Implement for Impact (I4I)

Scalable Professional Learning for CS Education

SSDA
Small School Districts' Association

CS4NorCal
Computer Science and STEM Education Rural Implementation Model

SCOE
Sacramento County Office of Education
EDUCATION EMPOWERS

IMPLEMENT FOR IMPACT

Scalable Professional Learning for CS Education

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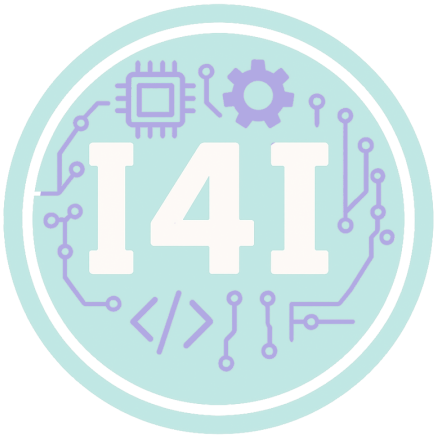

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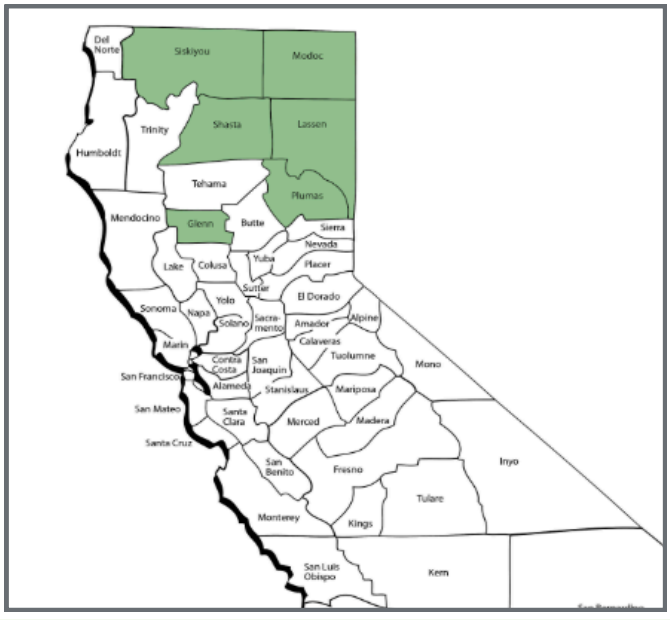
Abstract

California's small, rural school districts face significant systemic barriers to providing equitable computer science (CS) education, including funding inequities and limited access to professional development. To address this disparity, the CS4NorCal project, funded by a federal grant to the Small School Districts' Association, developed a regional, context-responsive professional learning model to build local capacity and create sustainable CS pathways. This article details the design, implementation, and outcomes of the project's capstone professional learning experience: the "Implement for Impact" (I4I) workshop series, a year-long program for secondary educators.

The I4I series was designed to move teachers from foundational knowledge of California's K-12 CS standards to impactful pedagogy by focusing on high-impact instructional strategies. The content was sequenced across four distinct workshops: (1) establishing a pedagogical foundation in Project-Based Learning (PBL); (2) introducing Agile project management to structure complex, collaborative student work; (3) exploring emerging CS concepts like artificial intelligence and cybersecurity as topics for student projects; and (4) developing strategies for showcasing student work to an authentic audience.

For professional learning practitioners, this article examines the evolution of the I4I series as a case study in designing and adapting professional development for a specific, high-need context. It details an iterative redesign that significantly improved participant retention - a common challenge in sustained professional learning - and highlights key outcomes, including consistently high educator satisfaction and a statistically significant positive effect on student science achievement. The findings present a promising and replicable framework for building local capacity that will be of interest not only to professional learning practitioners but also to the school leaders, regional intermediaries and county offices of education, and public funders they support. By grounding the model in classroom-ready practices like PBL and real-world applications, this work offers a sustainable approach to bridging the access gap in computer science education.



PART I - Background and Context

Introduction

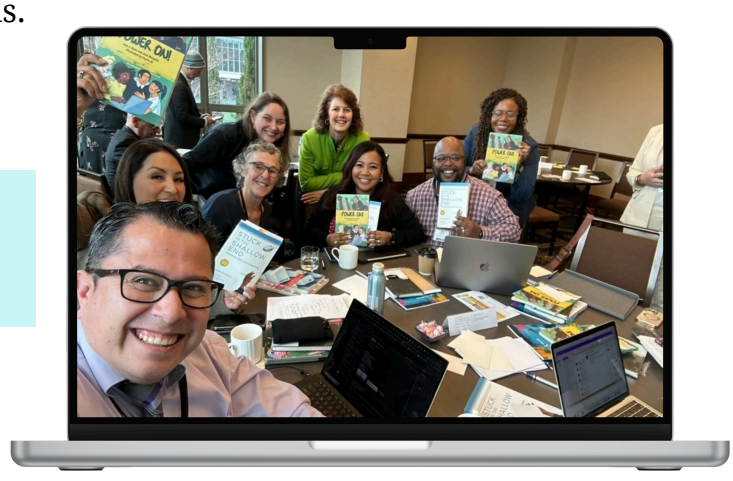
In 2018, California established statewide computer science (CS) standards but failed to provide a clear implementation plan for its numerous small, rural school districts. These districts face systemic barriers, including funding inequities, insufficient technological infrastructure, and limited access to professional development, that have impeded their ability to offer the same opportunities as their urban peers. During the 2019-2020 school year, only 24% of California's rural high schools offered a CS course, compared to 56% of schools in suburban and urban areas (Code.org et al., 2020).

One in every ten students in California lives in a rural area—over half a million students—and 67% of the state's school districts are classified as small (Jones, 2019).

The reasons for these gaps are systemic. A national report found that superintendents in rural districts are significantly less likely than their urban counterparts to agree that their school board is committed to offering CS (Google & Gallup, 2020). These barriers include funding inequities, insufficient technological infrastructure, and limited access to professional development.

