persistence. 4.D.: Revisions made to curricula & training material, implementation guidelines, and digital platform, per evaluation results.	4.A. Y2-Y5 4.B. Y2 4.C. Y2-Y5 4.D. Y2-Y5

While *SMASH 3.0* will reach a total of 500 high school students annually, the evaluation will take place over the course of two phases with a subset of students. Phase 1 will include a pilot study at two sites with up to 100 students from July 2024 to May 2025. During Phase 2, data will be collected from 500 *SMASH 3.0* participants in 2 cohorts (250 students per cohort) and 500 comparison students to take part in the program impact analysis. See Section E for details.

B3. Project Design to Address Needs of Target Population

Section A highlights the disparate opportunities afforded to marginalized communities to enter, persist, and succeed in the CS pipeline. **SMASH has intentionally targeted** geographical areas with marginalized students, including urban areas with high concentrations of Black, Latine, and/or Native, low-income, under-resourced schools. Historically, the demographics of SMASH participants have been 80% Black or Latine, 73% qualifying for Free/Reduced-Price Lunch (as a proxy for low-income), 52% first-generation in college, and 52% girls of color or non-binary. To meet the needs of these marginalized populations, the program will include the following components:

1) **Culturally-Responsive Staff Trainings:** Culturally-relevant pedagogy is key to engaging marginalized students (Ladson-Billings, 1995). SMASH trains staff on culturally-responsive facilitation to engage students in CS, while fostering development of their CS identity.
2) **Introductory CS Course:** Even when schools have advanced CS courses, the lack of preparatory courses create a learning curve which is often too steep for students with no prior exposure, thus restricting access to students with additional capital and resources to explore computing (Goode & Margolis, 2011). *SMASH 3.0* will provide an introductory course focused on understanding core CS principles and computational thinking/coding by way of project-based learning in which students collaborate to solve issues through technology-enabled solutions. In alignment with AP CS Principles, students will be introduced to core coding concepts (e.g., loops, conditional, list), learn to design and evaluate solutions, apply CS to solve problems through the development of algorithms and programs, and use data to discover new knowledge. Students will also explain how computing innovations and systems work and explore their potential impacts to communities.
3) **Project-Based Learning Tied to the Intersection of CS & Tech Ethics**: Programs that recognize students' identities, life experiences, and community contexts are essential to the persistence of marginalized groups in STEM pathways (Ashcraft, Eger, & Scott, 2017). As such, students in the program will participate in CS workshops to work on a group project on

a topic of their choice. These workshops allow them to research the issue, explore problem solving, and develop the skills to build a solution while understanding the ethical implications of the proposed technology. The sessions lead to a pitch competition where groups present their project to the wider national community and a team of "expert" judges in the entrepreneurship and/or venture capital industry.

4) **Building CS-Focused Network of Peers**: Marginalized students, particularly in advanced courses, are often isolated as an "only" within their school context (Moses, 1993) and face hostility and exclusion (Lee et al., 2020; McGee & Bentley, 2017; Dee & Gershenson, 2017), necessitating the development of a network of like peers to support each other. *SMASH 3.0* is built upon the premise that developing strong peer relationships can be a protective factor on a CS pathway. During this time, students will participate in residential programming, such as identity building workshops and discussions around social issues, while also participating in informal in-person gatherings (e.g., dining together).

5) Exposure to Networks of Computing Professionals with Similar Identities: Marginalized students are often discouraged in STEM due to a lack of diverse role models (Ferreira, 2001). To combat this barrier, the majority of facilitators and STEM professionals recruited for *SMASH 3.0* are Black, Latine, Native, or women based on the premise that students should see themselves reflected in computing to build their own sense of belonging (Shin, Levy, & London, 2016). However, given the underrepresentation of Black, Latine, and Native professionals in computing (Scott, et al., 2018), role models via digital media can provide greater accessibility to a range of computing professionals (Steinke, et al., 2021). As such, *SMASH 3.0* will also build a digital platform enabling access to videos of computing role models to expand the pool of professionals.

