Indigenous Computer Science Interest and Access Study: Phase 2.0

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Acknowledging and Honoring

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Executive Summary

In 2022, Indigitize Computer Science, in partnership with Amazon Future Engineer (AFE), convened a study coalition that included American Institutes for Research® (AIR®), Native Pathways (NaPs), and Reimagine Research Group (RRG). Together, our coalition worked to better understand Indigenous students' interest in and access to computer science (CS) opportunities, with each partner bringing different perspectives but shared commitments to advancing educational progress through community-based research. Our inquiry represents a coordinated effort to position Indigenous[1] students and communities as knowledge holders, innovators, and leaders in technology.

Although national data have been collected on Asian, Black, Hispanic, and White students, Indigenous communities are often rendered statistically invisible due to small sample sizes, inconsistent reporting, and broader systems of exclusion. This invisibility makes it difficult to assess Indigenous students' interests in, access to, and experiences with CS a dominant field shaping education, career pathways, and the future workforce. The consequences of such omissions threaten educational equity, fair access to the labor market, and the future of Tribal sovereignty and self-determination. As a result, this study is not simply about generating better data, but about doing so in partnership with Indigenous researchers, educators, and communities.

Phase 1.0 launched in fall 2022 and concluded in spring 2024. It focused on establishing baseline data on CS access in Tribal communities, drawing from existing Code.org data sets, conducting a national literature scan, and engaging with Native CS educators and experts to identify existing "wise practices"[2,3] in CS education and research in and with Tribal communities. Phase 2.0 of the study commenced in summer 2024, shifting focus from assessing the CS landscape to deeper inquiry. Phase 2.0 included four areas of focus that will be described on the following pages.

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[1] Throughout this report, the terms "Indigenous" and "Native American/Alaska Native (NA/AN)" are used interchangeably for readability. Specific Tribal or community names are used where identified by participants.

[2] Brian Calliou and Cynthia Wesley-Esquimaux, "A Wise Practices Approach to Indigenous Community Development in Canada," in *Restorying Indigenous Leadership: Wise Practices in Community Development*, ed. Cora Voyageur, Laura Brearley, and Brian Calliou (Banff, Alberta: Banff Centre Press, 2015), 31–59.

[3] Pammla Petrucka, Donna Bickford, Susan Bassendowski, William Goodwill (Elder), Catherine Wajunta (Elder), Bernadette Yuzicappi (Elder), Lorraine Yuzicappi, Paul Hackett, Bonnie Jeffery, and Marlene Rauliuk, "Positive Leadership, Legacy, Lifestyles, Attitudes, and Activities for Positive Aboriginal Youth Futures," *International Journal of Indigenous Health* 11, no. 1 (2016): 177–197.

What emerged across these efforts was not only a clearer understanding of the barriers that Indigenous students face in accessing CS education but also a deeper recognition of the strength, ingenuity, and vision these students bring to the field. This vision is often rooted in community, cultural knowledge, and a sense of purpose beyond the classroom. These findings are just the beginning. Addressing generational disparities in CS access will require sustained investment, policy change, and a reimagination of what technology education could be.

We lit this fire to illuminate what has long been overlooked. It is our shared responsibility to keep this fire burning so that future generations can gather around it, learn from it, and build something even brighter. The work ahead is to ensure these insights move beyond this report and into classrooms, communities, policy, and practice. We invite you to tend this fire too.

What We Did (Methods and Process)

Inquiry 1: Retrospective Code.org Analysis

AIR conducted a retrospective analysis of the reports and data collected by Code.org.[4] AIR reviewed the data downloaded from Code.org's 2021–24 State of CS reports, with a focus on 2023–24 data.[5] Code.org uses high school data collected using the National Center for Educational Statistics (NCES) list of schools that enroll students in at least one high school grade (9–12). Data elements of focus included access to foundational CS courses, participation in foundational CS courses, access to Advanced Placement (AP) CS courses, and scores on AP CS courses. Most data elements were obtained by Code.org through state education agency collaboration or online portal requests. AIR also reviewed Code.org's online tracker of its 10 key policies for the most recent policy adoption data.[6]

Inquiry 2: Indigenous CS Teacher Survey

AIR aimed to identify research activities that resonate with Indigenous communities by initially planning to work directly with three communities. The methods included developing focus group and survey protocols that were reviewed and approved by AIR's Institutional Review Board (IRB) and internal experts. The instrument used for the survey was adapted from existing

[4] Code.org, "About Code.org," https://code.org/about.
[5] Code.org, *2024 State of Computer Science Education*, https://advocacy.code.org/stateofcs/.
[6] Code.org, "State Tracker of Our 10 Policies," https://docs.google.com/spreadsheets/d/1YtTVcpQXoZz0IchihwGOihaCNeqCz2HyLwaXYpyb2SQ/pubhtml.

tools used with elementary school teachers in the Wind River Elementary CS Collaborative[7] and the AFE-Gallup CS Survey.[8]

Ultimately, a survey was administered to Grades 6–12 teachers who received professional development (PD) or technical assistance in CS from Indigitize or attended a conference focused on CS for Indigenous students in the Four Corners region (New Mexico, Colorado, Utah, or Arizona). Initially, 405 eligible teachers were invited to participate, but 35 emails were returned because of invalid email addresses. Of the remaining 370 invitations, 124 teachers (34%) completed the survey. The survey was administered electronically in partnership with Indigitize from April to May 2025. The survey covered areas such as teacher demographics, understanding of CS and student access, student interest in CS, access to coding and artificial intelligence (AI), teacher beliefs about CS, and student strengths and contributions. Participants were compensated with a $50 electronic gift card for their participation.

Inquiry 3: Student Focus Groups

Indigitize Computer Science (Indigitize hereafter) facilitated two student focus groups with Indigenous youth at partner schools in the NACA (Native American Community Academy) Inspired Schools Network (NISN): Oceti Sakowin Community Academy (OSCA) in Mni Lúzahaŋ Otȟúŋwahe (Rapid City, South Dakota) and Endazhi-Nitaawiging Charter School (ENCS) in Miskwaagamiiwi-zaaga'iganing (Red Lake, Minnesota).[9] Focus groups were conducted in person using a semi-structured interview protocol tailored to each age group, centering student voice through storytelling, dialogue, and relational facilitation. Recordings were transcribed manually and reviewed for accuracy. Data were coded line-by-line using site-specific, detailed codebooks grounded in Indigenous research methodologies and then organized into matrices to identify patterns across codes and research questions. Ultimately, we identified six themes and one sub-theme per school. Our analyses of each theme prioritized student language and cultural context.

Inquiry 4: Talk Story Dialogues

NaPs-RRG engaged the Haak'u (Acoma Pueblo, New Mexico) and the Amskapi Piikani Tribal (Blackfeet Nation, Browning, Montana)[10] communities in a *Rose*, *Thorn*, *Bud*, *Roots (RTBR)* Talk

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[7] Wilson, Joseph P., Kathryn M. Rich, Jared O'Leary, and Veronica Miller. "Wind River Elementary Computer Science Collaborative: Connecting Computer Science and Indigenous Identities and Knowledges on the Wind River Reservation." *Journal of Computer Science Integration* 6, no. 1 (2023): Article 5. https://digitalcommons.chapman.edu/cgi/viewcontent.cgi?article=1016&context=jcsi.

[8] Gallup and Amazon Future Engineer, *Developing Careers of the Future: A Study of Student Access to, and Interest in, Computer Science* (2021), https://www.gallup.com/analytics/506696/amazon-research-hub.aspx.

[9] NACA Inspired Schools Network, "About," https://www.nacainspiredschoolsnetwork.org/.

[10] Throughout the report, the research team employs the community-designated name, *Amskapi Piikani* (Blackfeet), except in direct quotes.

Story process (YAKANAL)[11] related to CS. The rose (bloom) represents strengths, gifts, assets, and interests; the thorn symbolizes challenges and lessons learned; the bud signifies new or emerging ideas and opportunities for growth; and roots represent foundations, necessary support systems, connections to a place, and core values. Talk Story dialogues engaged middle school students, parents/caregivers, educators, Tribal community members, and Elders in each community and focused on access, interest, and opportunities for building CS education pathways in ways that center Indigenous nation-building and Tribal sovereignty.[12]

What We Learned (Key Findings)

Inquiry 1: Retrospective Code.org Analysis

The retrospective Code.org[13] analysis presents a comprehensive overview of the state of CS education access and participation among Native American and Alaska Native (NA/AN) students in the United States. The report addresses key research questions related to access, participation, and policy progress for CS education in states with the highest concentrations of Indigenous students.

- **Access to CS Education:** The report highlights that NA/AN students have the least access to high schools offering foundational CS courses compared with their peers. In the 2023–24 academic year, 66% of NA/AN students attended a high school offering foundational CS courses, an increase from 60% in 2020–21. However, access remains out of reach for many NA/AN students, particularly in states with high concentrations of Indigenous students.
- **Participation in CS Courses:** The report reveals overall parity for NA/AN participation in high school foundational CS courses, with notable variations across states. While some states demonstrate participation parity, others show underrepresentation.[14] Despite broader gains in CS participation, NA/AN students have not benefited equally, with student participation rates remaining relatively steady since 2020–21.
- **AP CS Exam Participation:** NA/AN students are underrepresented in AP CS exam participation, accounting for only 0.3% of 2023 AP CS exam takers, although they represent 0.9% of the national K–12 population. However, of the NA/AN students who took the AP CS exam, nearly half scored a 3 or higher.
- **CS Education Policies:** The report examines the adoption of key CS education policies in states with high concentrations of NA/AN students. Most of these states have adopted

[11] YAKANAL, "Indigenous Youth Culture Exchange and The Cultural Conservancy Partnership," https://www.yakanal.org.
[12] Refer to Exhibit 4 for a more detailed summary of the RTBR process and the question areas that guided this study.
[13] Code.org.
[14] Parity is when the percentage of NA/AN students participating in CS is equal or greater than the percentage NA/AN students in public K–12 schools.

three key policies: CS standards, teacher certification in CS, and allowing CS courses to count for graduation requirements. The analysis found that a greater adoption of CS education policies is correlated with increased access to foundational CS courses for NA/AN students.

Conclusion: The retrospective Code.org analysis provides a national overview of access to and enrollment in foundational CS courses, AP course enrollment, and passing rates for Indigenous students. It also highlights the limitations of using extant data from multiple sources and emphasizes the need for targeted efforts to improve CS education access and participation for NA/AN students.

Inquiry 2: Indigenous CS Teacher Survey

The Indigenous CS Teacher Survey presents the findings from a survey conducted with CS teachers. The survey aimed to gather insights on teacher demographics, attitudes toward teaching Indigenous knowledge and languages through CS, and beliefs about the potential of coding and AI in solving community problems.

Key Findings:

- **Demographics**:
  - The survey had 124 teacher respondents, of whom 65% were female and 36% were male.
  - Most respondents (81%) teach at public schools, while others teach at Tribally-controlled, private, Bureau of Indian Education (BIE)-operated, or other types of schools.
  - A significant portion of respondents (44%) teach middle school, followed by high school (28%).
  - Of the respondents, 19% identify as Indigenous, with the majority teaching at public schools.
- **Teacher Attitudes:**
  - The majority of teachers are highly supportive of integrating Indigenous languages and knowledge into CS education.
  - Teachers believe that coding and AI can be valuable tools for preserving Indigenous knowledge and addressing community issues.
- **Beliefs About Student Learning:**
  - Teachers generally agree that learning coding is beneficial for students (83%), with slightly fewer supporting AI education (71%).

  - A significant number of teachers (84%) believe that coding can provide solutions to Tribal community problems, with a similar percentage (85%) believing the same about AI.

- **Opportunities for Learning:**
  - Teachers indicated that opportunities for learning coding and AI are more likely to occur in school than outside school.
  - CS or technology-focused classes and activities at school are seen as influential in encouraging Indigenous students to pursue CS.
- **Motivations and Role Models:**
  - Teachers observed that students are motivated by their enjoyment of technology and video games, with less emphasis on programming or coding.
  - Role models in CS, particularly those who identify as Indigenous, are seen as influential for students.
- **Themes From Beliefs About How CS Can Address Community Problems:**
  - Teachers highlighted several themes in which coding and AI can solve community problems, including cultural heritage and language preservation, data management, environmental solutions, technology development, and education.

Considerations and Limitations: The survey served as a pilot and captured initial thoughts from a small sample of teachers. The findings are not representative of all teachers who teach Indigenous students, and the sample size was too small to test for statistically significant differences between Indigenous and non-Indigenous teachers.

Inquiry 3: Student Focus Groups

Student focus groups revealed that Indigenous youth engage most deeply with CS when it feels relevant, relational, and rooted in culture. Students brought curiosity and insight but also named barriers such as limited access to devices, the internet, and support. Their reflections point to the importance of culturally grounded, community-connected CS learning.

- **Students ground CS in lived experience.** Indigenous students connected CS concepts to what they already knew, including video games, electronic devices, language, family, and place, making learning more personal, relevant, and intuitive.
- **Relational pedagogy supports engagement.** Emotional safety, humor, and vulnerability helped younger students participate, whereas older students responded to prompts that invited personal relevance and community connections.

- **Curiosity and ingenuity are developmental and cultural.** Students across both schools showed creative problem solving and a desire to understand how technology works, asking about the anatomy of a computer or connecting AI to environmental impact and language revitalization.
- **Access and infrastructure shape opportunity.** Students expressed strong interest in CS but noted limitations in device access, reliable internet, and support outside the classroom, particularly in rural and Tribal communities.
- **Technology is seen as a tool for sovereignty.** Rather than viewing CS as separate from culture, students imagined how CS could sustain language, strengthen community ties, and reflect their community's values.
- **Peer dynamics shape belonging.** Seemingly subtle moments, such as being interrupted or affirmed, send early messages about who belongs in CS spaces. These interactions especially affected Indigenous girls and shaped their sense of voice, confidence, and participation.
- **Students are already navigating tech ethics.** Even without formal instruction, students showed awareness of privacy, surveillance, and environmental consequences. Students asked or shared reflections about asserting boundaries with AI, questioning device usage and linking technology to land and responsibility.

Conclusion: These findings underscore the urgent need to invest in CS education that honors Indigenous ways of knowing, fosters emotional and cultural safety, and expands meaningful access to technology. As students continually reminded us, access to CS is personal, communal, and full of possibilities. The work ahead calls for school leaders, policymakers, and Tribal communities to cocreate CS pathways that are relevant, relational, and rooted in sovereignty.

Inquiry 4: Talk Story Dialogues

As part of this study, NaPs-RRG facilitated Talk Story dialogues with Tribal communities in Acoma Pueblo and the Blackfeet Nation to explore local perspectives of CS education. Using the RTBR framework, these conversations surfaced intergenerational insights on the possibilities, concerns, and values that shape how communities envision Indigenous CS.

- **Community members, particularly adults, tended to talk about CS from the perspective of consumers of CS products, rather than as creators and innovators.** The data suggest a need for more investment in CS PD opportunities for educators and foundational CS education for parents/caregivers, youth, and other community members.
- **Youth overall expressed a strong interest in CS while also indicating that they do not have the necessary support systems (e.g., CS teachers and mentors) and often feel intimidated**

by the requirements for CS fields. Relatedly, the findings also underscore the need for more CS mentors, role models, educators with CS knowledge, exposure to CS career pathways for youth, and stronger support for CS programming at the Tribal and school leadership levels (i.e., policy).

- **A culturally relevant and responsive CS learning experience for Indigenous youth should be hands-on, immersive, and place-based.** CS educational resources should be grounded in Indigenous worldviews, particularly those tied to health and well-being, and connected to solving real-world issues based on community needs and interests.
- **Tribal sovereignty and nation-building efforts should inform what Indigenous CS looks like.** Community members suggested creating tools, apps, or programs that could be used to help their respective communities in areas such as cybersecurity, natural resource management, health and wellness, and language and cultural revitalization efforts. Youth could play a vital role in building these tools for their communities if they have access to CS knowledge and learning opportunities.
- **Youth often do not have the tools that would allow them to expand their knowledge of and interest in CS or interact with CS in their own homes.** Findings suggest the importance of investing in infrastructure, such as broadband and fiber optics for stable internet connectivity, and providing technology (e.g., computers and laptops) to support youth interest in and access to CS education and career pathways.
- **Community members shared ideas about how CS could be Indigenized while wondering whether this was possible.** Findings indicate that an Indigenous CS involves amplifying core values, such as centering relationships and respect for cultural knowledge, Indigenous languages, Elders, and one another. These are strengths of Indigenous communities that can inform policy to build an Indigenized CS. At the same time, this CS needs to honor data and land sovereignty and not reinforce extractive, colonizing practices. Although communities understand that CS is the future and see how critical it is for Indigenous youth to become CS professionals and innovators, they have data sovereignty concerns, particularly relating to language and cultural information.

Conclusion: These community-rooted dialogues reveal that any meaningful expansion of CS education in Tribal communities must begin with relationships, cultural grounding, and respect for sovereignty. From infrastructure to curriculum, every decision should reflect Indigenous values and lived realities. The future of CS in Indian Country is not just about access but also about ensuring that Indigenous youth can shape, lead, and imagine what technology looks like on their own terms.

In 2022, we set out with the goal of engaging 10,000 Indigenous students in Indigenized computer science experiences by working directly with schools, districts, and teachers. By spring 2025, we surpassed that goal, serving over 15,000 students. While there are not nearly enough educational pathways for Native youth to meaningfully engage with technology and computer science, we are committed to increasing visibility, opportunity, and access.

– *Indigitize's Mission*

Introduction

…What Is the History of This Study?

Recognizing the limitations and insufficiencies of the available data on Indigenous students in the context of CS education, Indigitize, NaPs, RRG, and AIR collaborated as a study coalition to work with Indigenous communities to address longstanding gaps in CS access, opportunity, and visibility. In 2021, AFE commissioned Gallup to conduct and publish a national study on student interest in and access to CS via a survey of U.S. students.[15] While the study shed light on a number of barriers and opportunities within CS education, it did not report outcomes for Indigenous students; it only reported outcomes for White, Black, Hispanic, and Asian students. The absence of disaggregated data made it difficult to assess student interest, access, or lived experience, further perpetuating statistical invisibility. In response to this critical need, AFE supported the launch of an expanded inquiry and issued a request for proposals in 2022 to deepen understanding of Indigenous CS access in partnership with trusted research organizations, including Indigitize, NaPs, RRG, and AIR, who were selected to carry out this work. Phase 1.0 began in September 2022 and concluded in April 2024.[16]

…What Does Phase 2.0 of the Study Look Like?

This study explores access to and visions for high-quality CS education centered on and for Indigenous students and Tribal communities. The coalition recognized that research should be built on community engagement and relationship building. The coalition also recognized that student voices and needs cannot and should not be separated from community voices and needs, especially from Indigenous worldviews. The coalition adopted a research practice–partnership approach, engaging interest-holders beyond students and Indigenous community members, including teachers, administrators, parents/families, Tribal community members, and leadership.

Phase 2.0 includes community-based research that draws from different approaches and data sources. There are **five main research questions** (RQs) and **four data sources** (Code.org data; student, parent, and teacher surveys; student, parent, and community member focus groups; and Talk Stories). RQs were developed based on Phase 1.0 findings and in collaboration with the coalition partners and advisors.

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[15] Gallup and Amazon Future Engineer, *Developing Careers of the Future*.
[16] Amazon Future Engineer et al., *Indigenous Computer Science Interest Study: Summary of Phase 1.0 Findings* (April 2024), https://drive.google.com/file/d/1N-uAnTz4lANN64SDjvEujoF8NEYLurcG/view.

RQ1	In what ways could CS support Indigenous language revitalization, nation-building, Tribal sovereignty, and self-determination, as well as other forms of Indigeneity?
RQ2	What are Indigenous students' and their communities' interest in CS education and career pathways?
RQ3	What does access to CS education and pathways look like for different Indigenous students and their communities?
RQ4	What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?
RQ5	*(Community-driven)* One or two other optional questions a community wants to understand about Indigenous CS

…Who Are the Partners in the Coalition?

The study's Computer Science Coalition (CSC) is a group of the following organizations and researchers representing both Indigenous and Western ways of knowing:

…What Do We Hope You Get Out of the Report?