"Why not here? Why should our kids be behind the 8-ball because of where they live?"
– Rob Adams, retired Superintendent, Redding Elementary School District

To address this disparity, the Small School Districts' Association (SSDA) secured a nearly $4 million federal grant to launch CS4NorCal. The project focused on six of California's most remote counties, where some districts serve fewer than 100 students, educators may drive hours for training, and unreliable internet can hinder online learning. CS4NorCal designed and delivered professional learning and student-facing resources tailored to overcome these specific challenges, building local capacity to create sustainable CS pathways. One of CS4NorCal's most innovative strategies for enriching computer science education was the development of a professional learning workshop series, which empowered teachers to design project-based, real-world CS experiences that fostered students' collaboration, problem-solving, and career-ready skills.



CS Educators getting their learning on at a Computer Science Conference

Targeted Literature Review

Building on this understanding of persistent inequities, CS4NorCal professional learning was designed using effective strategies for supporting rural teachers. Research underscored the need for sustained, context-responsive professional learning that addresses isolation, resource constraints, and diverse student needs (Glover et al., 2016; Vernon-Feagans et al., 2013). The California Computer Science Strategic Implementation Plan notes that resourcing CS education is dependent on local contexts and best led by those who know them (California Department of Education [CDE], 2019). Reflecting this, the Small School Districts' Association (SSDA) designed CS4NorCal's professional learning on a Theory of Action that "a regional capacity-building approach…adaptive to local context can…provide students in high-need rural areas with a progressive continuum of exposure to CS instruction and experiences".

This regional, context-responsive approach was grounded in broader research that has identified the key features of high-quality professional development, with prominent CS initiatives providing models for how to effectively support teachers and promote equity. According to research led by Darling-Hammond et al. (2017), effective professional learning includes sustained duration, moving beyond one-off workshops to be content-focused and collaborative.

These principles are exemplified by programs like Exploring Computer Science (ECS), which was explicitly designed to broaden participation among underrepresented students through a multi-pronged approach combining rigorous curriculum with intensive, ongoing teacher support (Goode, Chapman, & Margolis, 2012). The two-year ECS professional learning model includes summer institutes, academic year workshops, and in-class coaching, as well as communities of practice, which have proven to mitigate the isolation often felt by CS teachers, particularly in rural areas (Davis, Ravitz, & Blazevski, 2018).

> "This isn't just about coding. It's about opening doors to future careers, developing critical thinking skills, and showing rural students that they belong in tech."
>
> – Yuri Calderon, SSDA Executive Director

PART I - Background and Context

Building on the findings from ECS, CS4NorCal designed a professional learning approach to support the educators it intended to serve. The approach strategically included a focus on CS content, as well as a focus on high-impact instructional pedagogies, prioritizing project-based learning (PBL) and work-based learning (WBL) to deepen student engagement and build sustainable CS pathways. This was informed by a strong body of research that indicated when students learn computer science through authentic, inquiry-driven projects, they demonstrate higher academic achievement, stronger problem-solving skills, and greater persistence in the subject. PBL makes CS more relevant and enjoyable by connecting coursework to students' interests and real-world problems, which is crucial for sustaining their interest in computing (Barron & Darling-Hammond, 2008; Zhang & Ma, 2023). Similarly, work-based learning strategies, such as work site tours and internships, provide students with opportunities to apply their knowledge in authentic contexts, strengthening their motivation and helping them envision a tangible future for themselves in the technology industry (Ross et al., 2020). By centering its professional development on these experiential approaches, SSDA leveraged a powerful, evidence-based strategy to bridge the gap between classroom learning and career aspirations, thereby reinforcing the project's core mission to create lasting and meaningful CS education opportunities for rural students.

Conceptual Framework

Guided by this body of research, CS4NorCal developed a logic model (Appendix A) to translate these evidence-based principles into a concrete implementation plan. The logic model identified specific outcomes, such as increased teacher confidence and student interest in CS, along with performance targets for delivering professional learning, implementing CS pathways, and providing work-based learning activities.

Staff at SSDA and the Sacramento County Office of Education (SCOE) designed grade-band-specific professional learning for teachers and leaders, supplemented by an ongoing regional community of practice. The professional learning model was directly adapted from the work of SCALE-CA, an NSF-funded project, and its week-long "Summer of CS" institute (Ryoo, Margolis, & Amalong, 2019). Piloted by SCOE in 2019, the Summer of CS provided the foundational design that SCOE and SSDA expanded upon to create a two-year sequence for CS4NorCal. This expanded sequence first exposed educators to core CS concepts and then prepared them to integrate them with other subjects and apply them in real-world settings. CS4NorCal funding allowed for developing a more intensive professional learning plan for secondary teachers, featuring 66 hours focused on CS content in the first year and 54 hours dedicated to CS integration and application in the second year.

PART I - Background and Context

Professional Learning Model (Secondary Teachers)		
	Summer	**Academic Year**
Year 1	30 hours CS Course Specific PL Options: CS Discoveries, Exploring CS, and CS Principles	24 Hours (Just-in-Time) Workshops 12 Hours CS + Core integrated content
Year 2	30 Hours of CS PL Additional Options: Bootstrap Algebra, Equity Minded Instruction, and CS Integration	24 Hours Implement 4 Impact

The second year of this sequence was designed to move teachers from foundational knowledge to impactful pedagogy, culminating in the Implement for Impact (I4I) workshop series. This capstone experience is rooted in experiential approaches, primarily project-based learning (PBL) and strategies for incorporating work-based learning (WBL). SSDA and SCOE deliberately chose PBL because of its proven effectiveness and flexibility; as a pedagogical strategy, it can be applied equally well in computer science, science, or math courses. Alongside PBL, the framework emphasized work-based learning to explicitly connect classroom activities to career pathways. This component was included to help students, particularly those in remote communities with limited exposure to the technology industry, envision a tangible future for themselves by applying their skills in authentic, career-oriented contexts. This dual focus on PBL and WBL provides a powerful and practical solution, enabling small, rural schools to integrate CS in a way that is both academically rigorous and directly relevant to students' future opportunities.