6) **Digital Platform Access to CS-Specific College and Career Readiness Resources:** The constraints of time and resources for in-person programming focused on diverse CS career paths requires supplementation online. As noted above, students will access a digital platform to expand their knowledge of computing role models aligned to student interests and in emerging CS areas (e.g., AI). Given the importance of repeated CS exposure and opportunities, the platform will also serve as a resource repository for additional CS exposure opportunities, postsecondary CS departments/institutions, and internship opportunities.

C. Quality of Project Personnel

Project Personnel

With a SMASH core value of *We Lead with Racial Justice and Reflect the Communities We Serve*, our team is 50% Black and 30% Latine, 58% women, and 3% non-binary. Our staff's professional backgrounds are extensive and relevant, from educators to STEM professionals, we approach our scholars with shared personal experiences, creating a safe and supportive learning environment.

SMASH, in partnership with the Kapor Foundation, will oversee the design and implementation of the program, as well as collection of program participation data (e.g., attendance tracking). An independent evaluation team from AIR will lead the formative and summative evaluation. Letters of support can be found in Appendix C and details of key personnel can be found in Appendix B.

Table 2. Leadership team responsible for program implementation and evaluation activities.

Design & Implementation Team Member	***Role***
[redacted], Vice President of SMASH, Project Director	Oversee program implementation design. Supervise the program lead, curriculum lead, operations lead, digital engagement lead, site directors, facilitator training, curricular

	development, seasonal staff and overall site management.
[redacted] Ph.D., Chief Research Officer of Kapor Foundation, Co-Director	Act as team liaison, meet regularly with implementation and evaluation teams to ensure progress of project goals and objectives, and support reporting & dissemination.
[redacted] National Director of Curriculum and Training of SMASH	Oversee the development of curricular content. Supervise curriculum developers and training facilitators responsible for creating program content and training site staff, inclusive of training and implementation specialists, residential directors, residential advisors, and academic facilitators.
[redacted] Data Administrator of SMASH	Develop tracking mechanisms for all formative and summative data from program staff & participants (e.g., demographics, attendance, transcripts, deliverables).
[redacted], Operations Administrator of SMASH	Coordinate site activities to ensure operations run effectively (e.g., recruitment, onboarding, IT). Collaborate with IT, People Operations, Events, Communications, Finance teams to ensure sites are supported in budget management, onboarding, and scholar + staff recruitment.
[redacted], Ed.D., Digital Engagement Lead	Lead the development of the digital platform, including content creation, oversee technical consultants, and monitor engagement.
External Evaluation Team Member	***Role***
[redacted], Ph.D., Principal Researcher, AIR	Oversee evaluation and provide methodological and intellectual leadership to both the implementation study & impact study, act as key point of contact with partners, oversee grant spending & reporting to partners, quality control, and dissemination of findings.
[redacted] Ph.D., Senior Researcher, AIR	Lead impact study, develop evaluation plan, develop outcome measures, conduct statistical matching for both QED cohorts, request the National Student Clearinghouse data, analyze quantitative data (e.g., student & facilitator survey data, NSC administrative data), and supervise junior analysts for data cleaning and analytic tasks.
[redacted] Ph.D., Researcher, AIR	Develop & finalize all implementation measures, supervise research assistants in conducting implementation data collection, manage qualitative data collection & analysis, lead the formative feedback, and support partners with continuous improvement and modifications.

D. Quality of the Management Plan

To achieve the program goals and objectives on time and within budget, *SMASH 3.0* will track our management plan through Asana, as well as meet regularly to review progress, examine qualitative and quantitative data, identify challenges, and make changes. *SMASH 3.0* follows two phases: Phase I: Pilot Implementation and Recruitment January 2024-July 2025; Phase II: Full Implementation, Evaluation, Reporting/Dissemination July 2025-December 2028.