- We hope you will understand more about how Indigenous communities relate to CS and how they see CS supporting community needs, nation-building, and Tribal sovereignty.[17]
- We hope you learn more about the approaches our coalition took to engage in the study activities.
- We hope you can use the research instruments developed for this study with your communities to continue answering questions about K–12 Indigenous CS.
- We hope you are inspired to support more K–12 Indigenous students to learn CS in ways that are relevant to their lives.

…Where Can I Find Certain Topics in This Report?

- If you are interested in the **underlying values** of this coalition… check out the Coalition Values section.

[17] *Note.* Enlarged key quotes are reflected on break pages to illustrate the collective voice of the coalition's values.

- If you are interested in how we **defined Indigenized CS**… check out the Collective Understanding of Indigenized CS section.
- If you are interested in understanding **youth and community member perspectives** on Indigenous CS… check out Inquiry 3 on Indigenizing CS through Student Perspectives and Inquiry 4 Talk Stories.
- If you are interested in understanding **teacher perspectives** on Indigenous CS… check out Inquiry 2 on an Indigenous Teacher Survey.
- If you are interested in the **research methodologies and instruments** used in this study… check out the Collective Methodologies and each of the subsequent methodologies for each Inquiry 1 through 4.

"The most important part of any program is to cultivate and center relationships. Without relationship, trust can't be established, and if there is no trust, then the true story can't be told or shared."

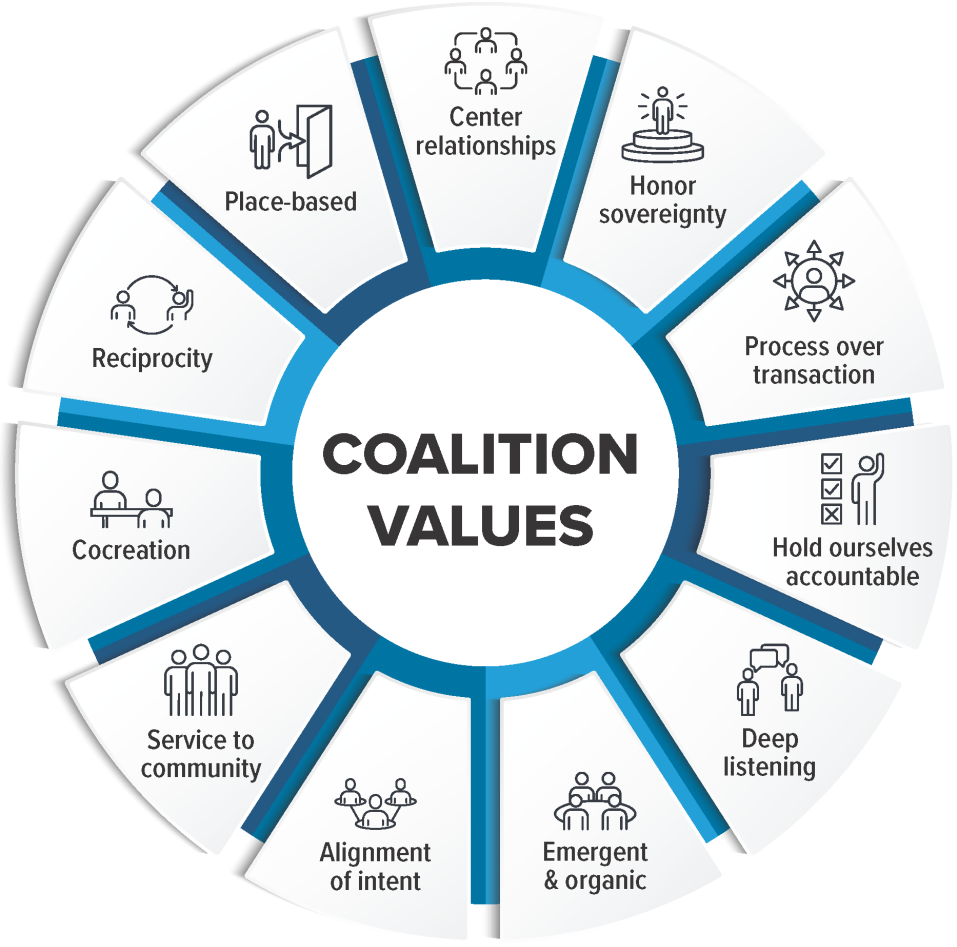
- Study Coalition Member Viewpoints on Values

Coalition Values

Why Did the Coalition Create a Set of Core Values to Guide the Work?

The coalition worked to identify a set of values in Phase 1.0 of the project that we felt would guide our collective work and how we partner with Indigenous communities and each other. We felt that identifying and communicating our core values to one another and community partners was central to building and uplifting authentic relationships grounded in trust and mutual benefit.[18]

Exhibit 1. Indigenous Computer Science Study Coalition Values Guiding the Study



[18] See Exhibit 1.

What Process Did We Use for Collectively Defining Our Core Values?

The coalition also realized that it was not enough to identify its values because the individuals and the organizations within it define values differently, and we wanted to make sure to honor diverse perspectives and amplify our collective voices. Thus, the coalition began a process of jointly defining its core values, which is loosely based on a process from Zacarian and Silverstone's *In It Together* (2015).[19] This included each coalition member writing about and reflecting on what the values should be, what they meant, why they were important, how they were connected to other core values, and what they looked like in practice. Then, we each pulled out key themes across our definitions, and a smaller team summarized and synthesized our definitions and pointed out areas of tension or difference. By collectively defining our core values and checking in regularly as a group, the process helped us identify what values we embodied and what we might need to better amplify our chosen values. The check-ins served to help support self-accountability and navigate conflicts, as well as build relationships, a shared understanding, and mutual respect for one another.

How Have the Values Been Honored and Amplified in the Phase 2.0 Work?

As a coalition, we integrate our core values into every aspect of our work—from reflecting on them internally to centering them in our relationships with communities. Our core value of reciprocity, for example, is reflected in the relationships that the CSC namely AIR and NaPs-RRG—has cultivated with partner communities and the Indigitize team. These relational and reciprocal partnerships have created opportunities for learning, collaboration, and capacity building across youth, families, educators, and districts.

Similarly, we intentionally amplified other values, including centering relationships, deep listening, and cocreation, by strengthening existing relationships and taking the time to connect with and listen to community needs and questions about the study. For example, the NaPs-RRG team engaged community partners with whom they had established relationships of trust to share our intentions as researchers and discuss how our work could align with the community's efforts and needs. Conversations about mutual benefit and reciprocity were centered from the beginning and carried throughout the research process. The research teams were intentional about supporting local businesses and connecting to places, such as engaging local caterers and requesting traditional foods where possible. These relationships will extend beyond this study, as we will return to the communities to share results in meaningful and accessible ways and continue cross-pollinating this work with partners across our network.

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[19] Debbie Zacarian and Michael Silverstone, *In It Together: How Student, Family, and Community Partnerships Advance Engagement and Achievement in Diverse Classrooms* (Thousand Oaks, CA: Corwin, 2015).

"Active listening to community goals, interests, and outcomes so we are in alignment with community desires and the collective work we do together is guided by this."

– *Study Coalition Member Viewpoints on Values*

Collective Understanding of Indigenized CS

Why Create a Collective Understanding of Indigenized CS?

It is important to describe the context of our thinking and process to arrive at our understanding of CS. The definition at the bottom of this page is our collective, humble understanding, thus far, of what Indigenized CS can be. We, the CSC, recognize that in describing our thinking, we have tried to speak across sovereign worldviews (i.e., Indigenous and Western), including their epistemologies, which have fundamentally different conceptualizations of what CS is, why it is important, and how and for what it can be used. This is further complicated by the unilateral, violent nature of settler colonialism, in which the Western worldview has been weaponized to dominate and extinguish Indigenous ways of knowing and being, including via CS.

We further recognize that Indigenous peoples have designed and implemented computing technologies since time immemorial, and our intent is not to define what Indigenous (or Ancestral) computing is because that is not our role. With that, we recognize the inherent sovereignty of Indigenous ways of knowing/being, and we rely on them to arrive at what we call Indigenized CS—it is a reflection of our attempt to coordinate a consensual relationship between Indigenous and Western knowledge in ways that provide an understanding of how mainstream CS can be reclaimed, repaired, repurposed, and Indigenized for/by Indigenous peoples for an Indigenous future and self-determination.

Our shared understanding of Indigenized CS was codesigned by Indigenous and non-Indigenous technologists, scientists, and educators throughout a year of weekly virtual meetings. We view it as a ***living work in progress*** and look forward to refining and expanding it with Indigenous youth and community members as we engage in Indigenized CS work alongside them.

Our Collective Understanding of an Indigenized CS

Computer Science is a broad field and can mean many things, which can reflect each community's context, worldview, and values. Yet, at its core, Indigenized CS is the active making and use of proactive and responsive computing technologies that renew human and more-than-human kinships, Indigenous continuance, and self-determination.

Glossary of Terms from Our Collective Understanding

- **Active making** refers to a life cycle of numerous activities (e.g., imagining, designing, building, testing, and refining) that create computing technologies built from Indigenous worldviews.
- **Active use** refers to purposeful engagement with existing computing technologies.
- **Computing technologies** encompass all hardware, software, and systems designed to process, store, and transmit information. They focus on the creation, development, and operation of computational systems.
- **Indigenous continuance** refers to a community or a nation's ability to adapt and grow in ways that sustain its cultural, linguistic, and political livelihoods and avoid preventable harms in the future.[20]
- **Proactive** refers to computing technologies that are imagined from and embody Indigenous ontologies (e.g., in Diné, this philosophy means to "walk in beauty" [Hózhó]; in Cheyenne, it means "to be a good relative" [Tse-pėhevoestomo'êstove]; in Lakota, it means "all my relatives" [Mitakuye Oyasin]).
- **Responsive** refers to computing technologies that respond to a threat, an opportunity, a challenge, or an existing problem, particularly one that was created through settler colonialism.
- **Self-determination** refers to "the right to autonomy or self-government"[21] and "the legal right of people to decide their own destiny in the international order."[22]

A Youth- and Community-Facing Description of Indigenized CS

The coalition also sought to establish a youth- and community-facing version of the definition:

Computer science is a broad field that can mean many things. Yet, said simply, Indigenized computer science can be described as a creative journey to make and use computers in ways that align with the Indigenous cultures and lifeways students come from. This includes the design of the actual hardware (e.g., laptop, smartphone, tablet, robots, servers) and software (e.g., video games, databases, apps, operating systems).

For example, an individual could be said to be practicing Indigenized CS when they

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[20] Kyle Powys Whyte. "Indigenous Science (Fiction) for the Anthropocene: Ancestral Dystopias and Fantasies of Climate Change Crises." *Environment and Planning E: Nature and Space* 1, nos. 1–2 (2018): 224–42.
[21] United Nations General Assembly, *United Nations Declaration on the Rights of Indigenous Peoples*, Article 4 (2007).
[22] Legal Information Institute, "Self-Determination (International Law)," Cornell Law School, https://www.law.cornell.edu/wex/self_determination_(international_law)

- design the software of an app to teach your Indigenous language;
- design software for a complex Indigenous game that relies on traditional stories for the game storyline, which can be played on PlayStation or Xbox;
- design encrypted code to protect digitally stored Indigenous knowledge, such as Tribal data and records;
- build and program drones to collect data for Tribal wildlife management and Tribal historic preservation areas, for example; or
- design an app for Indigenous plant identification and/or medicinal uses.

> “Reciprocity is mutual partnership and benefit, transparency, and deep listening.”
>
> – *Study Coalition Member Viewpoints on Values*

Data Sovereignty, Reciprocity, and Relational Accountability

Our approach to this work was shaped by a shared commitment to Indigenous Data Sovereignty (ID-SOV), which is the inherent right of Indigenous peoples to control, manage, and protect the data pertinent to their communities and cultures. While our practices varied across sites and teams, we were united in our shared responsibility to upholding Tribal sovereignty, honoring community relationships, and ensuring that data practices were culturally responsive, locally relevant, and ethically sound.

ID-SOV informed every stage of our research process, from design to dissemination, and underscored our responsibility to upholding Tribal sovereignty and honoring the relationships we built with communities. While there are many definitions of ID-SOV, we grounded our approach in a community-facing articulation of the concept, which affirms "the right to determine the means of collection, access, analysis, interpretation, management, dissemination, and reuse of data about the Indigenous people from whom it has been derived or to whom it relates."[23] This framing paraphrases Snipp's work in *Indigenous Data Sovereignty: Toward an Agenda* and reflects the aspects of ID-SOV most aligned with our commitments to relationality and community governance.

To strengthen our shared understanding of sovereignty-affirming data practices, several members of the CSC completed *The Fundamentals of OCAP®*,[24] a training grounded in the principles of ownership, control, access, and possession—a data sovereignty framework developed by First Nations researchers in Canada. While OCAP was developed outside of the United States, its principles provide valuable insight into upholding our commitments to ID-SOV and community-led research—and for some of us, as Indigenous researchers, these commitments carry additional responsibility.

These commitments shaped how we approached the stories shared with us, drawing on Tuck and Yang's framing of "refusal" in research, where communities determine "what is off limits, what is not up for grabs or discussion, what is sacred, and what can't be known."[25] With this in mind, we intentionally resisted deficit-oriented narratives in our engagement with Indigenous student data. As such, refusal in this context, is not about rejecting research altogether but rejecting and refusing to engage in extractive practices that reduce Indigenous youth and their

[23] Definition quoted from the International Institute for the Sociology of Law (IISJ) workshop description, *International Law, United Nations Declaration of the Rights of Indigenous Peoples, and Indigenous Data Sovereignty* (Oñati, Spain, July 11–12, 2019). The workshop cites this definition to Snipp (2016) and to *Indigenous Data Sovereignty: Toward an Agenda*, edited by Tahu Kukutai and John Taylor (ANU Press, 2016).
[24] First Nations Information Governance Centre. (2014). *The First Nations principles of OCAP®*. https://fnigc.ca/ocap-training/
[25] Eve Tuck and K. Wayne Yang, "R-Words: Refusing Research," in *Humanizing Research: Decolonizing Qualitative Inquiry with Youth and Communities*, ed. Django Paris and Maisha T. Winn (Thousand Oaks, CA: SAGE, 2014), 223–47.

communities to stories of pain or trauma. Further, as Tuck and Yang argue, refusal is a research stance that protects the integrity of the communities by honoring what is shared and what is intentionally withheld.

Reciprocity and trust were core to our research processes, shaping how we engaged with—and remained accountable to—partner schools and communities. We returned both raw and analyzed data throughout the study and committed to offering continued support in ways that are meaningful, useful, and aligned with community priorities. This included developing accessible materials to share progress across different stages of the research process and awarding grants to each focus group school to support local CS or technology initiatives. We worked closely with community liaisons and school leadership to build understanding and transparency, review findings, and identify ways Indigitize could offer further support through PD, resources, and ongoing partnership.

Positionality Statement

As Indigenous and non-Indigenous researchers, we are deeply aware of the histories that shape our presence in this work. We carry not only the responsibilities of our roles as facilitators and researchers but also the responsibilities of being good relatives—as community members and descendants—to those who have long been the subjects of extractive and harmful research.

We are not separate from the communities with whom we engage. We are born to and shaped by them. This proximity does not grant automatic legitimacy, nor does it erase the need for rigor or reflection. Rather, it demands that we move with intention, honoring both the knowledge offered and the silences held. We, too, are accountable for the legacies of extractive research and must work to not reproduce them.

Collective Methodologies

This section outlines the collective methodologies, research questions, and data sources used to carry out Phase 2.0 of the *AFE and Indigitize Computer Science Indigenous Computer Science Interest and Access Study*. In this phase, we engaged in the following four areas of inquiry across the CSC's teams:

- A retrospective analysis of Code.org's State of CS report data[26]
- Administering a survey to teachers who attended the 2024 Four Corners Computer Science Convening[27] (4CC hereafter) in Durango, Colorado, and/or who received PD through Indigitize
- Focus groups at NISN[28] partner schools in South Dakota and Minnesota
- Talk Story[29] dialogues with students, families, leadership, Elders, and educators in two Native communities: Haak'u (Acoma Pueblo, New Mexico) and Amskapi Piikani (Blackfeet Nation, Montana)

Together, these activities offer a multifaceted understanding of how Indigenous students experience CS education across diverse educational and community contexts in the United States.

Our approach, collectively rooted in Indigenous scholarship and the core tenets of community-based research (CBR), centered relationality, and cultural responsiveness. Drawing on Indigenous research methodologies, we looked to Linda Tuhiwai Smith's *Decolonizing Research Methodologies* (2012), who writes that research with Indigenous peoples must be accountable to community needs and histories and must "privilege Indigenous worldviews and aspirations."[30] Similarly, Brayboy et al. (2011) describe Indigenous research as guided by "relationships, responsibility, respect, and reciprocity," principles that shaped how we approached our partnerships and our interpretations of student experiences.[31]

Our research was also guided by the foundational principles of CBPR (Israel et al., 1998),[32] especially as it is applied in Indigenous contexts. LaVeaux and Christopher build on Israel et. al.'s eight principles of CBPR by proposing nine Indigenized principles that better reflect Tribal sovereignty, cultural protocols, and community-defined priorities.[33] For us, this meant codesigning with school partners, structuring research around local priorities, and ensuring that the data we collected would be meaningfully returned to communities.

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[26] Code.org.
[27] "Four Corners Computer Science Convening," https://sites.google.com/computersciencealliance.org/4cornerscs/home.
[28] NACA Inspired Schools Network.
[29] YAKANAL.
[30] Linda Tuhiwai Smith, *Decolonizing Methodologies: Research and Indigenous Peoples*, 2nd ed. (London: Zed Books, 2012).
[31] Bryan McKinley Jones Brayboy et al., "Reclaiming Scholarship: Critical Indigenous Research Methodologies," in *Qualitative Research: An Introduction to Methods and Designs*, ed. Sharan D. Lapan, Mary T. Quartaroli, and Frances J. Riemer (San Francisco: Jossey-Bass, 2011), 423–50.
[32] Barbara A. Israel et al., "Review of Community-Based Research: Assessing Partnership Approaches to Improve Public Health," *Annual Review of Public Health* 19, no. 1 (1998): 173–202.
[33] Deborah LaVeaux and Suzanne Christopher, "Contextualizing CBPR: Key Principles of CBPR Meet the Indigenous Research Context," *Pimatisiwin: A Journal of Aboriginal and Indigenous Community Health* 7, no. 1 (2009): 1–25.

In this sense, our methods are not only guided by academic frameworks but also by the responsibilities we carry as researchers, relatives, and community members. We understand research as a process that is reciprocal, culturally grounded, and upholds self-determination. These shared commitments of relational accountability, community relevance, and Indigenous self-determination shaped all four lines of inquiry across Phase 2.0—each offering a distinct yet connected lens on how Indigenous students engage with CS education.

Exhibit 2. Phase 2.0 Research Questions (RQs) and Associated Data Sources

RQs	*Talk Stories*			*Surveys*			*Focus groups*		*Interview*	*Code.org data*
	Student	Teacher	Community	Student	Teacher	Parent	Student	Parent	Community member	
RQ1. In what ways could computer science (CS) support Indigenous language revitalization, nation-building, Tribal sovereignty, and self-determination, as well as other forms of Indigeneity?										
a. What does CS mean to Indigenous students and their communities?	✓	✓	✓		✓	✓	✓	✓	✓	
b. How do Indigenous students and communities describe their connection to CS?	✓	✓	✓	✓			✓	✓	✓	
c. How can CS educational opportunities be responsive to current Indigenous student needs?	✓	✓	✓				✓	✓	✓	
RQ2. What are Indigenous students' and their communities' interests in CS education and career pathways?										
a. What factors influence or support the Indigenous students' choices to pursue CS?	✓	✓	✓	✓	✓	✓	✓	✓	✓	
RQ3. What does access to CS education and pathways look like for different Indigenous students and their communities?										
a. At what ages, educational levels (e.g., elementary/middle/high/post-secondary), and conditions in the community do access and pathways look like?				✓	✓	✓		✓	✓	✓
b. What are students' current utilization of technology, and on what platforms?	✓	✓	✓		✓	✓	✓	✓	✓	
c. What barriers or challenges limit CS education access for Indigenous students and their communities?	✓	✓	✓		✓	✓	✓	✓	✓	

RQs	*Talk Stories*			*Surveys*			*Focus groups*		*Interview* Community member	*Code.org data*
	Student	Teacher	Community	Student	Teacher	Parent	Student	Parent		
d. What are the needs of Indigenous students and their communities to fully leverage CS education and pathways?	✓	✓	✓		✓	✓	✓	✓	✓	
RQ4. What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?										
a. In what ways do the strengths inform policy (i.e., school, school district, charter school, Tribal, state, national)?	✓	✓	✓		✓	✓	✓	✓	✓	
RQ5. *Option to choose up to two research questions (if any)* that are specific to the local Indigenous student population/Tribal school/Tribal community that meet their research needs related to Indigenous CS.										