"I hope to implement some of the new strategies in my classroom beginning at the start of 2025."
– I4I Participant

"I loved all the time in the break out rooms getting to collaborate and share"
--I4I Workshop Participant

PART II–Educator-Facing I4I PL Workshop Series

Product Design & Development

The Implement for Impact (I4I) workshop series was developed to address two key commitments of the CS4NorCal project: providing a second year of professional learning focused on applying computer science in other contexts, as well as incorporating work-based learning (WBL) into the student experience. The project's original plan to use a web-based service for virtual industry connections was revised due to concerns about the financial burden on participating districts after the grant ended. This prompted a two-year exploration into more sustainable, locally-supported WBL solutions, which included researching regional labor markets, hiring a consultant, and meeting with local colleges and industry partners. Simultaneously, a project rescope condensed the core CS content instruction into a single year, leaving the second year of professional learning undefined and available for new material. These two needs converged in the creation of I4I, which was intentionally designed with a focus on skills applicable in the workplace.

The content for I4I was assembled by a team of seven facilitators, who sought to provide educators with the pedagogical tools and content knowledge to create engaging, real-world CS education experiences for students. The workshops were sequenced to first build a foundation in PBL, provide tools for managing complex projects, introduce new technical concepts for student work, and culminate in strategies for showcasing that work to an authentic audience.

Workshop 1: Project-Based Learning

The series began with a workshop on Project-Based Learning (PBL) that established the pedagogical foundation for the entire I4I series. The workshop's core philosophy was introduced by distinguishing PBL as the "main course" of instruction, rather than a "dessert" project added at the end of a unit. This approach frames the project as the unit itself, where instruction is integrated, driven by student inquiry, and connected to a real-world context with a public audience. The workshop was structured around "The Six A's of Powerful Projects": Academic Rigor, Authenticity, Applied Learning, Active Exploration, Adult Connections, and Assessment Practices. This framework was used to guide participants in developing their own high-quality projects.

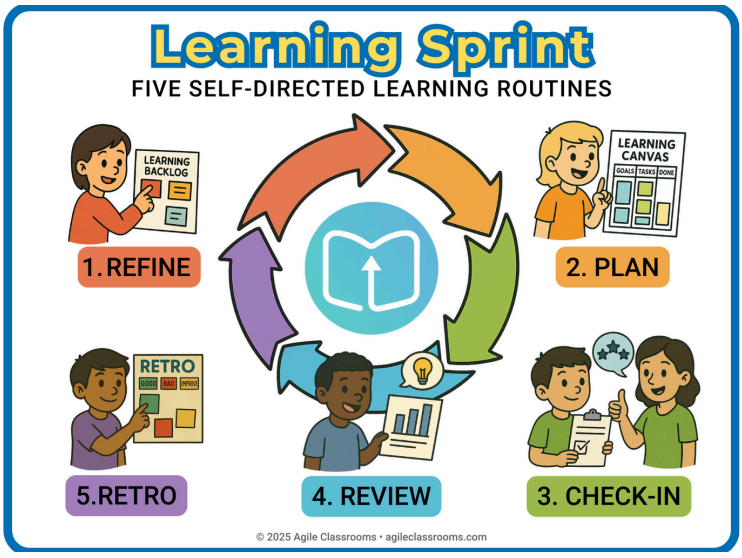
Early in the workshops, participants journaled about a moment of "Significant Learning" from their own lives to connect the pedagogy to deep and memorable learning. They learned to craft compelling, open-ended "Driving Questions" and used Design Thinking strategies, such as the "50 Things" brainstorming activity, to generate a wide range of potential CS project ideas. Throughout the sessions, participants used a "Modular Project Planner" to build out their ideas, incorporating key elements like a project launch, critique, revision, and exhibition. A significant emphasis was placed on creating a positive classroom culture through structured critique, using the "Austin's Butterfly" video as a model for how kind, specific, and helpful feedback can lead to high-quality work through multiple drafts. The workshop culminated in a "Project Tuning Protocol," where teachers presented their CS project plans to their peers and received feedback to refine their work for classroom implementation.

PART II–Educator-Facing I4I PL Workshop Series

Workshop 2: Agile Project Management

To provide a structure for managing the complex work inherent in PBL, the second workshop in the I4I series immersed educators in Agile project management. This methodology from the technology industry has been adapted for flexible, student-centered learning environments. The workshop was primarily experiential and designed for participants to understand Agile by engaging in it as members of a student team. The core framework presented was "The Learning Sprint," an iterative cycle consisting of five key routines: Learning Backlog Refinement, Sprint Planning, Check-In, Sprint Review, and Sprint Retrospective. Participants learned how these routines are supported by "Visible Learning Artifacts" like a Sprint Backlog and Progress Increment, which are typically managed on physical or digital project boards to make the workflow transparent. This structured approach was framed as a way to empower students, fostering skills in collaboration, adaptability, and real-world problem-solving.

> "I enjoyed working in the breakout rooms with other teachers. It's fun and helpful to bounce ideas off each other and that kind of collaboration brings a lot to my own experience"
> -I4I Workshop Participant



Workshop activities included intentional team-building exercises, such as creating a "My World Map" and a "Team Alliance," which helped establish the collaborative norms that distinguish Agile teams from traditional classroom groups. The primary workshop activity was a multi-day "Learning Sprint Simulation" in which teams were tasked with designing a classroom invention using a physical computing device. This hands-on project required them to move through each of the five Agile routines, from planning and prioritizing tasks to reviewing their progress and reflecting on their teamwork.

The workshop also included an asynchronous activity - the "choose your own adventure" backlog, where teachers selected from tasks like reading the original "Agile Manifesto," watching industry videos on Scrum, exploring an "Agile Escape Room" in Trello, or trying a hands-on simulation like the "Paper Airplane Factory". Finally, the workshop transitioned from experience to application, with dedicated time for teachers to plan for their own classroom implementation, consider necessary scaffolds, and make actionable commitments to increase agility in their teaching practice.