Table 3. Key Milestones, Timeline, Management Plan

Goal 1: To build the capacity of staff to implement *SMASH 3.0*.						
Key Milestones	**Lead Team**	**Timeline**				
		‘24	**‘25**	**‘26**	**‘27**	**‘28**
Hire 150 staff across sites per year as course and workshop facilitators and residential staff.	C&T, O	Jan-Apr/ Nov-Dec	Jan-Apr/ Nov-Dec	Jan-Apr/ Nov-Dec	Jan-Apr/ Nov-Dec	Jan-Apr/ Nov-Dec
Onboard staff with required resources to implement (i.e., tech, curriculum, HR, COVID protocols).	O	Mar-May	Mar-May	Mar-May	Mar-May	Mar-May
Train seasonal staff in curricula, pedagogy, and asset-based and restorative practices.	C&T	May-Jul	May-Jul	May-Jul	May-Jul	May-Jul
Host “office hours” for seasonal staff for staff implementation questions and problem solving.	C&T	Apr-Jul	Apr-Jul	Apr-Jul	Apr-Jul	Apr-Jul
Set up observational periods with staff to support in *SMASH 3.0* implementation.	C&T	Jul	Jul	Jul	Jul	Jul
Refine training materials for staff based on program cycle data & debriefs	O	Nov	Nov	Nov	Nov	Nov
Goal 2: Use and improve a digital platform to provide students resources related to college & career readiness for CS pathways.						
Key Milestones	**Lead Team**	**Timeline**				
		‘24	**‘25**	**‘26**	**‘27**	**‘28**
Refine digital platform	DE	Mar-Dec				

Onboard *SMASH 3.0* participants during Phase II onto digital platform	DE		Jul			
Pilot test digital platform during programming	DE		Jul			
Refine digital platform based on testing	DE		Aug-Sept			
Launch full scale launch of platform activities	DE			Jan-Dec	Jan-Dec	Jan-Jul
Refine digital platform based on evaluation data	DE		Aug-Sept	Aug-Sept	Aug-Sept	Aug-Sept
Goal 3: To improve student CS-based and social-emotional outcomes.						
Key Milestones	**Lead Team**	**Timeline**				
		'24	**'25**	**'26**	**'27**	**'28**
Refine student curriculum material	C&T	Oct	Oct	Oct	Oct	Oct
Recruit target schools to market *SMASH 3.0* for eligible students.	SDs	Jan-Feb	Sept-Oct	Sept-Oct	Sept-Oct	Sept-Oct
Recruit & admit new cohorts of 500 students across 5 sites.	SDs	Mar-Jun	Nov-Jun	Nov-Jun	Nov-Jun	Nov-Jun
Onboard students with required resources to implement (i.e., technology, COVID protocols).	O	May-Jun	May-Jun	May-Jun	May-Jun	May-Jun
Facilitate 3 weeks of in-person programming	SDs w/ seasonal staff	Jul	Jul	Jul	Jul	Jul
Hold semi-final and final virtual pitch competitions across sites for student presentations of projects	SDs w/ seasonal staff	Jul	Jul	Jul	Jul	Jul
Goal 4: To evaluate, refine, and implement *SMASH 3.0*.						
Key Milestones	**Lead Team**	**Timeline**				
		'24	**'25**	**'26**	**'27**	**'28**
Hold monthly meetings to ensure regular communication between evaluation & prog teams	K, AIR, All SMASH	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec
Completion of Phase I of evaluation cycle (Full scope found in Appendix J2)	AIR	Jul-Dec	Jan-May			
Completion of Phase II of evaluation cycle (Full scope found in Appendix J2)	AIR		Jul-Dec	Jan-Dec	Jan-Dec	Jan-Dec

Hold SMASH staff planning retreat	All SMASH, K, AIR	Oct	Oct	Oct	Oct	Oct
Disseminate lessons learned and effective strategies towards CS engagement (e.g., EIR Project Directors' meeting, conference presentations, peer-reviewed articles, and general media)	K, AIR, All SMASH		Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec

C&T=Curriculum & Training; O=Operations; DE=Digital Engagement; SDs= Site Directors; K=Kapor