Note. This table lists all data sources created for this study. The column headings represent the data sources used to generate results in this report across the four lines of inquiry. The additional instruments that were developed and not used (student and parent surveys, community member interviews) can be found in the appendices.

"We are committed to giving back in a way that is meaningful, useful, beneficial...to the Tribal communities we will collaborate with and in ways that are determined by their communities."

– *Study Coalition Member Viewpoints on Values*

Inquiry 1 Methods: Retrospective Code.org Data Analysis

What Is the Purpose of This Retrospective Code.org Data Analysis?

Code.org[34] annually collects CS data for K–12 students across the United States and summarizes the findings in a State of CS annual report.[35] AIR analyzed the national data compiled by Code.org with a lens focused on understanding Indigenous student access to and participation in CS, as well as state adoption of policies that Code.org has identified as essential to build and sustain a comprehensive CS education system.

How Was This Study Activity Conducted?

AIR conducted a retrospective analysis of the reports and data collected by Code.org. AIR reviewed data downloaded from Code.org's 2021–24 State of CS reports, with a focus on the 2023–24 data. Code.org uses high school data collected using the NCES list of schools that enroll students in at least one high school grade (9–12). Some states also provided data on K–8 offerings and enrollment, as well as access and participation data. Demographic variables (including race/ethnicity) were from state education agency data.

Data elements of focus included access to foundational CS courses, participation in foundational CS courses, access to AP CS courses, and scores on AP CS courses. Most data elements were obtained by Code.org through state education agency collaboration or online portal requests. Other data collection methods used by Code.org included direct contact with states and school course catalogs.

AIR also reviewed Code.org's online tracker of its 10 key policies[36] for the most recent policy adoption data. These policies are divided into the following four groups:

- Clarity (statewide plan and K–12 standards)
- Capacity (funding for CS teacher professional learning, clear certification pathways, and incentives for preservice teachers to gain CS exposure)
- Leadership (dedicated CS positions at a state agency)
- Sustainability (requiring high schools to offer CS, allowing CS to satisfy a graduation requirement or a higher education admissions requirement, and including CS as a high school graduation requirement)

[34] Code.org.
[35] Code.org, *State of Computer Science Education*.
[36] Code.org, "State Tracker of Our 10 Policies."

Code.org uses a rubric[37] to evaluate whether or not a state has adopted a key policy.[38]

Inquiry 2 Methods: Indigenous CS Teacher Survey

What Was the Original Intent of This Line of Inquiry?

AIR was the lead for this line of inquiry and aimed to work directly with three Indigenous communities with whom AIR and Indigitize already had relationships. We planned to identify the types of research activities that resonated the most with each of these communities. These potential research activities included focus groups (with students, parents, and community members) and surveys (with students, teachers, and parents). We aimed for geographic diversity in the types of communities we approached.

We developed focus group and survey protocols, which were reviewed and approved by AIR's IRB and internal experts.[39] The surveys were adapted from existing instruments, including the Gallup CS Survey[40] and the Wind River Elementary Computer Science Collaborative's parent and teacher surveys.[41]

We had initial virtual conversations with five different Indigenous communities in Arizona, Minnesota, South Dakota, and Wyoming. Although the communities recognized the importance of CS education for their students, AIR and prospective partners incurred some challenges, including competing priorities and timing in the academic year and getting all appropriate school and Tribal agreements signed in time. Ultimately, we ended up developing and administering a teacher survey to those who participated in Indigitize's teacher PD programs or attended the 2024 4CC[42] in Durango, Colorado.

Overview of the Survey

Participants: Eligible participants included teachers who taught Grades 6–12 and received PD and/or technical assistance in CS from Indigitize or attended a conference focused on CS for Indigenous students in the Four Corners region (New Mexico, Colorado, Utah, or Arizona).

[37] Code.org, "Rubric for Evaluation of Ten Policy Ideas," https://docs.google.com/document/d/1WZ3rITFXnI2gNKmk8Bv5qthbJViEIEPRiK-lx3nW4MM/edit.
[38] Learn more about this in "Results for Research," Inquiry One.
[39] All protocols can be found in in Appendix A.
[40] Gallup and Amazon Future Engineer, *Developing Careers of the Future*.
[41] Wilson et al., "Wind River Elementary Computer Science Collaborative."
[42] "Four Corners Computer Science Convening."

Sample Size: An email with an invitation to participate in the teacher survey was sent to 405 eligible teachers; 35 of those emails were returned as invalid. From the remaining 370 invitations, a total of 124 teachers (34%) completed the survey.

Timeline: AIR administered the survey electronically in partnership with Indigitize from April to May 2025.

Instrument: The teacher survey was adapted from an existing instrument used with elementary school teachers in the Wind River Elementary CS Collaborative[43] and the AFE Gallup CS Survey.[44] A copy of the survey instrument can be found in Appendix A.

Content: The survey instrument consisted of items in the following areas:

- teacher demographics (e.g., what grades did teachers teach and what was the school type: public, private, on Tribal lands, charter school),
- probes on the understanding of CS and student access ("When you hear the term CS, what do you think of?"),
- probes on teacher perceptions of student interest in CS (activities, motivation),
- probes on teachers' understanding of student access to coding and AI,
- teacher beliefs about CS, and
- teacher understanding of student strengths and contributions.

Incentives: Participants were compensated with a $50 electronic gift card for participating in the survey.

[43] Wilson et al., "Wind River Elementary Computer Science Collaborative."
[44] Gallup and Amazon Future Engineer, *Developing Careers of the Future*.

Inquiry 3 Methods: Indigenizing CS Through Student Focus Groups

Indigitize led two focus groups that were collaboratively designed and facilitated with educators and community partners to ensure that the conversations were relevant, respectful, and grounded in local context. These discussions were anchored in five research questions[45] developed by the study's CSC and approved by our Research Steering Committee (RSC) during Phase 1.0 of the study.[46] Our approach was intended to explore how students interpret and experience CS education through the lens of their own cultural, community, and educational realities.[47]

Site Selection and Participant Overview

We partnered with two NISN schools: OSCA in Rapid City, South Dakota, and ENCS in Red Lake, Minnesota. These sites were selected based on longstanding relationships between our research team and the broader NISN community, as well as shared commitments to Indigenous education, cultural relevance, and equitable access to CS education.[48]

Focus group participants were selected based on the availability of the second- and sixth/seventh-grade teachers at each school. We chose Grade 2 to include early childhood perspectives and Grades 6 and 7 to capture preadolescent viewpoints from students who will soon be navigating formal CS education and career pathways. A total of 27 students participated across both schools: 11 students at OSCA (eight girls and three boys) and 15 students at ENCS (six girls and nine boys). All participants attended schools that center Indigenous knowledge systems and serve predominantly Indigenous student populations.

Participation was voluntary, and all sessions were conducted with school and parent or guardian consent. At the start of each focus group, our facilitator read aloud a verbal assent script that was approved by our IRB. The script was intentionally written to ensure that students understood the purpose of the discussion, their rights as participants, and their ability to opt out at any time. In addition, our team recorded each session to capture the discussions accurately; these recordings were stored and destroyed with HIPPA-compliant software.

In alignment with our commitment to reciprocity, we returned both raw and analyzed data to each partner community. This included transcripts, audio files, and editable slide decks

[45] See Exhibit 2.
[46] AFE et al., *Indigenous Computer Science Interest Study*.
[47] See Appendix B, Exhibit B-1.
[48] NACA Inspired Schools Network.

summarizing the findings, which schools could tailor and share with students, families, or educators.[49] Ultimately, our goals were to both uphold our coalition's values and to ensure that findings could be used in meaningful and relevant ways.

Our Partner Schools

Nestled in Mni Lúzahaŋ Otȟúŋwahe (Rapid City), the Oceti Sakowin (Seven Council Fires) Community Academy is an academically rigorous, community-driven, and Indigenous-led school. Grounded in the philosophies of the Oceti Sakowin, the school nurtures a learning environment rooted in the Lakota language, kinship, and collective responsibility, alongside core subjects such as math, science, and English language arts. OSCA opened its doors in fall 2022, served students in kindergarten through second grade during the 2024–25 school year, and expanded to third grade in fall 2025.

Endazhi-Nitaawiging, which means "the place where it grows," is an Ojibwe language and culture immersion school located in Miskwaagamiiwi-Zaagaiganing (Red Lake). Steeped in Anishinaabe values, land-based learning, and language revitalization, the school integrates community leadership and environmental stewardship with academically challenging instruction. ENCS was established in fall 2022 and served kindergarten through seventh grade at the time of the study, intending to add another grade each school year.

Focus Group Design and Facilitation

Both focus groups were designed to be conversational and grounded in relationships.[50] Each session began with students sitting in a circle to provide a sense of ease and mutual respect. We shared food and introduced ourselves, including our names and where we were from, in our Indigenous languages when possible. These openings reflected our intention to create a space that felt familiar and safe.

Our questions and facilitation approach were structured to create space for nuance—for the complexities of joy, curiosity, uncertainty, humor, imagination, and everyday reflections on learning and technology. Each group was facilitated by members of the research team, which included staff from Indigitize and NISN.

The first focus group, with second-grade students at OSCA, was facilitated by a NISN colleague. They led with the study's five core research questions[51] while the rest of the team supported by taking notes, asking clarifying questions, and offering additional prompts based on how the conversation unfolded. The second focus group, with sixth- and seventh-grade students at

[49] See Appendix B.
[50] See Appendix B, Exhibit B-1.
[51] See Exhibit 2.

ENCS, was cofacilitated by an Indigitize team member and the same NISN colleague. Although the questions remained consistent between both focus groups, the tone and pacing of the conversations naturally shifted, reflecting students' unique voices and perspectives.

Qualitative Data Analysis

Our approach to data analysis was rooted in relational accountability and guided by Indigenous research methodologies. We did not treat audio recordings and transcripts as raw data to be dissected but as living extensions of the conversations we were invited into. With this in mind, we began our analysis by transcribing each audio file by ear. Although we initially explored transcription software, it could not reliably capture the nuances of the discussions or the full range of students' voices. Manual transcription allowed us to actively listen for inflection, pacing, and moments of pause, which might have otherwise been flattened by automation.

Following transcription, we coded each transcript using a hybrid, line-by-line qualitative coding approach, aiming to remain attentive to the complexity of student insights. This allowed us to stay close to the conversation and recognize not only what was said but also what was withheld. Moments of silence or hesitation were understood as part of the conversation, not as omissions, and were interpreted through a culturally grounded lens that respected a broad range of communication.

To understand the complexities of the focus group discussions, we systematically coded each transcript and developed detailed codebooks for each site.[52] Coding helped us name and organize the ideas, patterns, and relational dynamics present in students' reflections. The codebooks for each school site were collaboratively developed and reflected both deductive and inductive patterns that emerged. In our analysis, parent codes referred to broad conceptual categories, while child codes captured more specific behaviors and insights. We iteratively refined each codebook throughout the process to better reflect the ideas and perspectives students brought to the discussion.[53]

Once coding was complete, we organized the data into matrices by school site to help us interpret patterns in context. These matrices allowed us to examine the frequency and distribution of codes while keeping student voices and experiences at the center of our analysis. Each of these comparisons helped surface broader themes that ultimately shaped our findings. Our initial set of matrices included: (1) parent codes × child codes, (2) parent codes × child codes × RQs, and (3) parent codes × child codes × student quotations.[54]

[52] See Appendix B.
[53] See Appendix B, Exhibits B-3 and B-6.
[54] See Appendix B.

At OSCA, our final codebook included seven parent codes and 44 child codes, capturing the nuances of how younger students made sense of CS learning. At ENCS, we identified seven parent codes and 37 child codes.[55] These codebooks were refined through iterative cycles of coding and group discussions, reflecting on the particular ways that students at each site engaged with CS education in relation to their local and community contexts. Together, these codebooks served as the foundation for understanding how students at each school learned CS and navigated and interpreted CS education.

A Note on Generalizability

We acknowledge that our strategy may prompt questions about the generalizability of the study because it differs from conventional approaches that seek demographic representation across broad and diverse populations. Both schools serve majority-Indigenous student populations, which contrasts with most public schools, in which Indigenous students often comprise a small minority. This is not simply a matter of proportion, however, but of design.

These schools were intentionally chosen because they operate within a framework that centers Indigenous knowledge systems, cultural practices, and community governance. Unlike many public schools serving Indigenous students, including those on or near reservations, our partner schools were founded to affirm Indigenous self-determination in education. In these spaces, curriculum, pedagogy, and school culture do not merely accommodate Indigenous students—they are built around them. This context enabled us to explore how CS education is experienced when Indigenous students are supported by systems intentionally designed with their identities, cultures, and communities at the center.

Further, recognizing that Indigenous student populations are frequently deemed statistically insignificant and that their perspectives are often omitted from educational research, we designed this study to center their experiences. In doing so, we are not only honoring the knowledge and insights of Indigenous youth but also contributing to a growing body of data where very little currently exists.

[55] See Appendix B.

Inquiry 4 Methods: Talk Story Dialogues

For Phase 2.0 of the study, NaPs-RRG engaged two Tribal Nation partners: Haak'u (Acoma Pueblo, New Mexico) and Amskapi Piikani (Blackfeet Nation, Montana). The Phase 2.0 research was guided by the five key research questions mentioned in the methods section, developed in collaboration with the coalition partners, the Indigenous Steering Committee, and Tribal Nation partners.[56]

To lay the ground for the Phase 2.0 research, the NaPs-RRG team developed protocols and worked with each community partner and research partner (AIR) to prepare the approval process through an IRB. Together with the Haak'u community, the research team worked directly with the school board and Tribal Council representatives to guide the research approval process; they approved using the AIR internal review system for the purposes of this study. For the Amskapi Piikani study, we worked with Blackfeet Community College (BFCC) to ensure we were following their ethical guidelines for research with their Tribal community members. The college will use the data originating from this study for institutional purposes in developing college programs and services. The college will also share the data with school partners to inform the alignment of curriculum and programs likely to stem from this study, building on existing partnerships. We collaboratively developed a memorandum of understanding with each Tribal community partner and then followed each community's protocol for obtaining signatures and approval to move forward with the study.

To engage the community members in dialogues about CS, the research team used a Talk Story approach. Talk Story dialogues reflect a broad Indigenous-based concept of engaging in storytelling and are similar to focus groups while being open-ended, emergent, and flexible to honor participant voices.[57] Specifically, the Talk Story dialogues were centered on an *"Rose, Thorn, Bud, Roots"* (RTBR) process, which uses a medicine plant metaphor to engage participants in an interactive dialogue. This technique is commonly used in design thinking[58] and was Indigenized by team members of the YAKANAL, the Indigenous Youth Culture Exchange, and the Cultural Conservancy partnership and shared with the research team. From an Indigenous worldview, the process reflects nature as our guide: "learning from our oldest teachers, the plants," as one YAKANAL participants put it.[59] The rose (bloom) represents

[56] See Exhibit 2.
[57] YAKANAL.
[58] Leanne Woods, Elizabeth Cummings, Jane Duff, and Kim Walker, "Partnering in Digital Health Design: Engaging the Multidisciplinary Team in a Needs Analysis," *Studies in Health Technology and Informatics* 252 (2018): 176–181.
[59] YAKANAL.

strengths, gifts, assets, and interests; the thorn symbolizes challenges and lessons learned; the bud signifies new or emerging ideas and opportunities for growth; and the roots represent foundations, necessary support systems, connections to a place, and core values (refer to Exhibit 4 for a summary of the RTBR process and question areas that guided this study).

The RTBR process provided an opportunity for participants to reflect on and share their thoughts on the following areas:

- opportunities and barriers for Native youth in pursuing CS fields and
- ways for Native youth and Tribal communities to improve CS pathways.

Communities and Context

This section provides more in-depth background information about the two Tribal communities—Haak'u (Acoma Pueblo, NM) and Amskapi Piikani (Blackfeet Nation, Browning, MT) with which the research team facilitated in-person Talk Story dialogues.

Haak'u

The dialogues with the Haak'u community took place in person at Haak'u Community Academy (HCA), a Tribally-run Grades K–8 school designed to support youth grounded in their cultural heritage and core values. The team engaged youth (ages 12–17); community members—including parents/caregivers, other family members, and leadership—as well as Tribal and non-Tribal educators (Grades PreK–8) and staff (e.g., educational aides, librarians, program coordinators, and supervisors) within the community. The dialogues with youth and community members took place during a Community STEM Night led by Indigitize on November 14, 2024. Educator and staff dialogues took place after school hours on February 19, 2025. An additional session with community members took place on the same date.[60]

Haak'u (Acoma Pueblo) is one of 19 Pueblos located in New Mexico. It is one of the oldest continuously inhabited communities in the United States, with evidence of occupation dating back more than 1,000 years.[61] Haak'u, meaning "a place prepared," is renowned for its unique location on top of a 367-foot mesa, which is why it is also referred to as "Sky City." *Haak'u meh* (the Acoma people) are known for their vibrant cultural traditions, including farming, pottery, and architecture, and are among the seven Pueblo peoples who speak Keres. The school systems include the Turtle School, an early childhood program; HCA, a Tribally run school serving preschool through Grade 8; and Laguna Acoma High School, which is a part of the Grants-Cibola County School District.

[60] See Exhibit 3.
[61] Pueblo of Acoma, "About us," https://www.puebloofacoma.org/about-us/.

Amskapi Piikani

The dialogues with the Amskapi Piikani community occurred in person at Blackfeet Community College (BFCC) and Browning Public Schools. Participants included youth (ages 13–18); community members (parents/caregivers, other family members, Elders, leadership, and college students); and educators (Grades 6–12)—all of whom were Native and/or members or descendants of the Tribe—and staff (e.g., assistant school principal, program directors, and student support).[62] The youth and community dialogues took place on April 5, 2025, and the educator session occurred on April 7, 2025.

Amskapi Piikani is one of the largest Tribes in the country and is located in Browning, Montana.[63] Originally nomadic buffalo hunters in the Northern Plains, the Amskapi Piikani people were settled onto a reservation, which borders Glacier National Park and Canada. Governed by the Blackfeet Tribal Business Council, an elected body, the Blackfeet Nation manages its own affairs, including education, health care, land management, and cultural preservation programs. Despite facing socioeconomic challenges common to many reservation communities, Browning continues to be a vital hub for Amskapi Piikani culture, history, and resilience. Major cultural events such as the annual North American Indian Days festival and institutions such as the Museum of the Plains Indian are hosted in Browning, showcasing the Tribe's vibrant cultural identity, resilient spirit, and enduring traditions.[64]

[62] See Exhibit 3.
[63] Relatives of the Amskapi Piikani also reside in what is now recognized as First Nations Saskatchewan and Alberta, Canada. They make up three Indigenous Nations: Kanai, Piikano and Siksika.
[64] Blackfeet Nation, “Our Lands—Blackfeet Nation,” https://blackfeetnation.com/lands/.

Exhibit 3. Talk Story Dialogues, Tribal Community Participants

Tribal community	Participants	# of participants
Haak'u (41 participants)	Youth (12–17)	5
	Community members	9
	Educators (Grades preK–8) and staff	27
Amskapi Piikani (97 participants)	Youth (ages 13–18)	48
	Community members	37
	Educators (Grades 6–12) and staff	12
TOTAL		**138**

Talk Story Dialogue Question Areas

This section describes the specific prompt areas that guided the Talk Story dialogues. Facilitators used prompts to spark ideas and conversation rather than as a strict protocol. First, the participants were invited to share responses to the following opening question as an icebreaker and a way to get to know each other: *What is an early memory you have of computers? The Internet?*

Participants were then invited to reflect on and share their understanding of CS based on the questions below.