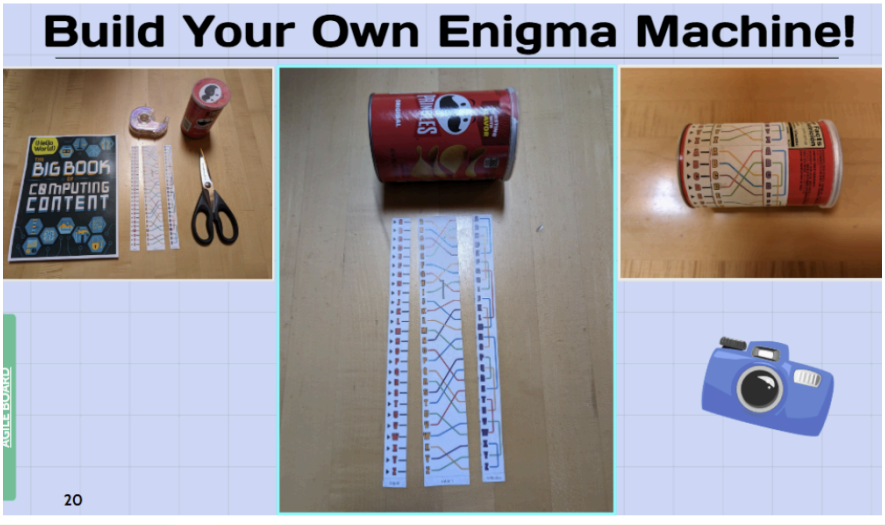
PART II–Educator-Facing I4I PL Workshop Series

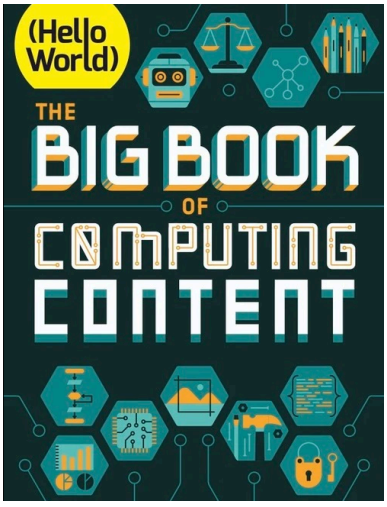
Workshop 3: Emerging Concepts in CS

Building on the foundation of PBL and the Agile routines for managing group work, the third I4I workshop embraced the Agile sprint structure to introduce new computer science content that could serve as topics for student projects. The workshop was organized into a series of daily sprints, each focusing on a different emerging concept: Digital Tools, Artificial Intelligence, and Cybersecurity. To connect these distinct topics and model the creation of a digital artifact, participants documented their experiences in a "Learning Journey," a visual portfolio they built throughout the sessions using a web-based design platform. This ongoing project served as a practical application of the digital media skills learned in the first sprint and was a direct allusion to I4I's final workshop on showcasing student work.

Each sprint immersed teachers in hands-on activities designed for classroom replication. The first sprint provided a deep dive into the web-based design platform, where participants learned to edit text, use design elements, and incorporate their own media, including using the built-in AI image generator. The Artificial Intelligence sprint offered a choice of engaging mini-lessons, allowing teachers to either train a specialized generative AI chatbot like "SeussBot" or explore machine learning by training a model to identify pizza in the "Slice of ML" activity or by creating a "Secret Handshake" with a micro:bit. In the Cybersecurity sprint, educators built and used their own Enigma machine in an unplugged "Cryptography in a Can" activity to learn the fundamentals of encryption and decryption. Following these hands-on experiences, participants engaged in research by reading articles from The Big Book of Computing Content and held breakout discussions to connect these emerging concepts to their own curriculum and communities.

> "AI is new to me and I've resisted learning more because I'm afraid that it will take away from our creativity, if we allow it. I'm glad that I got the opportunity to learn more about it's uses"
> --I4I Workshop Participant





PART II–Educator-Facing I4I PL Workshop Series

Workshop 4: Showcasing Student Work

The final workshop in the I4I series served as a capstone experience, designed to bring together the principles of the previous workshops by focusing on the authentic presentation of student work. The core purpose was to equip teachers with the tools to "make learning visible" by hosting exhibitions that celebrate student achievement and connect it to a relevant audience. The workshop established that showcasing student work is a key component of high-quality PBL, as it promotes equity, community pride, and transparency. To guide the design of a meaningful event, the workshop introduced "The 4 E's of Exhibition" as its central framework, challenging teachers to create an experience that is engaging, experiential, enlightening, and exemplary. The sessions began by reviewing the principles of PBL and the Modular Project Planner from Workshop 1 to ensure the final exhibition was grounded in the project's original pedagogical goals.

Throughout the workshop, participants engaged in a practical, collaborative planning process. Using a "Road Map to an Exhibition Worksheet," teachers worked in breakout rooms to brainstorm different types of exhibitions - such as a gallery walk, documentary, or interactive escape room - and design an event that incorporated the 4 E's. The workshop directly applied skills from earlier in the series, as the asynchronous task required participants to complete their own exhibition road map and use a web-based design platform to create a promotional flyer. The final session brought the entire I4I experience full circle: participants shared their completed exhibition plans and flyers and received peer feedback using the same "Project Tuning Protocol" that was introduced in the very first workshop. The series concluded with a discussion on curation, exploring how student work can be organized and preserved to live on beyond the exhibition itself.

The 4Es of Content

1.Entertains
The content should be entertaining and enjoyable to consume, making it more likely that your audience will engage with it and share it with others.

2.Engages
The content should engage your audience, encouraging them to join a conversation or take action, such as signing up for a newsletter or sharing the content on social media

3.Educates
The content should educate your audience by providing useful and relevant information that helps them solve a problem or achieve a goal

4.Empowers
The content should empower your audience, providing additional value, such as offering exclusive insights or providing access to special resources.