E. Quality of the Project Evaluation

AIR will conduct an independent evaluation to provide formative and summative evidence about the implementation and impact of the *SMASH 3.0* program. The implementation evaluation will assess whether the key components of the program have been implemented as planned—and why or why not—providing SMASH with ongoing feedback to inform adaptations and refinements to the program and its delivery. The impact evaluation will use a student-level matched comparison quasi-experimental design (QED) to assess the impact of *SMASH 3.0* on student outcomes, producing evidence about the program's effectiveness that will meet **What Works Clearinghouse (WWC) 5.0 Standards with reservations.** The evaluation will take place in five university campuses (i.e., sites) where *SMASH 3.0* summer residential programming will be implemented and follow students from high school through the first or second year in college (See Exhibit J3.3 for sites, enrollment goals, and student demographics). In Phase 1, *SMASH 3.0* will be piloted with 100 students in two sites from July 2024 to May 2025. In Phase 2, Grades 11 and 12 students will receive *SMASH 3.0*, starting in July 2025 (Cohort 1) or starting in July 2026 (Cohort 2). Data collection activities will occur in four years, with final analysis and reporting in 2028 (Year 5) and periodic feedback reporting throughout (Table 1 and Appendix J2 for study timeline). Eight research questions aligned with the project's conceptual framework and goals will guide the evaluation (Table 2).

Table 1. Program Rollout and Evaluation Timeline

Evaluation timeline		Sample	01/24-06/24	07/24-06/25	07/25-06/26	07/26–06/27	07/27-06/28	07/28–12/28
Phase		Students	Planning	Data collection, analysis, feedback				Final reporting
Phase 1: Pilot	Treatment	100 G11/12 students		Pilot SMASH				
Phase 2: QED Cohort 1	Treatment	125 G11 students			SMASH 3.0	Follow up data collection		
		125 G12 students				Follow up data collection		
	Comparison	125 G11 students 125 G12 students			Data collection			
Phase 2: QED Cohort 2	Treatment	125 G11 students				SMASH 3.0	Follow up	
		125 G12 students					Follow up	
	Comparison	125 G11 students 125 G12 students				Data collection		

Note. G: Grade. Student surveys will be administered once at baseline and twice post program (spring of the program year and the spring in the following year). Postsecondary enrollment and retainment data will be based on NCS extant data only and will be obtained in the fall post high school.

Table 2. Research Questions and Data Sources

Research Questions	Data Sources
Impact Evaluation	
1. To what extent did *SMASH 3.0* have an impact on student CS attitudes, and behaviors (e.g., engagement, critical thinking), and aspirations?	Student survey
2. To what extent did *SMASH 3.0* have an impact on students' college application knowledge?	Student survey
3. To what extent did *SMASH 3.0* have an impact on students' postsecondary outcomes (enrollment, selecting a CS major, and retention)?	National Student Clearinghouse (NSC) data
4. To what extent does impact of *SMASH 3.0* on student postsecondary outcomes differ by student characteristics?	NSC data
5. To what extent is the impact of *SMASH 3.0* on student postsecondary outcomes mediated by students' CS identity?	NSC data/student survey
Implementation Evaluation	
6. To what extent are the key components of *SMASH 3.0* implemented with fidelity?	Program records, facilitator survey
7. To what extent are students satisfied with *SMASH 3.0*?	Student survey, student focus groups
8. What facilitators and barriers are associated with *SMASH 3.0* implementation?	Program records, facilitator survey and focus groups

E1. Evidence That Meets WWC Standards

Research Design. The impact evaluation will use a student-level matched comparison QED design with propensity score matching (Rosenbaum & Rubin, 1983) that will meet *WWC standards with reservation*[1]. First, AIR will create a comparison group using statistical matching within each cohort. The matched comparison students will attend the same schools as *SMASH 3.0* participants and will be matched on demographic and academic characteristics (described below). Next, AIR will analyze the outcomes of students receiving *SMASH 3.0* against those of matched non-participating students with similar demographic and academic characteristics.

Matching Procedure and Baseline Equivalence. To ensure baseline equivalence between the SMASH 3.0 participants and the comparison group, within each cohort, AIR will conduct matching through two steps and with carefully selected covariates to minimize selection bias and baseline differences. First, AIR will compile a list of schools attended by the *SMASH 3.0* participants in each cohort, establish data sharing agreements with these schools to obtain administrative data for all Grades 11 and 12 students attending these schools. Students in grades 11 and 12 from these schools who are not participating in *SMASH 3.0* will serve as a pool of comparison students. Second, from this pool AIR will identify comparison students who are most similar to treatment students using 1:1 student-level propensity score matching (Rubin, 1997). Students will be matched on characteristics used for SMASH admission, such as Grade 10/11 GPA, involvement in CS extracurricular activities, plus race/ethnicity, socioeconomic status, and other covariates that are likely associated with the outcomes of interest (see Appendix J3 for details on matching). We will compare the *SMASH 3.0* students with the comparison group

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[1] Because students need to go through an admission process and satisfy admission criteria, it is not feasible to do a randomized trial.

to ensure balance on key covariates required by the WWC and will revise the matching procedure until baseline equivalence is achieved. The matching analysis will be conducted in the spring of 2025 (cohort 1) and spring of 2026 (cohort 2) before the treatment students start attending the summer activities to identify comparison students for baseline data collection.