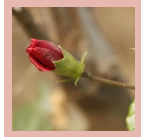
1. When you think of CS, what comes to mind?
2. (Youth, community members) How do you engage with CS in your own life?
3. (Educators) How do you engage with CS in your teaching (classroom, educational environment, other)?

These questions were asked to gauge Tribal community perspectives and understanding of CS and support participants in finding relevant connections to CS in their daily lives. This approach was based on the NaPs-RRG research team's learnings during the Wise Practices Research (Phase 1.0) that Tribal communities may have a different understanding of CS from the mainstream CS community because of their limited exposure to and awareness of CS.[65]

Next, the participants were guided through a dialogue using the RTBR process. RTBR prompt areas are shared in Exhibit 4 below.[66]

[65] Amazon Future Engineer et al., *Indigenous Computer Science Interest Study*, 2024.
[66] See Exhibit 4.

Exhibit 4. Rose, Thorn, Bud, Roots Process and Question Areas by Group for the Haak'u and Amskapi Piikani Communities

	Youth	Community members	Educators and staff
 **Rose (Strengths, gifts, assets, interests)**	• Interest in making an app, a video game, or a website • Interest in signing up for a computer science (CS) class, camp, or afterschool program	• Programs or practices in the community/school that support youth education and community-based CS learning • Opportunities for Native youth to go into CS-related careers that support community needs and values	• Programs or practices in the community/school that support youth education and community-based CS learning • Opportunities for Native youth to go into CS-related careers that support community needs and values
 **Thorn (Challenges, lessons learned)**	• Challenges or difficulties in learning about CS (currently or potentially)	• Challenges or barriers to youth access to CS • Supports needed to improve access and interest in CS education/careers • Generational barriers that may hinder CS interest, exposure, or learning	• CS challenges or difficulties for youth • Youth barriers to access and interest in CS education and careers • Challenges in teaching CS in own community or school
 **Bud (Emerging ideas, opportunities for growth)**	• Ideas for using CS knowledge to create tools (apps, games, robots, social platforms, and others) for own community, family, or self • Interest in attending a coding class, a boot camp, a hacking competition, or other	• Ways to support youth pathways (e.g., access, resources at home/school, careers) in CS • How to grow more Native mentors who can support youth interested in CS	• Ways to support youth pathways (e.g., access, resources at home/school, careers) in CS • How to grow more Native educators and mentors who can support youth interested in CS
 **Roots (Foundations, connections to place, core values)**	• Ways in which CS can help Tribal communities	• Ways in which CS can help Tribal communities • Ways in which CS can be Indigenized, and whether CS should be Indigenized • Desired core values in CS education or programs	• Ways in which CS can help Tribal communities • Ways in which CS can be Indigenized, and whether CS should be Indigenized • Desired core values in CS education or programs

Participants were invited to write down and verbally share their reflections based on the RTBR areas.[67] The prompts in each area were shared to seed the participants' thoughts, and facilitators invited them to reflect on the prompts that resonated with them the most, rather than requiring the participants to answer all of them directly. The session was audio recorded with permission from all participants in each group, and the audio recordings were later transcribed into a Word document using a third-party transcriber. Transcripts were then uploaded into a content analysis software program.[68] The research team met regularly to code and build consensus of their analyses and identify emergent key themes and patterns. This coding process sought balance through multiple perspectives (Indigenous and Western), and achieved inter-rater reliability through dialogue, consensus-building, and shared understanding.

Study Considerations

Numerous factors are important to consider to make the most of the research findings. The details of these factors are listed here.[69]

- Participants in both community studies shared varied understandings of what CS is or what it means. While researchers shared the coalition's CS Understanding,[70] both visually and verbally at the beginning of each session, many participants talked about CS in terms of using devices, technology, apps, and programs rather than producing, developing, or using other CS-related skills (in other words, they mostly shared how the products or outcomes of CS development are used in their own lives). The researchers wanted to make sure community members felt comfortable in the sessions and felt that it was important for everyone to have relevant entry points into the conversation about CS. To create a safe space for dialogue, researchers did not interfere with or correct participants who talked about the use of CS technology and devices; they rather guided the conversation toward CS itself when possible or appropriate.
- For the Haak'u community study, the research team collaborated with HCA and Indigitize to invite youth and other community members (e.g., parents/caregivers, other family, leadership) to participate in Talk Story dialogues during a Community STEM Night on November 14, 2024. The idea was to engage community members during an event they might be attending already to streamline recruitment and minimize the ask of community members. That said, the implementation process created a conflict for some community members who felt that they needed to choose between the Community STEM Night events

[67] See Exhibit 4.
[68] Dedoose (Version 9.0), SocioCultural Research Consultants, LLC, https://www.dedoose.com.
[69] Conventional/western social science research refers to these considerations as "study limitations." Our team feels this term reflects a deficit-based mindset and prefers the term "study considerations" because it better aligns with our research approach.
[70] See "Collective Understanding of Indigenized CS."

and the Talk Story dialogues. This led to a lower-than-anticipated number of participants during the first set of sessions (five youth participants and three community members). Youth and community voices were thus more limited than the research team had hoped, compared to educator voices. A few additional community voices (six in total) were able to be represented during an additional session held following the educator dialogues.

- Although the educator sessions at HCA were well attended, the session itself was limited to about 45 minutes, while the educator sessions with the Amskapi Piikani were about 90 minutes. The Haak'u educator session started a bit late, but the end time could not be changed due to educators' schedules and their need to sign out for the day. The researchers were able to get through all the prompts with the educators and support staff; however, some sections were a bit rushed, so the feedback may be more limited in a few areas.

"Centering relationships is what grounds us in our work. I would define this as interconnectivity with each other. It means honoring multiple perspectives and what we bring to this work."

– *Study Coalition Member Viewpoints on Values*

Results From the Research

Inquiry 1: Retrospective Code.org Analysis Results

These data, in particular, are connected to the overall study's RQ3.[71,72] We have organized a select set of key findings from our analysis using some high-level subquestions:

1. *(Access)* What does the state of Indigenous student access to CS courses look like in the United States?
2. *(Participation)* What does enrollment in foundational CS courses look like for Indigenous students in the United States?
3. *(AP participation)* What do AP CS course exam enrollment rates look like for Indigenous students in the United States?
4. *(Policies)* What does progress look like for CS policy in states with the highest concentrations of Indigenous students?

We recognize that the use of some terms can vary widely, so we have defined important key terms as follows:

- **Access** is evaluated in two ways: (1) the percentage of schools offering foundational CS and (2) the percentage of Indigenous students attending a school that offers foundational CS.
  - **Foundational** refers to CS courses that are aligned to the Computer Science Teacher Association K–12 Computer Science Framework (2017).[73] Courses must include a hands-on programming component: ≥ 20 hours for Grades 9–12 or ≥ 10 hours for Grades K–8. It must be offered during the school day (extracurricular clubs or afterschool programs do not qualify). Virtual courses may count, but they must both appear in the school's official catalog and be delivered as part of the regular school day schedule.
- **Participation,** or course-taking, is when students choose to enroll in these courses. This report uses these terms to describe participation:
  - *Parity* means that the percentage of NA/AN students participating in CS is equal to or greater than the percentage of NA/AN students in public K–12 schools.

[71] RQ3 asks, "*What does access to CS education and pathways look like for different Indigenous students and their communities?*"
[72] See Exhibits 5-15 for further insight into key findings. Additional findings are located in Appendix A.
[73] Computer Science Teachers Association (CSTA) and Association for Computing Machinery (ACM), *K–12 Computer Science Framework* (2017), https://csteachers.org/k12standards/interactive/.

- *Underrepresentation* means that the percentage of NA/AN students participating in CS is less than the percentage of NA/AN students in public K–12 schools.

- **AP participation** refers to the number of students who register and sit for the College Board's AP CS exams. This metric captures *only those who take an exam*, not everyone who takes an AP class. The two exams are:
  - AP Computer Science Principles[74]
  - AP Computer Science A[75]

CS Access: What Does the State of Indigenous Student Access to CS Courses Look Like in the United States?

NA/AN students have the least access to high schools that offer foundational CS courses in comparison to their peers and are the least likely to attend a high school offering a foundational CS course. Access to foundational CS is still out of reach for many NA/AN[76] students. On average, 66% of NA/AN students nationally attended a high school that offered a foundational CS course in 2023–24. That is an increase from the 60% that Code.org previously reported for 2020–21.[77,78]

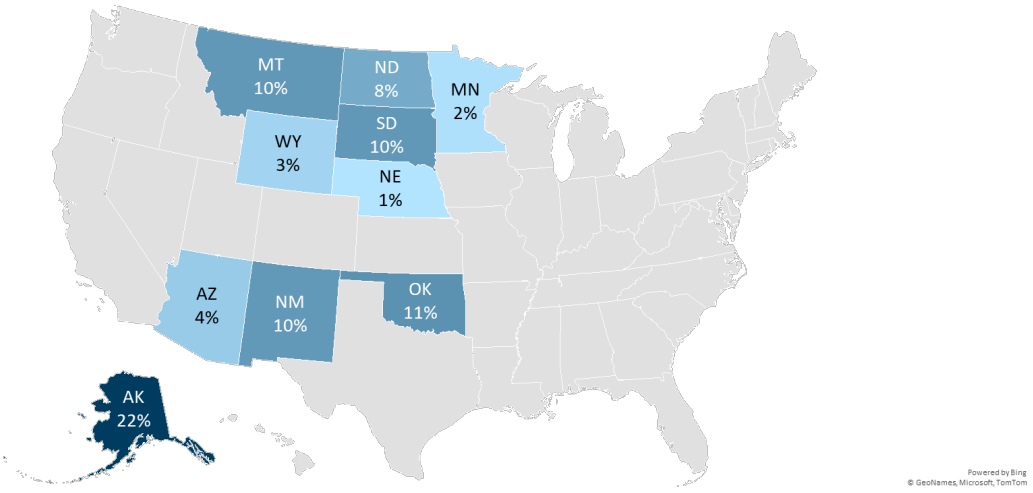
Exhibit 5. Percentage of Students Attending a High School Offering Foundational Computer Science, by Race/Ethnicity

Based on fall 2022 enrollment data from NCES, 10 states enroll more than half the national total of all public K–12 NA/AN students.[79] Together, the top 10 states enroll nearly 250,000

[74] "AP Computer Science Principles." College Board. https://apstudents.collegeboard.org/courses/ap-computer-science-principles.
[75] "AP Computer Science A," College Board, https://apcentral.collegeboard.org/courses/ap-computer-science-a.
[76] *Note*: NA/AN refers to Native American/Alaska Native in the exhibit.
[77] See Exhibit 5.
[78] Code.org, *State of CS Annual Access Report, 2024*.
[79] See Exhibit 6.

NA/AN K–12 students, which is 56% of the national total. With the exception of Alaska, these states form two clusters in the middle of the United States. Alaska, Wyoming, Montana, North Dakota, South Dakota, New Mexico, and Nebraska represent seven of the eight most sparsely populated states, and five states (Alaska, Montana, New Mexico, Arizona, and Wyoming) are among the 10 largest states in the United States in terms of total area. The rest of this analysis will focus on these states because they are places where bolstering NA/AN access and participation is critical.

Exhibit 6. Access to Foundational Computer Science in High School for Native American/Alaska Native Students

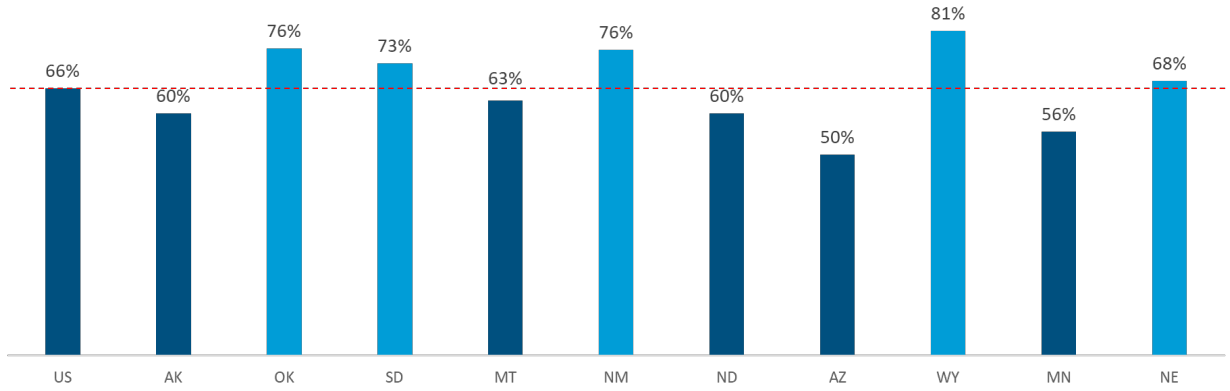


Source: U.S. Department of Education, NCES, Table 203.40 (2023) and Table 203.70 (2024).[80,81]

2023–24 CS access rates varied across the 10 states, from a low in Arizona, where 50% of NA/AN high school students attended a high school that offered foundational CS, to a high of 86% who did so in Oklahoma.[82]

[80] U.S. Department of Education, National Center for Education Statistics, "Table 203.40 (2023)" and "Table 203.70 (2024)," https://nces.ed.gov/programs/digest/ (access to both tables).
[81] *Note.* Fall 2022 is the most recent state-level enrollment data available. National *n* = 447,965; Alaska (AK) *n* = 28,259; Oklahoma (OK) *n* = 78,593; South Dakota (SK) *n* = 14,827; Montana (MN) *n* = 15,715; New Mexico (NM) *n* = 32,366; North Dakota (ND) *n* = 9,707; Arizona (AZ) *n* = 47,816; Wyoming (WY) *n* = 2,888; Minnesota (MN) *n* = 14,951; Nebraska (NE) *n* = 4,284; *n* = number of students.
[82] See Exhibit 7.

Exhibit 7. Percentage of Native American/Alaska Native Students Who Attend a Public High School Offering Foundational Computer Science, by State

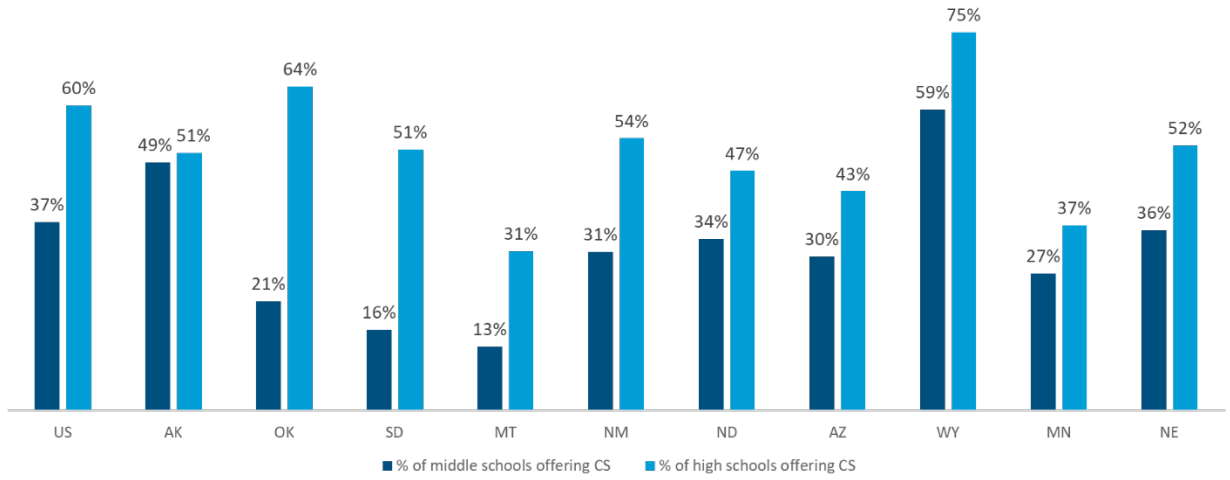


Five of these states[83] are above the national average of 66% for CS access.[84] Worth noting is that only two (Oklahoma and Wyoming) are above the national average for the percentage of high schools offering foundational CS. The relatively high access for NA/AN students despite otherwise limited statewide CS access in high school suggests that perhaps those states' targeted efforts to reach NA/AN students are succeeding.

At the middle school level, we see substantial gaps between the percentage of middle schools *offering* foundational CS compared to the percentage of high schools *offering* foundational CS. Exhibit 8 shows the percentage of middle and high schools *offering* a foundational CS course.[85] Nationally, 37% of middle schools offer CS compared to 60% of high schools. In these 10 states with high concentrations of K–12 NA/AN students, we see gaps ranging from 2 percentage points (Alaska) to 43 percentage points (Oklahoma) between middle and high schools offering foundational CS.[86]

[83] *Note*: States in Exhibit 7 refer to AK=Alaska; OK=Oklahoma; SD=South Dakota; MT=Montana; NM=New Mexico; ND=North Dakota; AZ=Arizona; WY=Wyoming; MN=Minnesota; NE=Nebraska.
[84] Code.org, *State of CS Annual Access Report, 2024*.
[85] Note that these data are focused on school-level course offerings and do not represent student-level enrollment.
[86] It is important to note that because not all middle schools reported data to Code.org, actual middle school access may be higher.

Exhibit 8. Percentage of Middle and High Schools Offering Foundational Computer Science (CS), by State

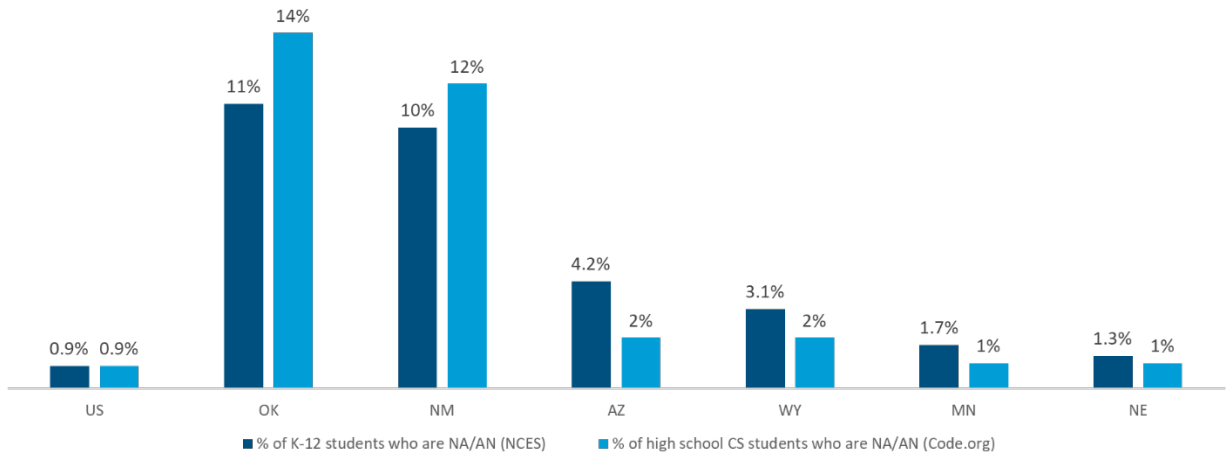


CS Participation: What Does Enrollment in Foundational CS Courses Look Like for Indigenous Students in the United States?

Moving from access to participation (i.e., course-taking), we see overall parity for NA/AN participation in high school foundational CS course offerings.[87,88] However, variation exists within the 10 states that had the highest percentage of NA/AN public K–12 students. Oklahoma and New Mexico demonstrate participation parity, while Arizona, Wyoming, Minnesota, and Nebraska show underrepresentation, with participation gaps ranging from 0.3 percentage points to 2.2 percentage points.[89]

[87] Code.org, *State of CS Annual Access Report, 2024*.
[88] See Exhibit 9.
[89] *Note*. This report relies on the most recent access data reported by Code.org. Arizona (AZ), Montana (MT), New Mexico (NM), and Wyoming (WY) data are from fall 2023–24; Minnesota (MN), North Dakota (ND), Nebraska (NE), and South Dakota (SD) data are from fall 2022–23; and Oklahoma (OK) and Alaska (AK) data are from 2021–22. These are the 10 states with the greatest proportion of NA/AN K–12 students, per NCES data.