Detailed guides and resources for all workshop activities are linked within the I4I Digital Digest, found in Appendix B.

PART II–Educator-Facing I4I PL Workshop Series

Implementation & Fidelity

Implement for Impact (I4I) was designed as a year-long capstone experience, requiring a significant commitment from participating teachers to attend all four workshops in the series. Throughout the grant period, staff from SSDA and SCOE closely monitored the implementation of this model, observing both its successes and the significant challenges it presented. Measuring fidelity, particularly through participant attendance and retention, provided information that informed an iterative redesign of the course to better meet the needs of educators and the goals of the project.

The implementation of the I4I workshops was intentionally designed to accommodate the unique constraints of small, rural school districts. Like other CS4NorCal professional learning activities offered during the academic year, the I4I series was offered outside of the traditional school day; each of the four workshops was delivered virtually in consecutive 90-minute after-school sessions. This scheduling - paired with a stipend for participating educators - was a deliberate strategy to increase access for educators in schools that often lack the resources to provide substitute teachers. This theoretically enabled more teachers to participate without interrupting student instruction. While this delivery model was eventually refined to a more flexible two-days-per-week format, its unique structure presented both successes and significant challenges related to participant recruitment and retention, which led to an iterative redesign of the course over the grant period.

During the series offered during the 2022-2023 academic year, there was a high level of attrition; of the 14 teachers who began the workshop series, only five attended 80% or more of the sessions. To expand participation in the workshop offered during the 2023-2024 academic year, staff from SSDA and SCOE made registration available to educators across California. While this statewide reach increased the number of educators registered for the workshop, a high level of attrition was still observed. Noting that 33 educators enrolled, only 10 met the 80% attendance threshold. These challenges were compounded by the varied CS experience of the participants; by design, teachers attended one of many different summer workshops and were brought together in the subsequent academic year to foster a broad community of practice in the I4I workshop. However, this approach resulted in a cohort with widely differing prior experiences with CS education.

These recruitment and retention challenges prompted staff at SSDA and SCOE to combine the I4I workshop series with CS4NorCal's CS Integration (CSI) summer workshop for the 2024-2025 school year. This redesign provided the critical connection that had been missing: all participants were introduced to micro:bit microcontrollers and the MakeCode block-based programming language during the summer, which served as a common technical foundation for the projects they developed in I4I.

The success of the redesigned model was underscored by an exemplary attendance rate, as 91% of participants attended 80% or more of the sessions.

PART II–Educator-Facing I4I PL Workshop Series

Outcomes

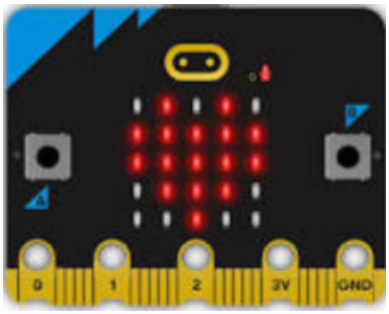
Participant satisfaction across the four professional development workshops from 2021 to 2024 was consistently high, indicating a positive reception of the program's content and delivery. Feedback from post-workshop surveys demonstrates that educators found the sessions to be valuable, relevant, and supportive of their professional growth.

Workshop 1: Project-Based Learning

The foundational workshop on Project-Based Learning (PBL) received overwhelmingly positive feedback. 100% of respondents agreed or strongly agreed that the facilitators were knowledgeable and that the materials and activities supported their learning. Furthermore, a combined 94% of participants reported that the workshop was a valuable use of their time. The hands-on, collaborative nature of the workshop was a frequently highlighted strength. One educator noted, "I enjoyed learning the questioning process and seeing it in action and not just learning about it." Another participant commented on the direct impact on their practice, stating, "Seeing the protocol for fine-tuning projects will really help with fine-tuning ideas in my class." This feedback suggests that the interactive and practical approach of the workshop resonated with participants and built their confidence in implementing PBL.

CS applications used in student projects:

Makecode block coding environment



micro:bit microcontroller

"The lessons on micro:bit coding were informative and helpful as a Language Arts teacher. The Data & Graphing lesson was somewhat above my in-classroom needs; however, it will be a good scaffold for my future learning and understanding. I really enjoyed Coding for ART/e-Textiles. The facilitators were amazing and very helpful."
– I4I Educator

PART II–Educator-Facing I4I PL Workshop Series

Workshop 2: Agile Project Management

The Agile Project Management workshop also garnered high praise from attendees. In the November and December sessions, 100% of survey respondents agreed or strongly agreed that the facilitators were knowledgeable and responsive. Similarly, 93% of participants found the workshop to be a valuable use of their time, and 87% felt the materials and activities supported their learning. Educators particularly valued the experiential learning activities. As one participant shared, "I enjoy(ed) the simulation project we used in the practice sprints to get a hands-on feel for using agile in a group setting." The workshop's focus on collaborative, student-centered learning was also a key takeaway, with one teacher remarking, "The group work and feedback that facilitators gave was a great reminder that I need to have students working collaboratively." This indicates that the practical application of Agile methodologies was a significant factor in the workshop's success.

"I think that with Agile, my students will feel more organized and have more personal clarity within their groups as they progress through their projects."
– I4I Educator

Workshop 3: Emerging Concepts in Computer Science

The workshop on Emerging Concepts in Computer Science, which covered topics like artificial intelligence and cybersecurity, was well-received by educators. A combined 89% of participants agreed or strongly agreed that the session met its objectives and that the materials were high quality and relevant. The opportunity to explore new technologies was a significant highlight for many. One teacher explained, "AI is new to me and I've resisted learning more because I'm afraid that it will take away from our creativity... I'm glad that I got the opportunity to learn more about its uses." Another participant praised a specific activity, simply stating they "Loved the ChatGPT exercise." The feedback suggests that the workshop successfully introduced complex, contemporary topics in an accessible and engaging manner, empowering teachers to explore new tools.