Valid and Reliable Measures of Relevant Outcomes. To measure CS mindset, CS engagement, critical thinking, CS aspirations, and college application navigation (RQs 1–2), AIR will administer an online student survey in both the treatment and comparison conditions before the intervention starts. Student surveys will be administered at baseline, in the spring of the program year, and the follow-up year to measure CS beliefs, attitudes, and behaviors outcomes. AIR will draw on previously validated survey measures to assess student outcomes, which meet the WWC's requirements for validity and reliability of outcome measures (see Appendix J4). CS beliefs, attitudes, and behaviors will be measured by scales including confidence in learning CS and programming, attitude toward success in CS, usefulness of CS and programming, CS mindset, and CS aspirations with demonstrated satisfactory reliability ($\alpha = 0.77$ to 0.92). College application knowledge will be measured by a college application knowledge scale ($\alpha = 0.85$; Watt et al., 2007). Instruments included in the student survey will be tested during the pilot year. AIR will also collect students' postsecondary outcome data (enrollment, selecting a CS related major, and retention) from National Student Clearinghouse (NSC), an extant college administrative data source that are considered valid and reliable and meets the WWC requirements.

Sample, Missing Data, and Power Analysis. The student-level QED design will have 1,000 students, half of whom will be *SMASH 3.0* participants. The treatment group includes 500 students from two cohorts of 250 rising Grades 11 and 12 students who will participate in the program starting in summer 2025 (cohort 1) or summer 2026 (cohort 2). The comparison group will include 500 students who will not participate in *SMASH 3.0* but will have similar demographic and academic characteristics and attend the same high schools as the *SMASH 3.0* participants from each cohort. We anticipate including all students in the sample for postsecondary outcomes, which will use the NSC[2] extant data. We anticipate some nonresponse and missing data on the student survey. To reduce nonresponse, AIR will use multiple successful strategies such as generous incentives for completing surveys, phasing data collection to reduce burden, early and ongoing communication about participation, and frequent and targeted follow-up with nonrespondents (Brueton et al., 2014; Dillman, Smyth, & Christian, 2014)[3].

The projected analytic samples will support minimal detectable effect sizes between 0.13 and 0.14 for continuous outcomes with the expected response rates and missing data assumptions. Kraft (2020) characterizes effect sizes between 0.05 and 0.20 "medium" effect sizes, and effect sizes in this range are educationally meaningful. For binary outcomes, we assumed a base rate of 0.35, and the results show the study is powered for 6.65 to 8.10 minimum detectable effect in percentage points (see power calculation details in Appendix J3).

Impact Analysis. To assess the impact, we will use linear regression models for continuous outcomes and logistic regression models for dichotomous outcomes (e.g., college enrollment, selecting a CS related major, retention), with the five sites and grade levels as fixed effects dummy indicators and adjusting for baseline differences and other relevant covariates. Each model will estimate whether a given student outcome differs between students participating

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[2] NCS has near universal coverage. Thus, we assume that those who are not in the NCS data are not enrolled in postsecondary institutions.
[3] The nonresponse rate on the student survey will not affect the impact evaluation's ability to meet the WWC standards: For quasi-experimental research, the WWC does not apply the attrition standard, only the baseline equivalence standard to ensure that groups are similar at baseline, which the evaluation will achieve through matching.

in *SMASH 3.0* and the matched comparison students. For analyses of differential effects on student outcomes (RQ4), we will incorporate appropriate interaction terms into the main impact model. For example, we will examine if *SMASH 3.0* has different effects on postsecondary outcomes for boys and girls. We will also conduct mediational analyses to explore the extent to which changes in student aspiration or CS identity mediate the program effect on student postsecondary outcomes (RQ5) (see details of the analytic models in Appendix J3).