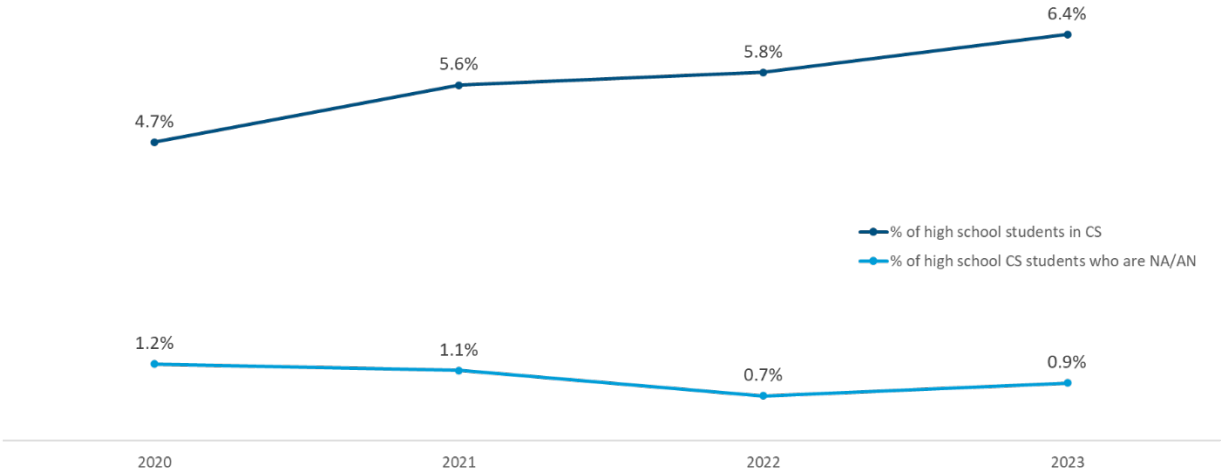
Exhibit 9. Native American/Alaska Native (NA/AN) Participation in High School Computer Science (CS) Compared to NA/AN Percentage of K–12 Enrollment, Nationally and for Top 10 States



The percentage of high school students in CS has increased since 2020–21, but the percentage of NA/AN CS students has declined.[90,91] This trend suggests that, despite broader gains in CS participation, NA/AN students are not benefiting equally.[92] However, a closer look at the data compiled for the last four Code.org reports reveals a more nuanced story.[93]

[90] Code.org, *State of CS Annual Access Report, 2024*.
[91] NCES, "Table 203.70 (2024)."
[92] *Note*. Alaska (AK), South Dakota (SD), Maryland (MD), and Montana (MT) are missing from this graph because they have never reported enrollment data disaggregated by race/ethnicity. Nebraska (NE) and Wyoming (WY) data are from fall 2023; Minnesota (MN) and New Mexico (NM) data are from fall 2022; and Arizona (AZ) and Oklahoma (OK) data are from fall 2021. National Center for Education Statistics (NCES) K–12 enrollment data are from fall 2022.
[93] See Exhibit 10.

Exhibit 10. Percentage of High School Students Participating in Foundational Computer Science (CS) (Fall 2020–23)



Nearly 230,000 more high school students participated in foundational CS courses in 2023–24 than in 2020–21.[94,95] However, NA/AN participation in foundational CS has essentially remained flat since 2020–21. Other racial/ethnic groups accounted for the overall growth, which is why the NA/AN percentage of total CS participants has declined even though NA/AN participation has remained relatively steady.

Given that the number of students identified as NA/AN by NCES has been declining since at least 2020, maintaining stable participation levels for this group may represent a success.[96]

Exhibit 11. Participation of High School Students in a Foundational Computer Science (CS) Course, by Race/Ethnicity

CS participation	Fall 2020	Fall 2021	Fall 2022	Fall 2023
National	538,809	626,132	693,077	767,912
Asian	63,282 (11.6%)	72,806 (11.3%)	84,700 (13%)	96,518 (12.6%)
Black	88,742 (16.2%)	103,245 (16.1%)	102,861(15%)	133,446 (17.4%)
Hispanic	105,941 (19%)	126,331 (19.7%)	139,114 (21%)	155,629 (20%)

[94] Code.org, *State of CS Annual Access Reports, 2021-2024*.
[95] *Note.* NA/AN refers to Native American/Alaska Native in the exhibit. The 2024 Code.org report applied updated methodology and retroactively revised prior years' national participation percentages. However, this was only applied to aggregate participation rates. Adjusted racial/ethnic breakdowns were not reported. This exhibit, therefore, uses the originally published 2021–23 figures to illustrate year-over-year changes in the percentage of high school students who are Native American. Only 2023 uses the updated Code.org methodology.
[96] See Exhibit 11.

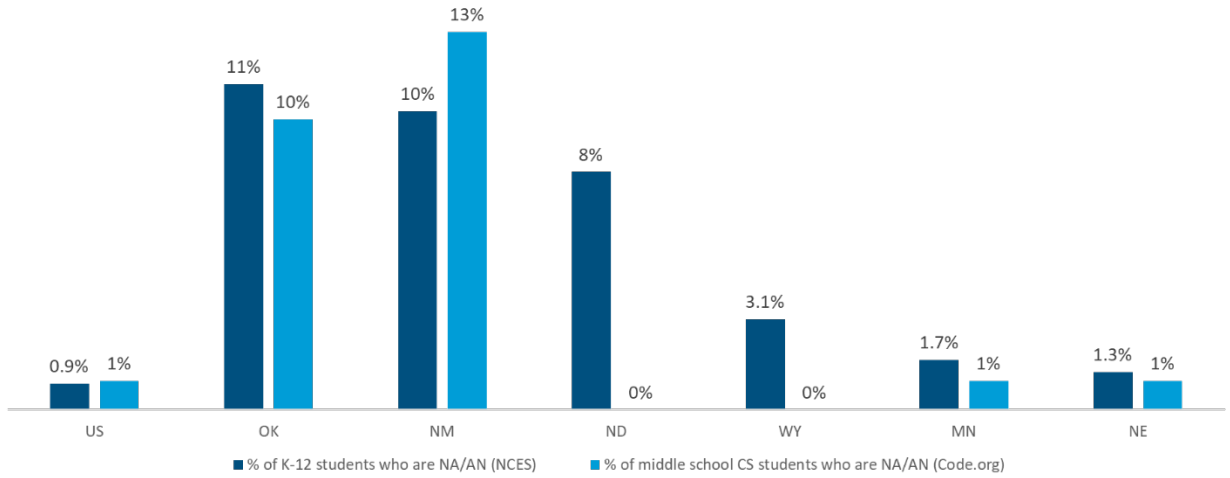
CS participation	Fall 2020	Fall 2021	Fall 2022	Fall 2023
Native American/Alaska Native	6,527 (1.2%)	7,104 (1.1%)	4,599 (0.7%)	6,585 (0.9%)
Native Hawaiian/Pacific Islander	2,160 (0.4%)	2,128 (0.3%)	1,695 (0.3%)	2,466 (0.3%)
White	262,021 (48%)	305,856 (47.6%)	314,161 (47%)	349,059 (45.5%)

Looking now at middle school participation in the sample of the top 10 states, we see that New Mexico demonstrates parity, while five other states (Oklahoma, North Dakota, Wyoming, Minnesota, and Nebraska) show underrepresentation.[97,98]

Code.org data do not show any NA/AN middle school students taking foundational CS courses in North Dakota and Wyoming, which may be because states cannot share or need to mask those data when sample sizes are low (fewer than five individuals). In addition, four of the top 10 states (Alaska, South Dakota, Montana, and Arizona) are not shown in Exhibit 12 because they have not provided Code.org with middle school participation data disaggregated by race.[99,100]

[97] Code.org, *State of CS Annual Access Reports, 2021-2024*.
[98] *Note.* The percentages in parentheses indicate the share of CS students who identify as that race/ethnicity for each year (e.g., 1.2% of all CS students identified as NA/AN in fall 2020). This table displays originally published 2021–23 figures.
[99] Code.org, *State of CS Annual Access Report, 2024*.
[100] *Note.* These are the 10 states with the greatest proportion of NA/AN K–12 students, per National Center for Education Statistics (NCES) data. AK, SD, MT, and AZ have not reported any middle school enrollment data disaggregated by race/ethnicity. States in the exhibit refer to AK=Alaska; OK=Oklahoma; SD=South Dakota; MT=Montana; NM=New Mexico; ND=North Dakota; AZ=Arizona; WY=Wyoming; MN=Minnesota; NE=Nebraska.

Exhibit 12. Native American/Alaska Native (NA/AN) Participation in Middle School Computer Science (CS) Compared to NA/AN Percentage of K–12 Enrollment, Nationally and for Top 10 States



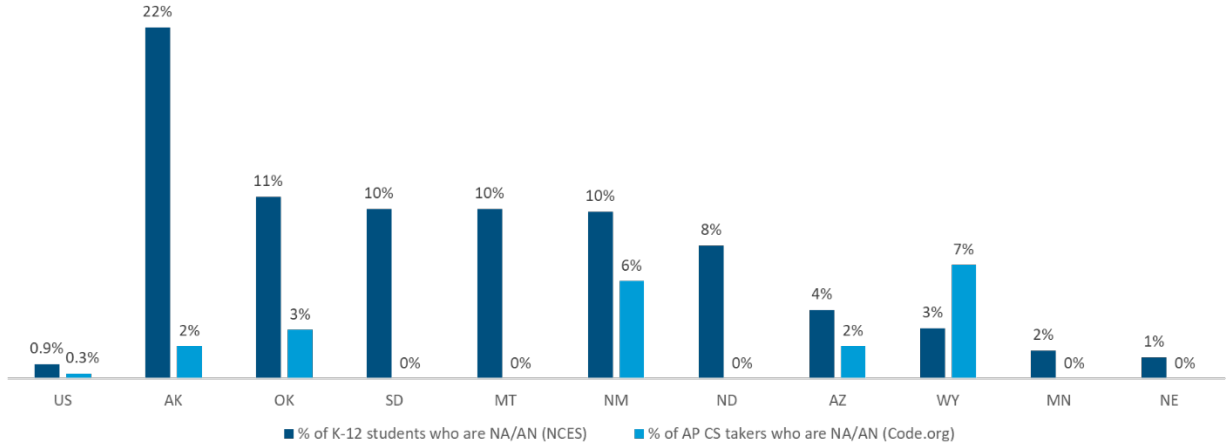
AP CS Participation: What Do AP CS Course Exam Participation Rates Look Like for Indigenous Students in the United States?

Exhibit 13 shows NA/AN student participation in the AP CS exam for NA/AN students in the top 10 states. In 2023, of the students who participated in the AP CS exam, only 0.3% were NA/AN, although NA/AN students represented 0.9% of the national K–12 population. These data indicate that NA/AN students are underrepresented in AP exam participation.[101,102]

[101] Code.org, *State of CS Annual Access Report, 2024*.

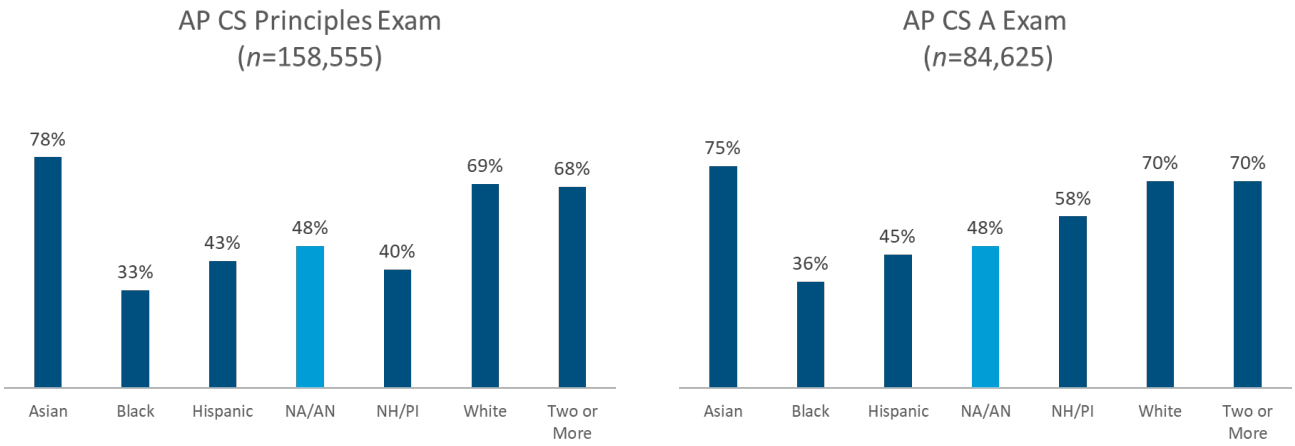
[102] *Note.* NA/AN refers to Native American/Alaska Native in the exhibit. These are the 10 states with the greatest proportion of NA/AN K–12 students, per National Center for Education Statistics (NCES) data. The 0% values indicate masked values or no participation reported, not missing data. States in the exhibit refer to AK=Alaska; OK=Oklahoma; SD=South Dakota; MT=Montana; NM=New Mexico; ND=North Dakota; AZ=Arizona; WY=Wyoming; MN=Minnesota; NE=Nebraska.

Exhibit 13. Participation in Advanced Placement (AP) Computer Science (CS), by Race/Ethnicity (2023)



For those NA/AN who participate in the AP CS exam, close to half earn a score of 3 or higher on exams compared to some peer groups (a score of 3 or more typically qualifies for college credit).[103] Many barriers to CS exam participation likely exist for NA/AN students, which policymakers can find ways to address.[104,105]

Exhibit 14. Percent of Students Earning a Score of Three or Higher on Advanced Placement (AP) Computer Science (CS) Exams, by Race/Ethnicity (2023)



[103] See Exhibit 14.
[104] Code.org, *State of CS Annual Access Report, 2024*.
[105] *Note.* NA/AN refers to Native American/Alaska Native and NH/PI refers to Native Hawaiian/Pacific Islander in the exhibit.

K–12 CS Policies: What Does Progress Look Like for CS Policy in States with the Highest Concentrations of Indigenous Students?

Code.org tracks state adoption of 10 key policies related to CS using a rubric and summarizes findings in an online tracker. AIR reviewed the policy status of the 10 states with the highest percentage of NA/AN students using the most recent version of the tracker, accessed April 2025.[106],[107] The following describes each of the policies.

1. **State Plan:** Create a statewide plan for K–12 CS
2. **Standards:** Define CS and establish standards for K–12 CS
3. **Funding:** Allocate funding for rigorous CS teacher professional learning
4. **Certification:** Implement clear certification pathways for CS teachers at the elementary and secondary levels
5. **Preservice Incentives:** Create programs at institutions of higher education to encourage all preservice teachers to gain exposure to CS
6. **State CS Position:** Established dedicated CS positions in a state education agency
7. **Require High Schools to Offer:** Require that all schools offer CS with appropriate implementation timelines
8. **Satisfies Graduation Requirement:** Allow CS to count toward a core graduation requirement
9. **Higher Education Admission:** Allows CS to satisfy an admission requirement at higher education institutions.
10. **Graduation Requirement:** Require that all students take CS to earn a high school diploma

Most of the top 10 states have adopted three key policies as outlined by Code.org: CS standards, teacher certification in CS, and allowing CS courses to count for graduation requirements.

From these data, we found that in general, a greater adoption of CS education policies is correlated with increased access to foundational CS courses, both overall and specifically for NA/AN students. However, states with higher proportions of NA/AN students tend to adopt fewer of Code.org's 10 key policies.

The top 10 states in Exhibit 15 exemplify this trend. Compared to the other 40 states, these 10 states have lower rates of adoption of Code.org's 10 key policies (62% versus 70%). The 10 states also have lower percentages of high schools offering foundational CS (48% versus 53%).

[106] See Exhibit 15.
[107] Code.org, "State Tracker of Our 10 Policies."

However, as previously mentioned, five of these 10 states are above the national average in providing NA/AN students with access to foundational CS in high school, suggesting that targeted efforts to provide access to NA/AN students are succeeding.[108]

Exhibit 15. Code.org Key Policies Adopted, by State

	State plan	Standards	Funding	Certification	Preservice incentives	State computer science position	Require high school to offer	Satisfies grade req.	Higher ed. admission	Graduation req.	Total # of policies
AK	Yes	Yes	No	Yes	No	Yes	No	District Decision	No	No	5
OK	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	7
MT	No	Yes	Yes	Yes	Incentives	No	No	District decision	No	No	4.5
SD	No	No	No	Yes	No	No	No	Yes	No	No	2
NM	Yes	Yes	No	Yes	No	Yes	Yes	Yes	No	No	6
ND	Yes	Yes	No	Yes	No	No	Yes	Required	No	Yes	6
AZ	No	Yes	Yes	Yes	No	Yes	No	District decision	No	No	5
WY	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	7
MN	Yes	No	Yes	No	No	Yes	No	Yes	No	No	4
NE	Yes	In progress	Yes	No	No	Yes	Yes	Required	No	Yes	6.5

Oklahoma and New Mexico are two notable examples of strong policy adoption and CS access and participation for NA/AN students. They rank number 2 and number 5, respectively, in terms of the percentage of K–12 students who are NA/AN. Both states exceed the national average for NA/AN student access to foundational CS in high school by 10 percentage points. Notably, each state has achieved CS participation parity for NA/AN students. Oklahoma has adopted six key CS education policies, while New Mexico has implemented seven. Both were early adopters of K–12 CS standards and offer CS teacher certification pathways, demonstrating a sustained commitment to building strong CS education systems.

What Are the Other Considerations for This Study Activity?

This analysis provides a national, high-level overview of access to and enrollment in foundational CS courses, AP course enrollment, and passing rates for Indigenous students. It

[108] *Note*. These are the 10 states with the greatest proportion of NA/AN K–12 students, per NCES data. Squares with a lighter shade of blue indicate that the policy is in progress or has been partially implemented.

also gives insight into the 10 states with the highest percentage of K–12 students who identify as NA/AN. However, using extant data from multiple sources has the following limitations:

- Comparisons across states and between states and national data reflect the most recent available data, meaning that some comparisons are across different years.
- Comparisons of CS participation and K–12 population share (for assessing parity and underrepresentation) are made by comparing Code.org and U.S. Department of Education NCES data. In addition, the top 10 states are identified using only NCES data. The most recent NCES K–12 enrollment data are from fall 2022. BIE schools and students are included in the Code.org national numbers but excluded from state participation numbers.
- An analysis conducted in 2023 by AIR's Indigenous Student Identification project indicated that federal race/ethnicity data (including NCES) are almost certainly inaccurate and that public K–12 NA/AN students may be undercounted by as much as 70% nationwide. Accordingly, the current report is limited by the inaccuracies of extant federal race/ethnicity data used for analysis.[109]
- Tribally-controlled schools and students seem not to be included in national or state participation numbers, and are thus not included in the data or this analysis. Similar to BIE schools, Tribally-controlled schools are only beholden to federal policy—they have greater autonomy in creating their own policies. An opportunity exists for Tribally-controlled schools to be included in future Code.org reports to establish baseline Tribally-controlled school and NA/AN student access to CS education and policies.
- Enrollment in foundational CS courses is not reported for several key states with large populations of NA/AN high school students in the Code.org data set. Alaska, California, Maine, Michigan, Nevada, New Hampshire, Ohio, and South Dakota are eight states that have never reported any enrollment data to Code.org. Many states, including Alaska, South Dakota, and Montana, have never reported enrollment data disaggregated by race/ethnicity.
- When Code.org requests CS information, states cannot share or need to mask the data when sample sizes are low (less than 5 individuals). When reporting numbers by race/ethnicity or gender, statistics become harder to report for some categories. States have even less available information to report about CS for kindergarten through Grade 8. Code.org does not have publicly available data before 2021.

[109] American Institutes for Research, *Indigenous Students Count: A Landscape Analysis of American Indian and Alaska Native Student Data in U.S. K–12 Public Schools* (2023), https://www.air.org/sites/default/files/2023-10/Indigenous-Students-Count-report-2023.pdf.

- Code.org defines what foundational CS means. In a future definition, we recommend including aspects such as computational thinking and problem solving.
- Given the uncertainty of the future of NCES data collection, AIR recommends exploring alternative options to supplement the existing demographic data.