"Just start small, but do it. I think a lot of the times teachers get caught up in wanting to make it perfect and rolling it out the right way and having everything go perfect, but, I mean, it's a classroom, and whatever you throw at the kids is going to change as soon as they interact with it. But the best thing you can do is just go for it."
- I4I Educator

PART II–Educator-Facing I4I PL Workshop Series

Workshop 4: Showcasing Student Work

The final workshop, which focused on showcasing student work, maintained the program's high level of participant satisfaction. A full 100% of respondents agreed or strongly agreed that the workshop fostered an inclusive learning environment and met its objectives. Additionally, 99% of educators rated the overall quality as high and felt the presenters had appropriate expertise. The collaborative elements were again cited as a major benefit. One participant shared, "I enjoyed working in the breakout rooms with other teachers. It's fun and helpful to bounce ideas off each other, and that kind of collaboration brings a lot to my own experience." The practical application of the content was also evident, with 89% of participants stating they will apply the information learned to their work. One educator succinctly captured the sentiment, calling it a "Great workshop and presenters!!"

The I4I workshop series was part of a broad professional development model that engaged 339 educators across 113 schools and educational entities in high-need rural areas. This cohort included 98 standard schools as well as 15 other entities, such as continuation high schools, preschools, and non-profit partners. Of those educators, 166 responded to at least one implementation survey, and 86 responded to more than one survey. Their responses, which likely contain duplicated student counts over time, suggest the project reached an estimated 10,800 students. Motivated by the goal of enhancing college and career readiness, the pedagogical approaches central to the series - particularly interdisciplinary, project-based, and work-based learning - aligned with broader positive academic outcomes observed in the evaluation. The final evaluation report for the CS4NorCal research project found that computer science instruction had a statistically significant positive effect on student science achievement and a positive, though not statistically significant, effect on mathematics achievement.

Flyer for an event to showcase student projects shared by an I4I educator.

"This workshop has greatly impacted a project I do with my students on national parks. I was able to tune it up and flesh it out."
– I4I Educator

PART III - Next Steps and Closing

Discussion

Learnings and findings from the CS4NorCal project implementation suggest that sustained, pedagogy-focused professional learning can be a powerful lever for change, particularly in high-need rural districts. The positive reception of the Implement for Impact (I4I) workshop series by educators, paired with the statistically significant improvement in student science achievement, indicates that the program's design was effective.

A key factor in the project's success appears to be the I4I workshops' emphasis on how to teach, rather than simply what to teach. By grounding the series in Project-Based Learning (PBL), the professional learning moved beyond abstract CS concepts and equipped teachers with a framework to make those concepts tangible, relevant, and engaging for students. This approach likely contributed to the observed gains in science achievement, as the inquiry-driven, problem-solving nature of high-quality PBL mirrors the scientific process itself. Furthermore, the integration of Agile project management provided a structure for complex, collaborative work, helping students develop critical career-ready skills like communication, adaptability, and teamwork. The workshops on emerging CS topics and showcasing student work likely boosted student motivation by connecting classroom activities to the cutting edge of the technology industry and providing an authentic audience for their learning.

The evolution of the CS4NorCal professional learning model underscores the importance of a sustained, multi-year approach. The initial design, which separated foundational CS content from the I4I series on application, proved challenging. The most successful iteration of the program was the final one, which tightly coupled the CS Integration summer workshop with the year-long I4I series. This redesign provided two critical components that were previously missing: a shared technical foundation and a pre-established professional community. This allowed the I4I workshops to function as a true capstone experience, where teachers could immediately apply pedagogical strategies to a common set of tools and concepts. The resulting 91% attendance rate in the final cohort, compared to previous years, highlights that for professional learning to be effective, it must be coherent, sequential, and build a strong sense of community among participants.

The I4I series is a model for building local capacity. By empowering teachers with powerful pedagogical frameworks, I4I equipped them to implement learning experiences that were responsive to their students' interests and local contexts. The emphasis on PBL and work-based learning strategies provided a sustainable solution for integrating CS in a way that is both academically rigorous and directly relevant to students' future opportunities. This approach provides a promising framework for other rural regions seeking to bridge the access gap in computer science education.

Limitations

While the CS4NorCal project yielded positive results, it is important to acknowledge the limitations that frame the findings, particularly concerning the Implement for Impact (I4I) workshop series. These considerations are essential for interpreting the outcomes and understanding the complexities of implementing educational initiatives in real-world settings.

First, the evaluation was not designed to isolate the specific impact of the I4I workshops on student learning outcomes. The statistically significant improvement in science achievement was measured at the project level, encompassing all professional learning and support activities. Therefore, while a connection between the pedagogical strategies taught in I4I and student success can be theorized, a direct causal link cannot be drawn. This is compounded by the fact that the dosage of the intervention varied; teacher participation in the professional learning and students' exposure to the new instructional strategies were not uniform across all classrooms, making it difficult to attribute outcomes to a consistent level of implementation.

Additionally, the educator feedback cited in this report is based on self-reported survey data that was primarily designed for formative purposes. The surveys were intended to provide facilitators with timely feedback to improve the workshop experience, not to serve as a summative evaluation of teacher practice or content mastery. As such, the positive responses, while encouraging, should be interpreted as measures of participant satisfaction and perceived value rather than as rigorous evidence of professional growth.

Third, the project's context presented significant and unavoidable challenges. The professional learning was delivered to educators in remote rural communities, many of which were contending with unreliable internet bandwidth, limited access to student devices, the COVID-19 pandemic, and the devastating impact of seasonal wildfires. Furthermore, teacher and administrator turnover and shifting school-level priorities affected the continuity of the professional learning cohorts. These breaks in continuity, especially between the summer workshops and the academic-year I4I series, could have diluted both the quality of implementation and its measurable impact.

Key Limitations

1

No isolated impact: Student gains can't be directly tied to I4I since outcomes were measured at the project level and participation varied.

2

Self-reported data: Survey feedback reflects satisfaction, not verified growth or practice change.

3

Contextual challenges: Rural barriers, the pandemic, wildfires, and turnover disrupted consistency and diluted impact.