Using a QED, valid and reliable outcomes measures, establishing baseline equivalence, and adjusting estimates for baseline differences will ensure that the study meets the WWC standards with reservations, which will not be affected by nonresponse or missing data.

E2. Performance Feedback and Periodic Assessment of Progress

AIR will conduct an implementation evaluation to (a) provide partners with performance feedback to inform continuous improvement of *SMASH 3.0*, (b) assess implementation fidelity in each year (RQ6), (c) assess treatment students' satisfaction (RQ7), and (d) identify facilitators and barriers to implementation (RQ8). AIR will conduct quantitative analyses of closed-ended survey data (e.g., student and facilitator surveys) and will conduct qualitative analyses of open-ended survey questions and focus group data by coding and categorizing data, using a coding structure derived from the project's conceptual framework.

Collecting Data. Implementation evaluation will be conducted in two phases: pilot study (Phase 1) and full implementation (Phase 2). AIR will use three data sources: program documents (e.g., attendance records), surveys and focus groups with students and facilitators. AIR will develop a facilitator survey with questions to understand the implementation of *SMASH 3.0* such as frequency of activities, use of materials, training reception, feasibility of program components, their experiences with the program and the extent to which they feel supported. Focus groups with facilitators and treatment students will identify facilitators and barriers to implementation. AIR will develop two semi-structured 60-minute focus group protocols, informed by the logic model, for facilitators and students. AIR will use an inductive approach to qualitative data analysis, employing rigorous procedures to assess and synthesize the qualitative data to answer all four evaluation questions. Data will be managed through reduction, organization, and connection and enable the research team to uncover major themes and patterns within and across sources (Lincoln & Denzin, 2003).

Pilot Study (Phase 1). AIR will conduct a pilot study (July 2024 – May 2025) at two university sites to understand the feasibility and usefulness of *SMASH 3.0*. AIR will collect program data and conduct facilitator interviews at both sites. AIR will interview a total of 6 facilitators (3 per university site) and 12 students (6 per university site). To analyze program records, AIR will work with SMASH program staff to identify indicators for each key program component and the criteria for adequate implementation for each indicator. AIR will then use program records to describe the level of implementation for both sites (**RQ6**). Interview data from facilitators and students will be conducted and analyzed for themes that indicate facilitators and barriers to implementation (**RQ8**). Outcomes of the pilot study will be reported to SMASH with recommendations for improvement prior to full implementation.

Full Implementation (Phase 2). AIR will use quantifiable indicators and data from facilitator surveys to systematically measure implementation fidelity of *SMASH 3.0* and monitor whether the expectations for implementation are met (**RQ6**). Using indicators developed during the pilot, AIR staff will analyze program records across five university sites once a year for each cohort to evaluate implementation fidelity and describe variations, if any, across sites.

To answer **RQ7**, AIR will develop and administer an online post-program survey that targets treatment students' perceptions of and satisfaction with key program components and overall program quality. AIR will also conduct focus groups with a random sample of students – 5 focus groups per site, 3-4 students per focus group – to further understand student perceptions of the quality of program components and the extent to which those components influenced their postsecondary plans. For **RQ8**, AIR will develop and administer an online facilitator survey to all facilitators and conduct focus groups with facilitators for each cohort to understand their perceptions of facilitators and barriers to the implementation of the key program components and to identify areas for improvement. AIR will conduct 3 focus groups composed of a random sample of 5 facilitators in each cohort. AIR will analyze the data to identify common themes about successes, challenges, and areas for improving program design and its implementation.

Providing Performance Feedback. The implementation study will provide formative data that offer performance feedback and assessment of progress throughout the duration of the project. AIR will share performance feedback with SMASH using a plan–do–study–act cycle facilitated by AIR to help program administrators review feedback data (study), determine improvements based on data (act), and then develop (plan) and implement those improvements (do). AIR will provide feedback through PowerPoint presentations, summarizing implementation data at the end of the program year for the pilot and in each QED cohort in subsequent years.