Ultimately, the Code.org analysis cannot tell us the whys of some of these questions (i.e., why Indigenous students attended high schools that offered CS at lower rates or why some states with higher populations of Indigenous students had above-average enrollment in CS). The larger Indigenous CS study, however, has begun to provide answers.

Inquiry 2: Indigenous CS Teacher Survey Results

This section of the report includes key findings from the Indigenous CS teacher survey. In addition, the focus group protocols and youth, parent, and teacher survey instruments will be housed on Indigitize's Indigenous CS Resource Hub[110] so they can be publicly accessed by those Indigenous communities that want to use them.[111]

Survey Analysis

The survey was analyzed in two ways. First, the Likert and closed survey responses were cleaned and analyzed using the R statistical package. The teacher surveys were analyzed descriptively by each survey section for patterns and trends. The analysis was quality control checked by another team member. There were also several open-ended questions. Two AIR team members used an internal secure 365 Copilot to analyze emerging themes from the through-question prompts. The team used the same set of prompts while coding and went through five rounds of reconciliation to arrive at a similar set of emerging themes. Another team member conducted an independent analysis of the open-ended items to check for any nuances that may have emerged from the open-end analysis independent of the 365 Copilot analysis.

Survey Results

Who took the survey? What grades did they teach, and they taught at what type of school?

Of the 124 teacher respondents the following results were reported:

- **65%** are **female** and **36%** are **male.**
- **81%** teach at **public schools, 9%** teach at **Tribally-controlled schools,** and the remainder teach at private, BIE-operated, or "other" schools.

[110] Indigitize, "Resource Hub," https://www.indigitize.org/resource-hub.
[111] See Appendix A for additional survey tables.

- **44%** teach middle school, **28%** teach high school, and the remainder said they teach middle and high school (8%) or "other" (15%) (4% did not respond to this question).

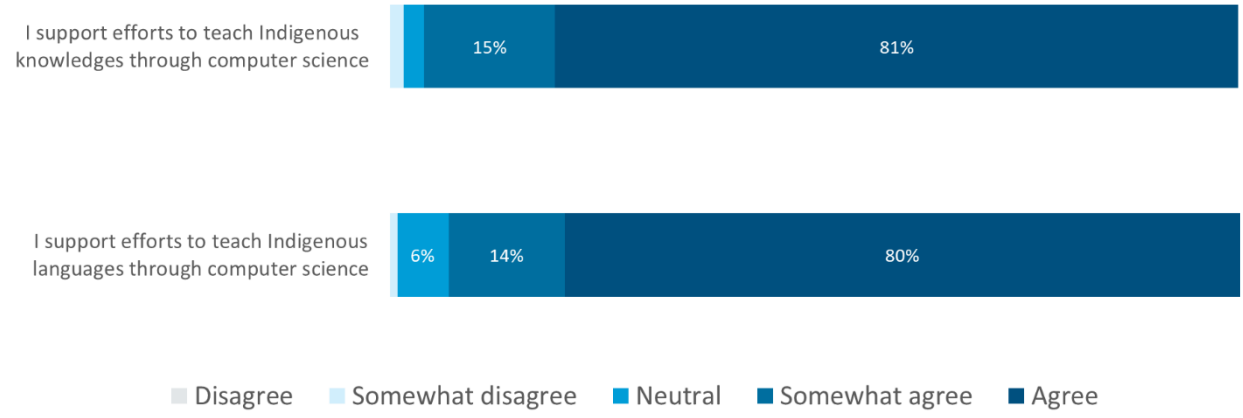
Of the 124 respondents, **24 (19%) identified as Indigenous, and of these 24** the following results were reported:

- 19 are female and 5 are male.
- 17 teach at public schools, and the remainder teach at Tribally controlled, BIE-operated, private, or "other" schools.
- 15 teach middle school, 3 teach high school, and the remainder teach middle and high school or "other," or did not respond to the question.
- The most frequently reported Tribal affiliation was Navajo Nation (10); Tribes/pueblos of New Mexico (5); Cherokee—unspecified (2); Lower Brule Sioux Tribe of the Lower Brule Reservation (2); Hopi Tribe—Arizona (2); Keweenaw Bay Indian Community—Michigan (1); Little Shell Tribe of Chippewa Indians—Montana (1); and Oneida—unspecified (1).[112]

What are teacher attitudes about teaching Indigenous knowledge and languages through CS?

Of the 124 respondents**, the majority** are highly supportive of efforts to teach Indigenous knowledge and languages through CS.

Exhibit 16. Teacher Attitudes about Teaching Indigenous Knowledges and Languages through Computer Science.



[112] See Appendix A for information about Tribal affiliation.

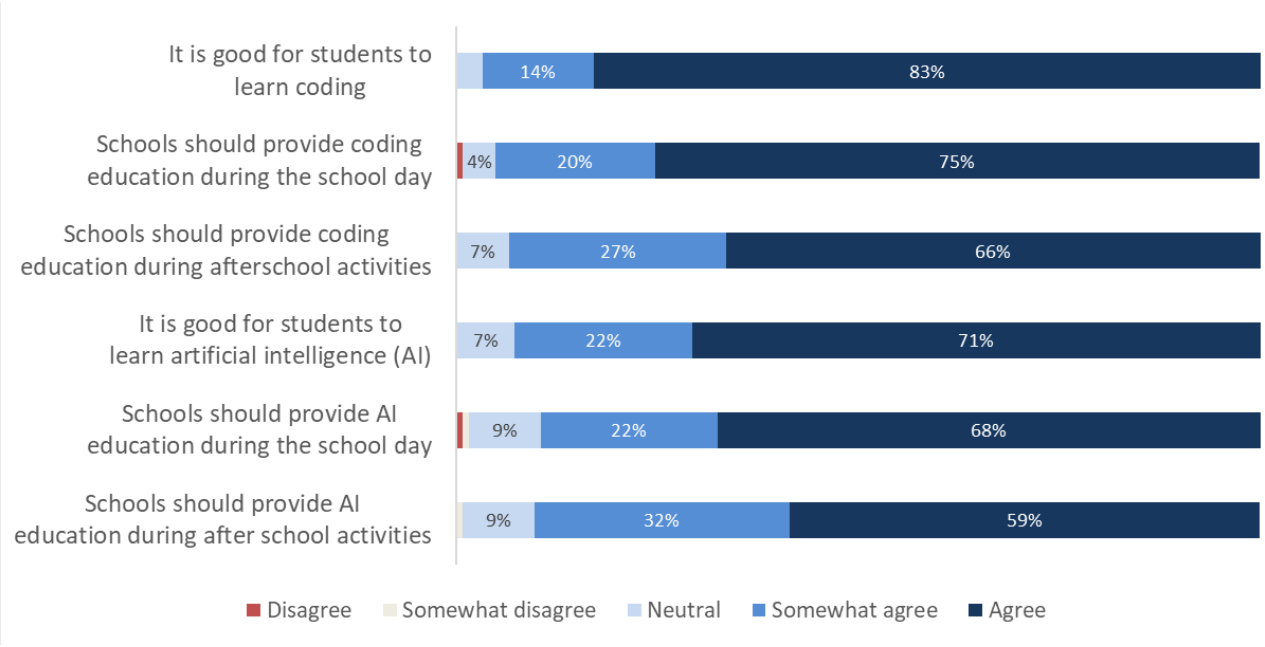
"...many of our students are not sure how to relate tech/computer science into their language/culture or how to use it to help solve issues that are relevant to them. Language/culture/values must be first and foremost when integrating any concept including computer science. Indigenous knowledge can be preserved and utilized through the use of western technologies."

– *Jodie Lockling, Phase 2.0 Research Steering Committee Member and Ojibwe Language Teacher*

What are teacher beliefs about students learning coding and AI?

More teachers agree that it is good for students **to learn coding (83%) than AI** (71%). Respondents support teaching coding during the school day (75%) and during afterschool activities (66%), but only 68% and 59%, respectively, said the same of AI education.

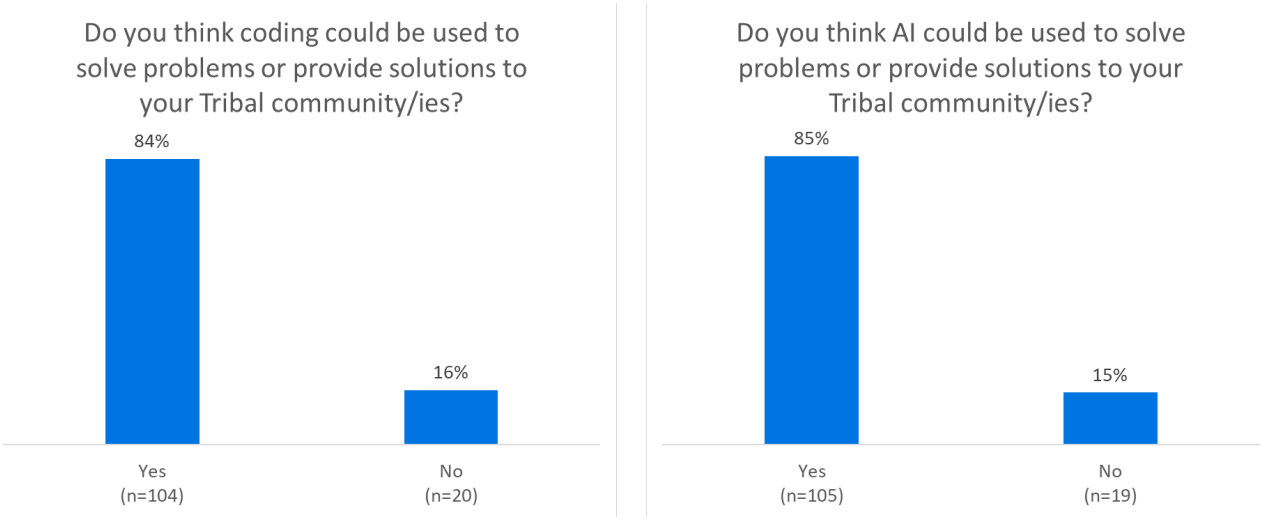
Exhibit 17. Teacher Beliefs about Indigenous Students Learning Coding and Artificial Intelligence.



In a separate yes/no question, 84% of teachers said they think coding could be used to provide solutions in their Tribal communities. When similarly asked if AI could be useful for problem solving in Tribal communities, about the same number of teachers (85%) also said "yes."[113]

[113] *Note*. The items about coding and AI were asked separately, so no significance testing was conducted comparing the two.

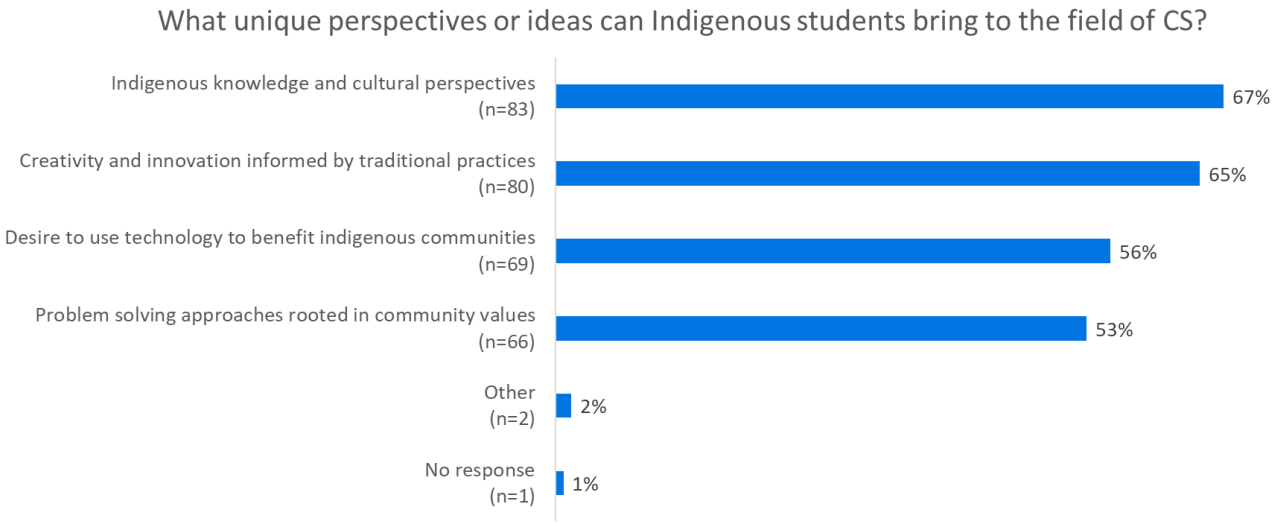
Exhibit 18. Teacher Beliefs about Whether Coding and Artificial Intelligence (AI) Could be Used to Address Problems or Provide Solutions in Tribal Communities.



Teachers also indicated that they believe students could bring a variety of perspectives and ideas to the field of CS. Bringing Indigenous knowledge and cultural perspectives was the most frequently cited example. The least acknowledged contribution was problem-solving approaches rooted in community values, which is notable given that most teachers responded "yes" when asked about the problem-solving potential of coding and AI.[114]

[114] See Exhibit 19.

Exhibit 19. Teacher Beliefs Perspectives or Ideas that on Indigenous Students Can Bring to the Computer Science Field.

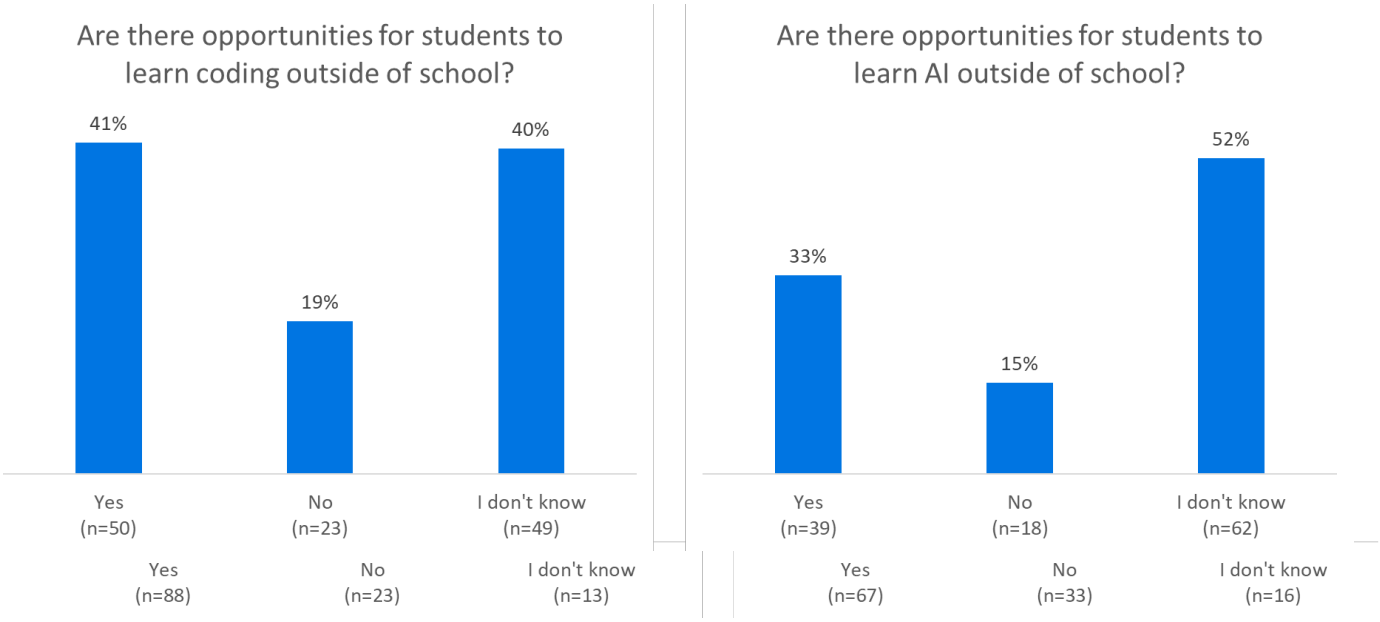


Where are the opportunities for students to learn coding and AI most likely to occur?

Teachers indicated that opportunities for students to learn coding and AI are most likely to happen in school as opposed to out of school; in both contexts, students are more likely to have access to coding instruction than AI education.[115]

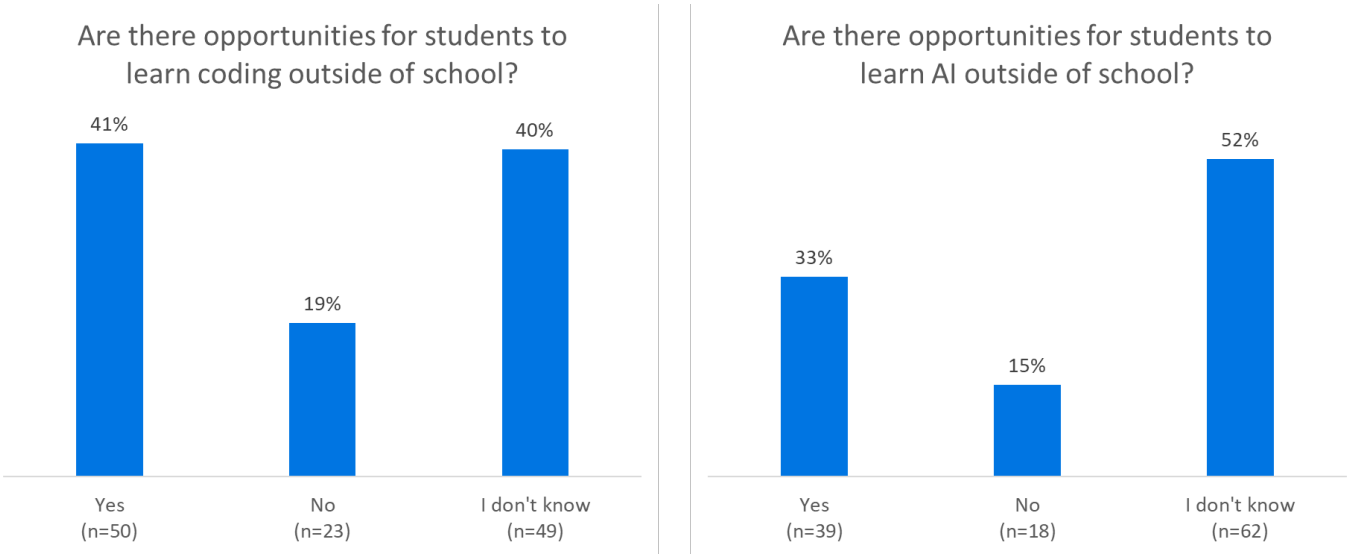
[115] See Exhibits 20 and 21.

Exhibit 20. Coding and Artificial Intelligence (AI) Opportunities at School



Note. The items about coding and AI were asked separately, so no significance testing was conducted comparing the two.

Exhibit 21. Coding and Artificial Intelligence (AI) Opportunities at Out-of-School

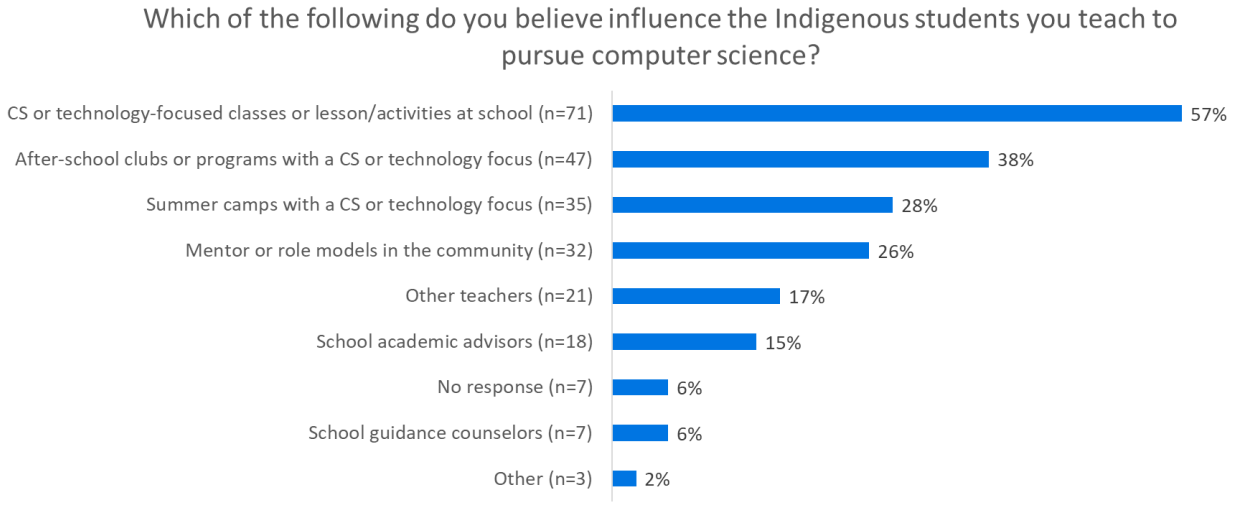


Note. The items about coding and AI were asked separately, so no significance testing was conducted comparing the two.