PART III - Next Steps and Closing

Finally, the findings from this project aren't universally applicable. The CS4NorCal initiative was tailored to the specific context of small, rural districts in Northern California, utilizing a particular set of curricula and tools, as well as a unique support structure. Urban or suburban school systems, or programs using different curricula and tools, professional learning schedules, or incentive structures, might experience different results. The successes and challenges detailed here should be viewed as a case study of one approach within a specific environment, rather than a universally applicable blueprint.

Future Research

The experience of the CS4NorCal project and the Implement for Impact (I4I) workshop series opens several promising pathways for future research, including a targeted and rigorous investigation into the efficacy of pedagogy-focused professional learning for CS education.

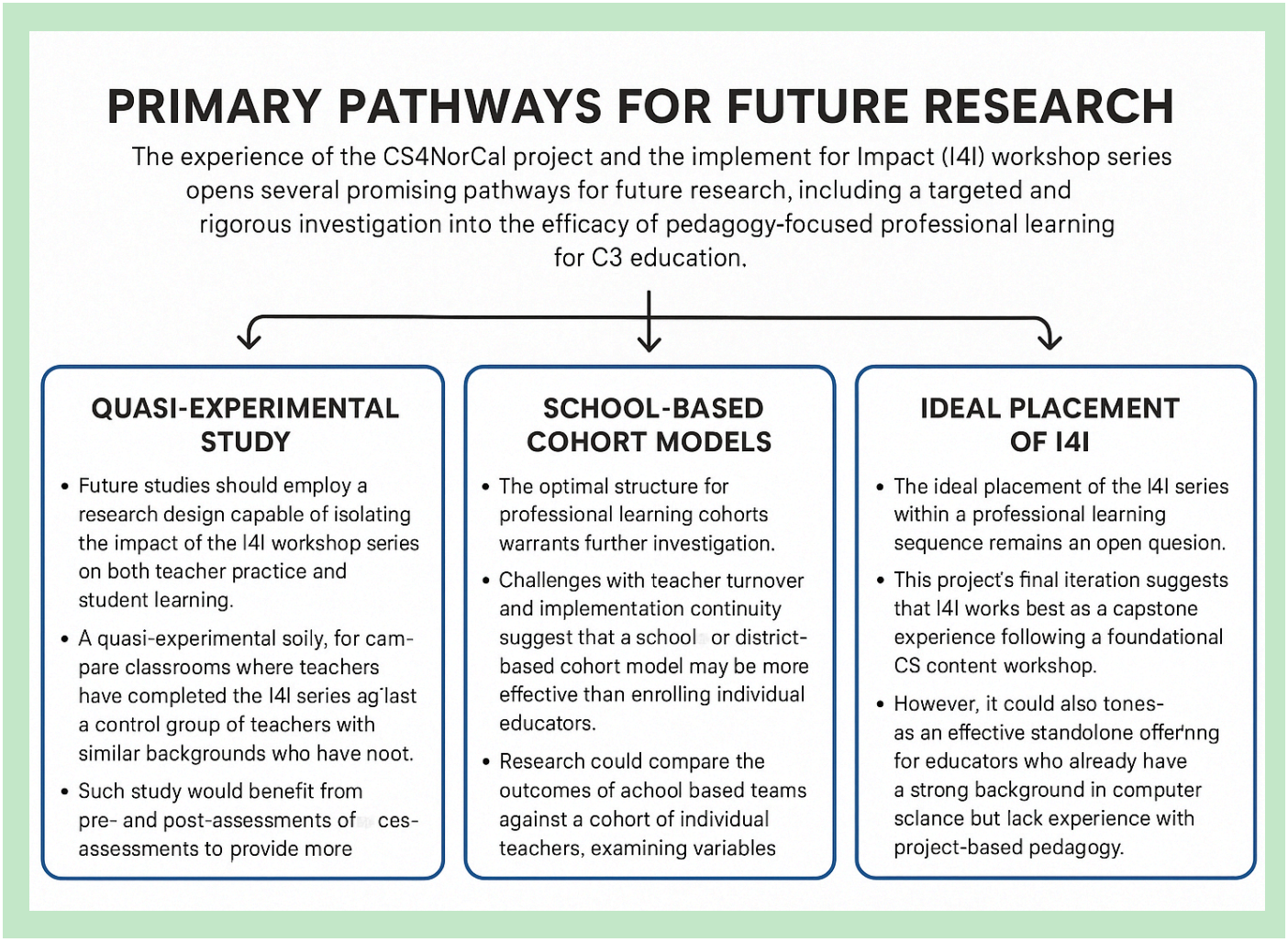
Future studies should consider employing a research design capable of isolating the impact of the I4I workshop series on both teacher practice and student learning. A quasi-experimental study, for example, could compare classrooms where teachers have completed the I4I series against a control group of teachers with similar backgrounds who have not. Such a study would benefit from the use of pre- and post-assessments of student computational thinking skills and content knowledge, potentially using standardized or validated CS assessments to provide more objective outcome data than is currently available. This would help to establish a clearer causal link between professional learning and student achievement.

Second, the optimal structure for professional learning cohorts warrants further investigation. The challenges with teacher turnover and implementation continuity suggest that a school- or district-based cohort model may be more effective than enrolling individual educators. Research could compare the outcomes of school-based teams against a cohort of individual teachers, examining variables such as implementation fidelity, teacher collaboration, and the sustainability of CS integration efforts within the school. This line of inquiry could provide valuable insights into building lasting local capacity for CS education.

Additionally, the ideal placement of the I4I series within a professional learning sequence remains an open question. This project's final iteration suggests that I4I works best as a capstone experience following a foundational CS content workshop. However, it could also function as an effective standalone offering for educators who already possess a strong background in computer science but lack experience with project-based pedagogy. A comparative study could explore these two models to determine the prerequisite conditions under which the I4I framework is most impactful.