Evaluating Implementation Fidelity and Identifying Factors That Support and Hinder Implementation. AIR will evaluate implementation fidelity, guided by the project's conceptual framework (RQ6). During the pilot, AIR will collaborate with SMASH staff to develop and refine an implementation rubric. The implementation fidelity analysis will analyze data from annual student focus groups, student attendance, meta-data of student usage of the platform. AIR will also identify facilitators and barriers to implementation (RQ7). For example, AIR will investigate whether administrative support from the university sites influence implementation. By collecting data over multiple years, AIR will examine changes in fidelity of implementation as the program matures and as the program addresses implementation barriers.

Periodic Assessment of Progress Toward Outcomes. In addition to the implementation analyses, we will assess interim progress toward study outcomes. The interim reports (2024–27) will include preliminary analyses of impacts on student outcomes for each cohort and for different follow-up data collections.

E3. Well-Articulated Key Project Components, Mediators, Outcomes, and Acceptable Implementation Thresholds

The evaluation design is informed by clearly specified program components and outcomes, as depicted in the logic model (see Appendix G). The logic model specifies two key program components: (1) summer residential programming that include CS courses, project-based workshops, SEL workshops, and networking opportunities and (2) college and career exploration digital platform that will deliver virtual sessions, inspirational videos of role models, and announcements of upcoming events. With these components, the program aims at improving students' CS attitudes, behaviors, and knowledge about college application, with a goal towards postsecondary outcomes. By improving these intermediate outcomes, *SMASH 3.0* expects to improve student postsecondary enrollment and retention and increase selection of a CS major. AIR will conduct mediational analyses and will follow the appropriate model to establish mediation where estimated treatment effects and the mediator effect are nonzero and in the expected direction (Preacher et al., 2010) (See the analytic models in Appendix J3).

The design will also document delivery of program inputs and establish clear and measurable thresholds for adequate implementation of the *SMASH 3.0* program (see Appendix J5 thresholds for implementation fidelity). The proposed measurable threshold for acceptable implementation of program inputs identified so far include (a) students joining at least 80% of the programming sessions provided by the residential program; (b) 75% students joining at least one networking event and SEL workshop during summer programming; and (c) 75% students visiting at least one of the guides or watching inspirational videos of role models during the program year, and 75% students participating in at least one virtual or in-person sessions on college and career related to CS during the program year. During the pilot study, AIR will refine measures with the program staff to establish clear fidelity thresholds for each program component and will identify components that need additional refinement or support. Then AIR will evaluate implementation fidelity among *SMASH 3.0* participants in the QED sample during the subsequent years using the established thresholds.

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SMASH Application Scoring Matrix

Target Ratio (SmarterSelect will automatically score the following attributes)

Target Ratio	Rationale	Yes	No	Weight
Race/Ethnicity	SMASH shows its commitment to underrepresented people of color in STEM by focusing on specific racial/ethnic groups (Black, Latinx, and Native American). The target applicant identifies racially as Black, Latinx, or Native American. These groups are the most underrepresented in CS and demonstrate the highest need for SMASH.	1	0	20%
Low-income	SMASH shows its commitment to low income students by targeting applicants who are eligible for free and reduced price lunch as defined nationally.	1	0	20%
1st in Family	SMASH shows its commitment to first-generation college bound scholars by targeting scholars with parents who have never received a bachelor's or 4-year degree (or higher) from an accredited college or university in the United States. A scholar who has a sibling in college is still first generation. A scholar whose parents took some courses, but did not complete a degree is still considered first generation.	1	0	20%
Involvement in STEM programs	SMASH targets applicants who are NOT involved in high touch, high quality STEM/CS programs similar to SMASH. Scholars not involved in other STEM/CS programs can potentially show greater impact gains.	0	1	20%
Target School	Kapor Foundation's Research and Evaluation Team identifies each year's target schools, which is based on a combination of factors including: schools serving greater populations of low-income households (based on student eligibility of Free or Reduced Price Lunch), greater proportion of students scoring on the lowest tier of state standardized testing, and greater proportions of Black, Latinx, and/or Native students. In addition, students attending schools in which Kapor Foundation has completed culturally-responsive and culturally sustaining (CRCS)-informed professional development with their educators.	1	0	20%