What opportunities can build Indigenous student interest in CS?

According to their observations, 71 teachers indicated that CS or technology-focused classes or lessons/activities **at school** influence Indigenous students to pursue CS, followed by 47 teachers who indicated that **afterschool** clubs or programs with a CS or technology focus also influence students.[116]

Exhibit 22. Teacher Beliefs about Indigenous Students Influences to Pursue Computer Science

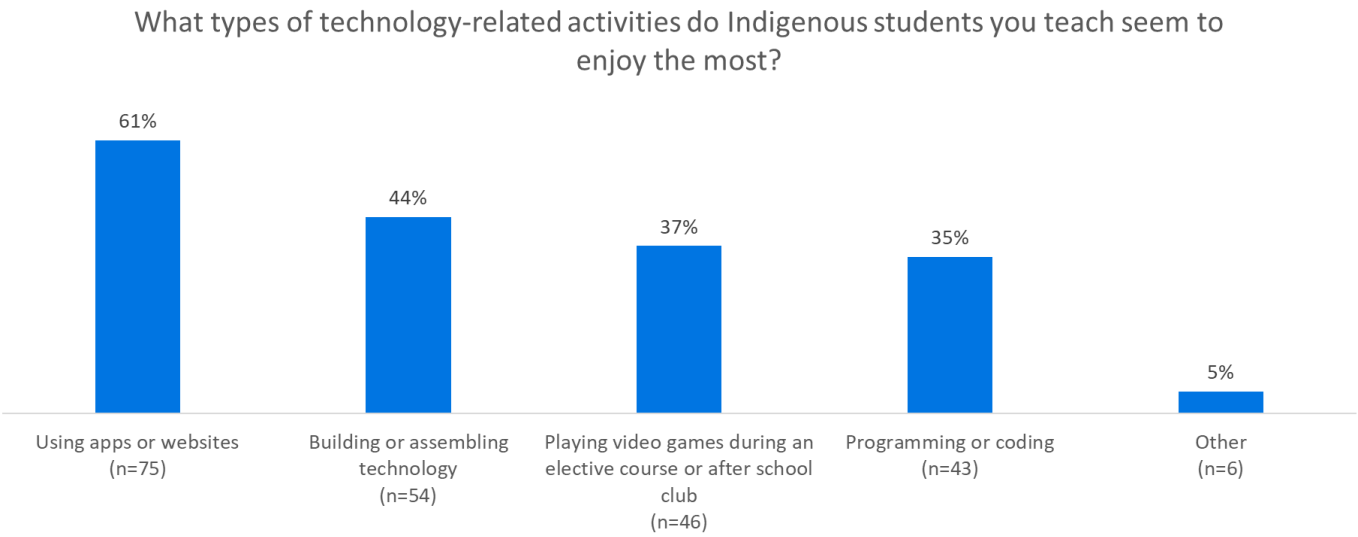


This finding underscores the importance of expanding access to foundational CS courses because the majority of surveyed teachers see in-school classes, lessons, or activities as a driver of Indigenous student interest in CS.

Teachers observed that their students seem to enjoy using apps or websites the most, while programming or coding was rated the lowest.[117]

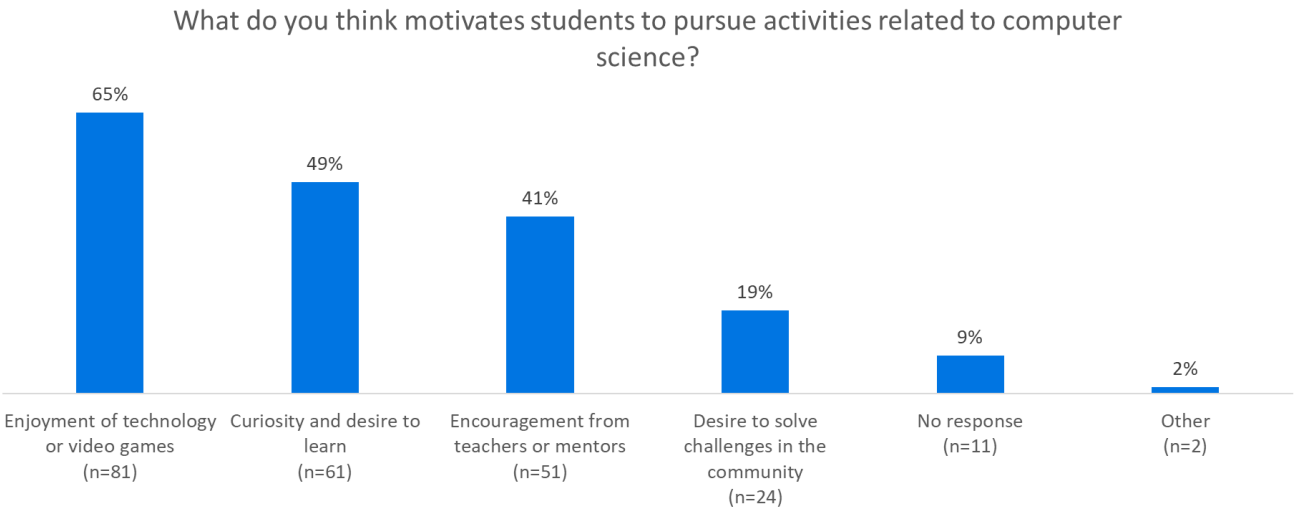
[116] See Exhibit 22.
[117] See Exhibit 23.

Exhibit 23. Teacher Beliefs of Technology-Related Activities Enjoyed by Indigenous Students



Teachers were also asked what they think motivates students to pursue activities related to CS. They most frequently indicated that students are motivated by enjoyment of technology or video games. A desire to solve challenges in the community was rated the lowest.[118]

Exhibit 24. Teacher Believes of Indigenous Students' Motivation to Pursue Computer Science

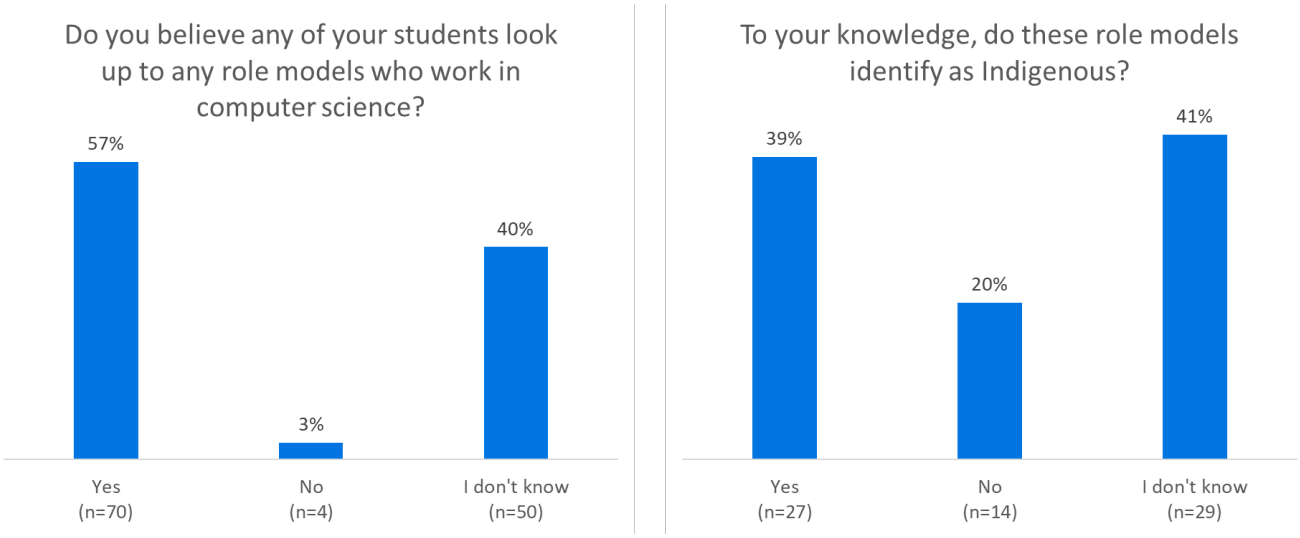


This finding is notable because of findings described earlier in this report showing that teachers believe coding and AI could be used to solve problems in Tribal communities. Despite agreement on this apparent potential, the majority of teachers did not indicate that it is a motivating factor for students.

[118] See Exhibit 24.

The survey also sought to further probe the influence of role models on student interest in CS. Of the 124 teachers surveyed, 70 (57%) indicated that they believe at least one of their students looks up to a role model who works in CS. Of those teachers, 27 (39%) said that students look up to a role model who identifies as Indigenous.[119]

Exhibit 25. Teacher Beliefs on Role Models in Computer Science for Indigenous Students



In open-ended responses, **teachers described examples of how coding** can solve problems or provide solutions in their communities. The following themes appeared in their descriptions:

- Cultural heritage and language preservation
- Data management and security
- Environmental solutions
- Technology and app development
- Community engagement
- Education
- Health care and job resources

In addition, **teachers described examples of how AI** can solve problems or provide solutions in their communities. The following themes appeared in their descriptions:

- Problem solving

[119] See Exhibit 25.

- Education
- Language preservation
- Resource and environmental management
- Community logistics
- Cultural preservation
- Health and wellness

"... there's a powerful opportunity to explicitly frame AI and emerging technologies as instruments Indigenous people can shape with our own values. Positioning AI as something we can Indigenize—rather than fear—could drive deeper engagement …"

– *Danielle Forward, Phase 2.0 Research Steering Committee Member and CEO and Cofounder of Natives Rising*

Summary Findings of the Survey

The majority of the respondents were female, about one fifth were Indigenous, most were middle school teachers, and most taught in public schools. In general, the teachers surveyed were very supportive of the use of CS efforts to teach Indigenous language and knowledge. There was also significant teacher support for students to learn coding during the school day. While a number of teachers agreed it is good for students to learn AI at school, support for this activity was not as high as it was for coding. Teachers also indicated that students are more likely to have access to coding opportunities than AI opportunities in school. Teachers felt that both coding and AI have the potential to address challenges within their communities. The top three emerging themes from qualitatively coding open-ended responses were technology and app development, education, and cultural heritage and language preservation; in relation to AI, the top three themes were problem solving, education, and language preservation.

Most teachers indicated that CS or technology-focused classes or lessons/activities at school influence Indigenous students to pursue CS and agreed that these classes should be taught during the school day. However, in the 2024 Code.org analysis, we found that Indigenous students are still the group with the lowest access to foundational CS. This is a reminder of why access matters—CS classes and lessons were cited by the greatest number of teachers as the influence for students pursuing CS. Also interesting to note were teacher perceptions of what CS activities students enjoy. They said that students most enjoy using apps or websites, or building or assembling technology; programming or coding were rated lowest. It is unclear in what ways teachers are engaging in programming or coding with students. While programming and coding are important components of CS, it is also important to consider a holistic definition and approach to CS that incorporates a variety of learning approaches. In the Code.org analysis, the study team also recognized the need for including aspects such as computational thinking and problem-solving aspects in Code.org's definition of foundational CS.

Considerations and Limitations

The Indigenous CS teacher survey served as a pilot and captured the initial thoughts and experiences of teachers who teach Indigenous students. The survey was administered to a small sample of teachers from a particular region of the country and cannot be taken as representative of all teachers who teach Indigenous students or Indigenous teachers in general. The sample is not representative of all Indigenous CS teachers as only one fifth of those surveyed identify as Indigenous teachers. The sample was too small to test whether the responses of Indigenous teachers differed in statistically significant ways from those of non-Indigenous teachers.

Inquiry 3: Indigenizing CS Through Student Focus Groups

This section presents findings from Inquiry 3: Indigenizing Computer Science Through Student Focus Groups. Building on the commitments outlined in our methodology, this inquiry explored how Indigenous students engage with CS and technology. We conducted two focus groups at Indigenous-led schools to better understand how students experience CS learning in relation to their cultural, community, and educational contexts. In alignment with Indigenous research methodologies, these discussions centered relationship building, respect for local knowledge and community, and student experiences and voice.[120,121]

What emerged from these conversations deeply reflects students' voices, offering insight into the ways students connect CS to their lived experiences, values, and sense of place. Rather than framing CS as an inaccessible, highly technical subject, students described their experiences through relationships, community, and curiosity and excitement. Their reflections illuminate how teaching and learning is not only shaped by access to technology but also by the cultural, emotional, and social contexts in which it is implemented.

A Closer Look at Oceti Sakowin Community Academy

Our first focus group took place with second grade students at Oceti Sakowin Community Academy in Mni Lúzahaň Otȟúȟwahe (Rapid City, South Dakota). This Indigenous-led school emphasizes academic rigor, Lakota language and philosophy, kinship, and collective responsibility. A group of 11 students (eight girls, three boys)—seated in a semi-circle—participated in a 45-minute, conversational focus group designed to center student voices, create space for relational dialogue, and understand how young learners make sense of CS and technology.

Following an in-depth, line-by-line coding process, we developed and iteratively refined a site-specific codebook with seven parent codes and 44 child codes. These codes were analyzed through feedback sessions and a series of matrices, including Parent Code × Child Code, Parent Code × RQ, and Code × Quotation.[122] We used the matrices to compare how frequently certain ideas came up, how they connected across RQs, and where students' own words brought those patterns to life.

We identified themes as clusters of related codes that most frequently and consistently captured insights, experiences, or ideas. Through this multilayered analysis, **six themes and one subtheme** emerged that reflect how students at OSCA make sense of CS and technology.[123]

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[120] Brayboy et al., "Reclaiming Scholarship: Critical Indigenous Research Methodologies."
[121] Smith, *Decolonizing Methodologies*.
[122] See Appendices B-2 to B-4.
[123] See Appendices B-2 to B-4.

These themes, supported by student quotations and frequency patterns, highlight the importance of cultural grounding, relational pedagogy, and emotional safety in shaping early student engagement.

Feeling Safe Enough to Try

Students were most willing to share ideas, take risks, and engage deeply with CS when they felt emotionally safe. This sense of safety was nurtured through caring and intentional facilitation, and modeled by culturally relevant encouragement, vulnerability, and active listening.

> **Teacher:** Okay, so, *mitakuyapi* (my relatives). So, can you guys say "*wóuŋspe?*"
>
> **Students:** *Wóuŋspe!*
>
> **Teacher:** That means knowledge, okay? *Wóuŋspe* means your knowledge, so—and we're also gonna use all of our knowledge. Our—now, say *wóksape.*
>
> **Students:** *Wóksape!*
>
> **Teacher:** Our wisdom. You're gonna use your wisdom and your *wóuŋspe*, your *wóksape*—now your *wóuŋspe.* You're gonna use all that and you're gonna apply it to everything—whatever—whenever he's talking and he's—you're gonna tell it exactly how you feel.

This moment reflects how culturally grounded pedagogy can support students' comfort and confidence in engaging with the concept of CS. Sensing hesitation, the teacher introduced the concepts of *wóuŋspe* (knowledge) and *wóksape* (wisdom) to reframe the conversation and position students as already carrying the knowledge to holistically engage. By encouraging students to "tell it exactly how [they] feel," the teacher affirmed that their experiences and emotions were valid and important. This relational and culturally affirming move helped create the emotional safety students needed to participate more fully.

Learning Through the Tools We Know

Students made sense of CS by connecting it to things they already understood, such as video games, devices at home, or tech used in class. When learning started from what was familiar, CS felt approachable and relevant.

> **Teacher:** Okay. *Thǒžáŋ* (niece) [redacted], go. What do you see?
>
> **Student:** Uh, I was scrolling on YouTube and, and then I seen [sic] a powwow and, I seen myself dancing in it. In my jingle dress. And that's the same powwow that I went to.

This brief but powerful reflection reveals how students relate to CS within their existing educational, digital, and cultural ecosystems. In this case, the student's experience was not distant, but deeply personal. Seeing herself dancing in a powwow video not only reflects the presence of technology in her daily life but also demonstrates the ways in which digital tools and platforms can help celebrate cultural identity. As such, technology becomes more than a source of entertainment; it is a learning space for affirmation, representation, and—sometimes—sharing. This underscores the importance of expanding CS access through tools and platforms that students regularly access and are fluent in, especially those that affirm students' identities, experiences, and communities.

Wonder, Discovery, and New Ideas

Student interest and excitement was especially evident when they were encouraged to notice details, name concepts, ask questions, and draw on their personal experiences. Students showed strong interest in CS, especially when it connected to their everyday lives, experiences, and sense of community.

> **Facilitator:** What would you want to learn more about [in] computer science or computer technology?
>
> **Student:** What's inside computers?
>
> **Facilitator:** What's inside computers. Word. Tell me a little more about that. What would you want to learn more about what's in those guts of those computers?
>
> **Student:** Guts?
>
> **Student:** Um, that—what's inside the—um, the screen.
>
> **Facilitator:** Okay. Okay. So, the different parts. Maybe what they do and how they come together.

The student's question— "What's inside computers?"—created space for deeper engagement, reflecting a genuine desire to learn more about CS. The facilitator's response models what effective culturally relevant strategies can look like: affirming student knowledge, asking clarifying questions, and helping students shape their thoughts. In this way, learning becomes an act of discovery and imagination rather than an abstract or inaccessible concept. Rather than relying on technological terms, the conversation is rooted in student learning and curiosities, reminding us that the most powerful entry point to CS is inquiry itself.

Learning in Community

Students regularly connected their understanding of technology and CS to the world around them, including home, school, and community settings. Cultural values, expectations, and ways of being shaped how students interpreted new concepts and made meaning of learning.

> **Student:** On my iPad I used to draw so much animal stuff.
>
> **Facilitator:** You draw [animal] stuff? Word. And tell me more about that, please. Do you have, like, a little pen that you use to draw things or—
>
> **Student:** Um, I have some kind of pen that can erase—erase it with.
>
> **Facilitator:** Okay, okay. And what do you like to draw when you draw [animal] stuff?
>
> **Student:** I don't know.
>
> **Facilitator:** You don't know? That's fine. And you give your pictures to people or what happens with them when they're done?
>
> **Student:** I used to give them—I used to draw some cartoon stuff … back at the church, and I used to give them around to people.

This exchange highlights the everyday spaces (churches, with family, at school) where students begin to define their relationship with technology. Rather than viewing CS as something confined to the classroom, the student sees technology as a tool that facilitates creative expression, experimentation, and social connection. Drawing and sharing digital art is not then just a hobby but also a meaningful way of participating in and contributing to their community. The facilitator's patient, affirming approach invites the student to connect their personal experiences that might otherwise be overlooked in technical conversations about CS, especially with regard to its relational and cultural intersections. In this way, technology becomes intertwined with relationships and identity, especially for younger learners who—generationally—have only ever known a world shaped by technology and automation.

Peer Support and Peer Barriers

Peer relationships played a powerful role in either encouraging or discouraging participation. Moments of peer support, in which students helped each other understand or explain ideas or validated each other's contributions boosted students' confidence and willingness to engage.

Subtheme: Early Messages About Who Belongs

Who gets interrupted—or whose ideas are taken seriously—sends early signals about who belongs in CS spaces. These dynamics shape confidence, identity, and long-term engagement, especially for Indigenous girls and other students historically marginalized in STEM.

> **Student A:** There's a bunch. Like, there's one doing this and—
>
> **Student B:** We do not care.
>
> **Student A:** (inaudible)
>
> **Student B:** We do not care!