PART III - Next Steps and Closing

Finally, future research could explore the adaptability of the I4I model. This could involve tailoring the workshops for different grade bands, such as elementary or middle school, or adapting the content for urban and suburban contexts to test its generalizability beyond rural settings. Such studies would contribute significantly to a broader understanding of how to effectively scale high-quality, pedagogy-driven CS professional learning across diverse educational landscapes.



Conclusion

Addressing the persistent gap in computer science education for students in rural communities requires a thoughtful and sustained approach. As outlined in the background of this report, the CS4NorCal project was founded on an evidence-based theory of action: that a regional, context-responsive professional learning model could build the local capacity needed to create sustainable CS pathways. This initiative sought to move beyond one-off trainings to provide deep, ongoing support for educators navigating the unique challenges of their small, remote districts.

PART III - Next Steps and Closing

The Implement for Impact (I4I) workshop series was the capstone of this effort, a testament to the project's commitment to high-impact pedagogy. By focusing on Project-Based Learning, Agile project management, and the integration of emerging technologies, the I4I series equipped teachers with practical frameworks for creating engaging, real-world learning experiences. The overwhelmingly positive feedback from participating educators demonstrates the value of this approach, which prioritized not just the "what" of computer science, but the "how" of effective, student-centered instruction. The iterative redesign of the professional learning sequence, culminating in a highly successful final cohort, further underscores the importance of creating coherent, community-centered learning for teachers.

The evolution of the I4I series offers valuable lessons for the future of CS education. The discussion and limitations presented here highlight the complexities of this work, from the challenges of rural implementation to the need for more targeted research. Yet, the project's overall success - including a statistically significant improvement in student science achievement - provides a compelling case for investing in long-term, pedagogy-focused professional learning. The I4I model offers a promising framework for empowering educators and, in doing so, providing students with the opportunity to become creators, innovators, and problem-solvers in a technology-driven world.

"Trying to absorb it all, but I like the PBL with Agile. Will try to use some of it and to investigate the process."
--I4I Workshop Participant

Summer professional learning cohort in Redding, CA.

CS4NorCal
Computer Science and STEM Education Rural Implementation Model

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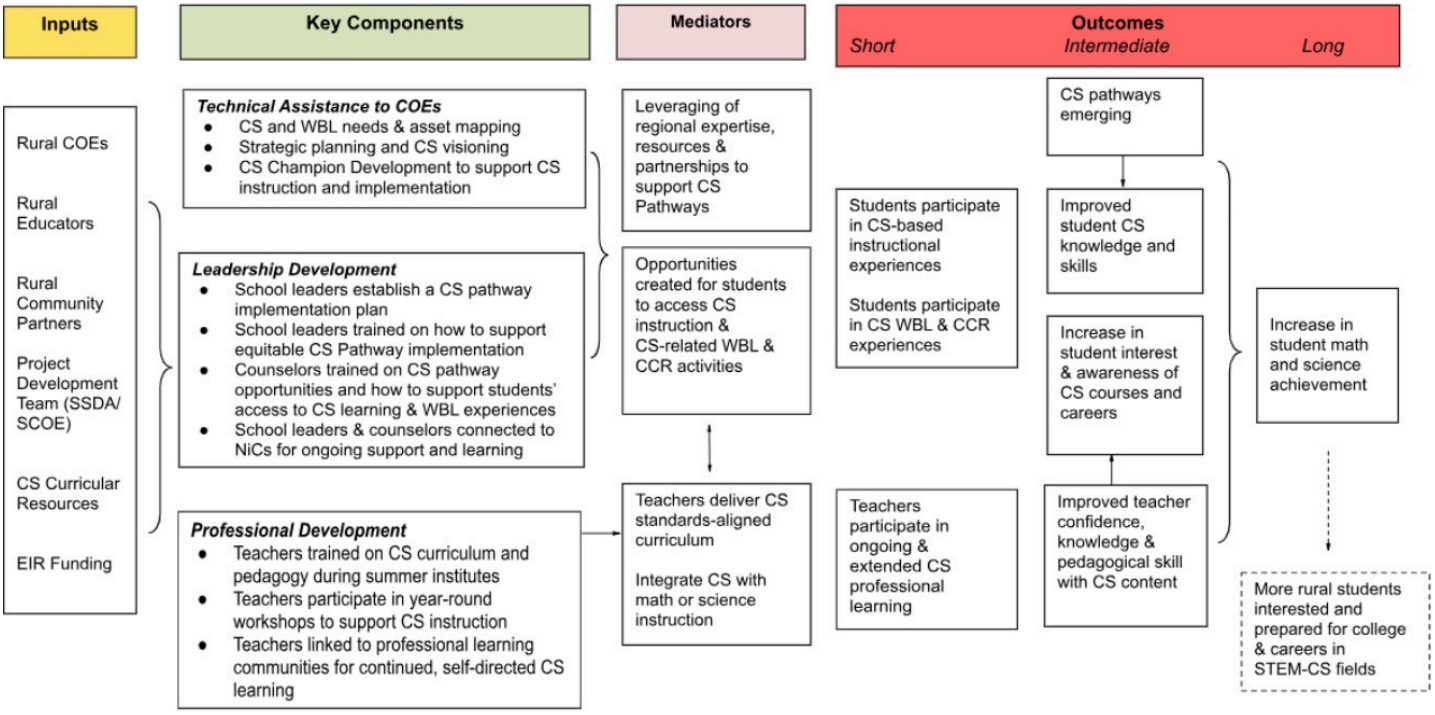
Appendix A - CS4NorCal Logic Model

Program: Rural STEM-CS Pathways Implementation Logic Model
Problem: Lack of access to STEM-CS-based instruction and opportunities in high-need rural areas inhibit potential college and career opportunities for students in high demand industry sectors.
Theory of action: A regional capacity-building approach to creating and supporting STEM-CS pathways that is adaptive to local context can promote an innovative field-based approach to providing students in high-need rural areas with a progressive continuum of exposure to STEM-CS instruction and experiences.



Appendix B - Workshop Digital Digest

The Professional Learning Toolkit for Implement for Impact is linked in the image below.