This moment captures a subtle but impactful dynamic. During the focus group, a young girl attempted to share her thoughts but was interrupted by a young boy who repeatedly said, "We do not care." While this exchange did not dominate the discussion, it certainly impacted the young girl, the class, and the room. This exchange illustrates how peer interactions can shape students' sense of safety, value, and belonging in learning spaces. These kinds of comments, even when intended playfully or dismissed as teasing, can significantly undermine a student's confidence, reinforcing messages about whose ideas matter. For Indigenous girls and other students historically underrepresented in STEM, these early interactions often shape long-term perceptions of whether they see themselves as welcome in such fields.

Safe Boundaries for Big Ideas

Thoughtful oversight, such as modeling responsible tech use, gentle corrections, and offering guidance, helped students feel safe to explore without fear of punishment. These boundaries not only encouraged creativity but also taught students how to use technology responsibly and consider their digital footprints.

> **Student:** I call her Alexa—I call my Siri "Alexa," but sometimes when she bes [sic] nosey, I say, "Mind your own business. Get out of here while I'm playing my games. Get out."
>
> **Facilitator:** So, you—sometimes you'll tell technology back on up?
>
> **Student:** Yeah.
>
> **Facilitator:** Alright.
>
> **Student:** Because she's being nosey.

This student's reflection—while initially humorous—offers meaningful insight into how young learners begin to recognize technology's reach and develop their own boundaries and sense of agency in relation to it. The student's personification of AI, referring to it as "Alexa" and telling it to "mind your own business," signals an emerging awareness of surveillance, privacy, and harmful data collection. Rather than passively accepting technology's invasiveness, the student asserts their voice and autonomy. As such, this reflection emphasizes the importance of early conversations regarding responsible technology use, digital footprints, and the broader concept of data sovereignty in education.

A Closer Look at Endazhi-Nitaawiging Charter School

Having explored the insights shared by second grade students at OSCA, we now turn to the perspectives of sixth and seventh grade students at ENCS in Miskwaagamiiwi-Zaagaiganing (Red Lake). While the OSCA focus group offered a window into how younger students begin to make sense of CS, the ENCS discussion provided a developmental contrast. In this setting, we gained insight into how preadolescent students interpret CS in the context of identity formation and an expanding awareness of societal and technological systems.

Similar to our OSCA analysis, we used matrices to track how student reflections aligned with our research questions, surfaced patterns across codes, and stayed close to the language students used to describe their experiences. Through this process, we identified **six themes and one subtheme**[124] that reflect the complexity of student perspectives at ENCS. These themes shed light on how students are beginning to articulate their relationships with technology, grounding their perspectives in imagination, environmental conservation, responsibility, and culture.

Interest, Curiosity, and Relevance

In this study, students expressed the highest levels of engagement when CS was connected to their everyday lives, personal interests, or ways of thinking. Curiosity often emerged when students could imagine themselves using technology for something meaningful, whether for creative projects or experimentation.

> **Facilitator:** For me, myself, I'd want to build a Lakota Siri, where I could say, "Siri, how do I say uncle in Lakota?" And Siri would be able to talk back to me. If you all were able to use technology or make things, what would you all want to make?
>
> **Student:** Maybe help you during school, like notes or something. Maybe a calculator on an app. And then make it—music available, so you can maybe listen to music. Maybe a

[124] See Appendices B-6 to B-8.

timer, so that we could, like, (inaudible). Just specifically things to help you during school. Or just a planner.

At ENCS, student interest in CS was most prominent when technology was presented as something familiar, useful, and adaptable to their own lives. One student imagined an app as a tool to more efficiently facilitate learning, naming specific components, such as a calculator, timer, and planner. Rather than engaging with technology as abstract or unfamiliar, the student named the most practical tools that could support schoolwork, daily habits, and mindsets. This reflection, in particular, suggests that students' curiosities about CS and technology deepen when they can envision tangible tools that align with their lived experiences and needs.

Tech as Sovereignty and Possibility

Students demonstrated a growing awareness of the social, environmental, and ethical implications of technology and ideas for how to strengthen language revitalization. They shared concerns about environmental impact and safety. At the same time, students imagined how technology could be used for empowerment.

> **Facilitator:** Oh, it'll have, like, the question in Ojibwe and then you have to answer back in Ojibwe? So, you got it, right?
>
> **Student:** Yeah, you there's—there's, like, a word in Ojibwe and matching the right word in Ojibwe.
>
> **Student:** It's like a wolf.
>
> **Student:** There's, like, a word for it in Ojibwe—Ojibwe, and then, like, you pick one that you think it is, and then at the bottom—at the bottom it says if you got it wrong.

While reflecting on a website that a paraeducator at ENCS developed to promote Ojibwe language revitalization, students described how they engaged with interactive language learning tools. They described that they would match an object or animal with its appropriate term in Ojibwe, illustrating that technology can serve as both a practical resource and a pedagogical asset. By blending Indigenous knowledge with CS and technology, students perceived technology as a bridge towards sustaining language, culture, and traditions. This example underscores the potential that exists at the intersection of technology and Tribal sovereignty, especially when it is guided by community-defined priorities.

Structural and Material Access

While many students expressed interests in CS, their ability to pursue those interests was often shaped by inconsistent access to devices, reliable internet, and opportunities both inside and

outside of school. While exposure to CS at school seemed relatively consistent, there remained significant technological gaps outside of class.

Subtheme: Tech, Land, and Environmental Impact. Students voiced growing awareness of how technology use affects the environment—from energy use and overheating servers to the broader footprint of AI systems. For many students, understanding technology also meant understanding its consequences and impact on the environment.

> **Student A:** How is AI bad for the environment?
>
> **Facilitator:** That's a good question. Does anybody have an answer for that? How is AI bad for the environment?
>
> **Student B:** I read somewhere that whenever your computer maybe heats up or something, whenever you're asking or maybe using AI or something, or watching something or something. That thing that they generate those things from they have servers there, and those servers heat up and, like, um, they just, like, run into all that bad stuff.

During our focus group, one student asked, "How is AI bad for the environment?" prompting a peer to describe how servers generate heat and contribute to environmental degradation. Their response reflected a nuanced and concerned understanding of how energy consumption can impact the environment. This exchange illustrates that students are not only using technology but they are also beginning to critically think about its broader consequences. In a context in which technological access and infrastructure are unequally distributed, the fact that students are asking questions about sustainability underscores their growing awareness of the environmental impact behind a screen.

Learning Through Relationships

Students understood technology and CS through the lens of relationships, including communicating, staying connected, and supporting communities. Their examples drew from everyday digital engagements—such as group chats, video calls, and other forms of shared online spaces—revealing how technology functions as a social, communal tool rather than an isolated, highly technical skill.

> **Student A:** Uh, like, you can have, like, group chats where you can put, like, multiple people in one thing and not in the other, and servers where you can be with, like, random people who you don't have added. And you can, like, call them or FaceTime them, stuff like that.

Facilitator: So, why would it be important to have an app where a lot of people could communicate at once, especially here in this community? Why would that be important?

Student B: Cause you talk about the community. You have other people around you talk about what's going on, things and social events that happen, and things like that. And maybe if you add people from different areas, you can see what's going on there, but sometimes it can get a little—a little dangerous around people, but yeah.

This moment further highlights how students view technology as a means of maintaining relationships and staying connected to their communities. One student described communication mediums in their technical forms, including group chats, video calls, and servers that support these connections. Another student, featured here, reflected on the relevance of these tools for discussing community events and maintaining relationships across varied distances, especially in the context of rural, dispersed communities such as Red Lake. Rather than approaching technology from an individualistic perspective, students emphasized its role in relationality.

Where I'm From Is How I Learn

Students made sense of CS through familiar tools and experiences, especially those at home. Personal devices and digital routines offered accessible entry points, grounding learning in the realities of students' everyday lives.

Facilitator: Let's say, for example, for maybe English class. What are you going to use a computer for?

Student A: Dictionary.

Facilitator: Dictionary. And then what were you thinking?

Student B: The Ojibwe dictionary.

This brief exchange illustrates how students relate CS to their everyday learning tools, especially those that reflect both academic and cultural relevance. When asked how they might use a computer in class, one student responded with "dictionary," while another clarified "the Ojibwe dictionary," signaling a connection between digital tools and language revitalization. These responses reflect how students are already integrating technology into their personal lives and cultural education, grounding CS and technology in familiar contexts and demonstrating that learning is shaped by where they are from and what matters to them and their communities.

Student Voice and Ingenuity

Students consistently demonstrated self-awareness, adaptability, and creative problem solving in how they approached CS. Their learning often unfolded through exploration, questioning, and making space for their own ways of sharing and learning, especially as it related to language revitalization and technology.

> **Facilitator:** Okay. So, artificial intelligence. What does that mean? What is artificial intelligence? Yeah?
>
> **Student A:** A robot.
>
> **Student B:** It's like knowledge that is coded into it, then you can ask it anything and it will give you an answer.
>
> **Facilitator:** You can ask it anything and it will give you an answer. What examples of AI do we have right now?
>
> **Student A:** ChatGPT.
>
> **Facilitator:** Perfect. ChatGPT. What else?
>
> **Student B:** Meta.

Students at ENCS approached CS with curiosity, confidence, and their own frameworks for understanding. When asked about AI, they did not hesitate to offer examples such as ChatGPT and Meta, or to describe AI as "knowledge that is coded into it." These were not inaccessible, technological definitions but personal interpretations that showed how students were actively trying to make sense of complex systems. Their responses reflected more than just familiarity with technology but also resourcefulness in how they used language, drew connections, and explained their ideas. Even without formal instruction, students were responding creatively, supporting their ideas with personal experiences, and connecting technology with what they already knew.

Cross-Site Synthesis

Though the OSCA and ENCS focus groups reflected two distinct developmental stages, examining them together can help reveal shared patterns in how Indigenous students engage with CS. At both schools, students connected CS to their everyday lives, though they did so in developmentally distinct ways. Younger students at OSCA often grounded their understanding in tactile exploration and direct experiences with devices or games. Older students at ENCS demonstrated a broader and more conceptual vocabulary, one that linked technology to ethics,

responsibility, and environmental impact. In both cases, students drew from what they knew, but the complexity of that knowledge deepened with age and exposure.[125]

The frequency of codes related to Facilitation Moves & Relational Pedagogy and CS & Technology was high across both sites, yet the emphasis differed. OSCA students frequently responded to facilitation styles that modeled vulnerability, humor, and emotional safety. This highlighted how trust and relational care create conditions for participation, especially for younger students. [126] ENCS students, on the other hand, responded strongly to prompts that invited personal and contextual examples. This suggests that relevance and recognition were key drivers of engagement at the preadolescent age range. [127] This shift demonstrates how facilitation can and should evolve alongside students' developmental readiness.

Finally, patterns of student engagement surfaced differently across both sites. At OSCA, behaviors such as kinesthetic learning and moments of shutting down were common, suggesting that younger learners are still developing their emotional and sensory strategies that support tech-based learning.[128] At ENCS, on the other hand, students more frequently demonstrated curiosity, asked clarifying questions, and identified resources that could support their learning.[129] This developmental shift toward increased self-direction and student interest underscores the importance of scaffolding that is responsive to students.

Recommendations

The following recommendations emerged directly from the purpose of this inquiry: to understand how Indigenous students experience CS learning in relation to their cultural, community, and educational contexts. In listening closely to students at OSCA and ENCS, we were reminded that CS education is inherently shaped by the relationships, values, and conditions in which it is taught. What students shared was not only insightful but instructive. The recommendations that follow reflect the voices, priorities, and possibilities that surfaced through each focus group, and they are offered as place-based, relational strategies for strengthening CS learning in Indigenous schools and communities.

[125] See Appendix B.
[126] See Appendices B-2 to B-4.
[127] See Appendices B-6 to B-8.
[128] See Appendices B-2 to B-4.
[129] See Appendices B-6 to B-8.

OSCA Recommendations

Embed Cultural Knowledge and Learning into CS Instruction. Students responded most strongly when CS was introduced through community knowledge, familiar tools, and Indigenous values.

- Continue to use Lakota concepts in teaching and learning.
- Continue to incorporate stories, family teachings, and local technology use into lessons.

Strengthen Relational Teaching Practices in CS and Technology. Students thrived when their learning environment felt safe, joyful, and encouraging.

- Continue to use relational strategies such as humor, vulnerability, and affirmation with students.
- Frame mistakes and uncertainty as part of the learning process to build student confidence.

Interrupt Gender Bias and Peer Barriers Early. Students, especially girls, experienced peer dynamics that limited their participation.

- Establish inclusive classroom norms that actively encourage balanced participation, such as turn taking, affirming others' ideas, and respectful listening.
- Design peer learning structures (such as partner work or small groups) that create intentional opportunities for students who may be overlooked, like girls or quieter students, to lead.

Support Digital Safety and Awareness. Students demonstrated awareness of surveillance, distraction, and responsibility with technology.

- Integrate conversations about digital safety, choice, and agency into early CS lessons.
- Teach students how to set healthy boundaries with tech in ways that honor curiosity and holistic wellness.

ENCS Recommendations

Connect CS to Place, Language, and Identity. Students made meaning of CS through family, land, community, and language. Where they are from is how they learn and should continue to be affirmed.

- Offer projects that connect CS to Ojibwe language, storytelling, or community priorities.
- Invite students to explore how tech can support their roles as young leaders.

Center Relationships as the Foundation for CS Learning. Students engaged deeply when learning was rooted in trust, care, and mutual respect.

- Continue to use relational strategies such as humor, vulnerability, and affirmation with students.
- Treat emotional safety and belonging not as soft skills but as essential infrastructure for CS.

***Make Space for Student Voice, Choice, and Ingenuity*.** Students navigated learning in their own ways through questioning and experimentation.

- Incorporate open-ended, student-driven CS activities that allow for different learning styles and ways of showing knowledge (such as self-paced learning menus or online programs).
- Use dialogue and reflection as tools to surface student thinking, not just in what they produce but also in how they engage.

Support Digital Safety and Awareness. Students showed high interest but uneven access to devices and supplementary CS opportunities.

- Strengthen one-to-one tech access and explore flexible learning time for CS.
- Partner with Tribal or local organizations to create out-of-school tech opportunities aligned with student interests, values, and safety.

Policy Implications

The findings from this inquiry highlight how Indigenous students experience CS in ways that are deeply shaped by culture, context, and relationships. While this study centers student voice and school-based experiences on a local level, the insights have broader relevance for both school leaders and lawmakers committed to equitable, community-driven, and community-rooted CS education and technology nationwide. The decisions we make today—whether on a school board or on Capitol Hill—impact Tribal communities (labor market, cybersecurity, language revitalization, etc.) now and into the future. We recommend that leaders at every level consider the following:

1. **Invest in Culturally Responsive CS Programs**

   Fund initiatives and PD opportunities that support schools in developing or adapting CS curricula grounded in Indigenous language, culture, and knowledge systems. Ensure that Tribal consultation is an integral part of the process.

2. **Expand Digital Literacy Programs Across Tribal Communities**

   Invest in community-centered digital literacy initiatives that reach beyond K–12 schools to include families, Elders, and other community members. Digital access without digital

fluency limits meaningful participation in the workforce, education, and civic life. Programming should be codesigned with Tribal communities, offered in Indigenous languages where possible, and reflect local contexts, values, and priorities.

3. **Support Reliable Technology Infrastructure in Tribal Communities**

   Technological and broadband infrastructure remains inequitable in Tribal communities. Allocate resources for one-to-one devices and broadband expansion in all Tribal schools and communities, especially those that are rural.

4. **Ensure All Data Sharing Agreements Uphold Tribal Data Sovereignty**

   Require that any data collection or sharing involving Indigenous students, schools, or communities be governed by clear agreements that respect Tribal data sovereignty. These agreements should be codeveloped with Tribal Nations and include protocols for consent and use aligned with OCAP.[130] Mandate that state and federal agencies to interact with Tribal communities as sovereign partners, not as subjects of research or extraction.

Inquiry 4: Community-Based Talk Story Dialogues

As part of the CSC, a collaborative research team comprising RRG (Corvallis, Oregon) and NaPs (Laguna, New Mexico) facilitated a community-based research study exploring interest, access, and barriers to CS education among Indigenous youth and communities. RRG focuses on lifelong learning in museums and other cultural and educational environments, with a focus on culturally responsive STEM learning, research, and evaluation practices. NaPs focuses on multicultural science education, program evaluation, research, and advocacy for equality of worldviews in education and research/evaluation through an Indigenous lens. Together, the collaborative research team aims to bring together Indigenous and Western paradigms, Indigenous research methodologies, and culturally responsive approaches designed to center and honor Indigenous youth and communities with whom we engage. Our team aims to be partners in the work, rather than external researchers, and build in time to create relationships with community partners, leaders, and funders, as well as share back the results and findings as we are learning and create space for dialogue and shared interpretation.

This section of the report reflects findings from the Phase 2.0 community-based research, which engaged two Tribal Nation partners: Haak'u (Acoma Pueblo) in New Mexico and Amskapi Piikani (Blackfeet Nation) in Montana. Phase 1.0[131] engaged 10 individuals at the intersection of

[130] FNIGC, *First Nations Principles of OCAP®*.
[131] Amazon Future Engineer et al., *Indigenous Computer Science Interest Study*.

Indigenous ways of knowing and CS education and identified wise practices[132, 133] for engaging Indigenous youth and communities in CS education and research that center community core values, nation-building, and Tribal sovereignty. For Phase 2.0, the research team built upon key findings from Phase 1.0 to inform a participatory, community-based research process designed to deepen understanding and relationships in support of growing Indigenous CS education pathways, access, and interest across Indian Country. Phase 2.0 was guided by five key research questions which were developed in collaboration with the coalition partners, Indigenous steering committee, and Tribal Nation partners.[134]

What We Learned (Findings)

In this section, we share a summary of key findings for the Community Talk Stories based on the CSC's research questions. Following this summary, we share more in-depth findings and key themes for both the Haak'u and Amskapi Piikani communities.

RQ1. In what ways could CS support Indigenous language revitalization, nation-building, Tribal sovereignty, self-determination, and other forms of Indigeneity?

- Community members saw valuable connections and shared many ideas for how CS could be engaged to support **Tribal sovereignty and nation-building efforts.** Key ideas related to ways that CS could be used to develop tools, apps, or programs to support community values and needs, such as protecting community borders; cyber security; emergency preparedness programs (e.g., police, hospitals, fire departments); natural resources management; animal husbandry; communication tools; local GPS tools (e.g., building community-specific navigation tools to survey important historical and cultural sites); health and wellness (holistic wellbeing); and language and cultural revitalization and documentation efforts.
- The Haak'u and Amskapi Piikani communities shared different perspectives on how CS could be used for language and cultural revitalization and reclamation efforts and what would be appropriate. While the Haak'u community is interested in using CS to develop these tools, the adults in particular expressed **data sovereignty concerns,** noting that the Haak'u community and other Pueblos share much of their linguistic and cultural knowledge. If Haak'u were to build such CS tools and platforms, they could inadvertently put their Pueblo

[132] Rita Martinez, Keiko Beers, Jill Stein, and Shelly Valdez, *Amazon Future Engineer Part A Report: Wise Practices—Individual Talk Story Dialogues on Conducting CS Research with Indigenous Communities* (unpublished manuscript, Reimagine Research Group and Native Pathways, 2023).
[133] Rita Martinez, Keiko Beers, Jill Stein, and Shelly Valdez, *Amazon Future Engineer Part B Report: Wise Practices—Individual Talk Story Dialogues on Conducting CS Research with Indigenous Communities* (unpublished manuscript, Reimagine Research Group and Native Pathways, 2023).
[134] See Exhibit 2.

relatives in vulnerable situations, exposing aspects of their own Keresan language dialects and cultures to misappropriation by both non-Native and Native people. Amskapi Piikani community members were a little more open to the possibilities of using, for example, public platforms for language and cultural revitalization and reclamation efforts; a few people suggested ideas such as Google Translate or similar public platforms for translation of the Amskapi Piikani language, as well as dictionary platforms, as a way to learn more about the language.

- Both communities emphasized that they **need access to CS knowledge and skills** that would enable them to build, develop, or create CS tools to support nation-building efforts, such as providing Native youth leaders with training in CS in ways that center community values and practices and support service to their communities. As a couple of members from the Amskapi Piikani community noted, at this stage, they are only users or consumers of CS tools and products, rather than creators and innovators, and as a result are limited in their ability to offer those nation-building opportunities.
- **Financial and resource challenges** play a role in impeding access to technology and connectivity, which are essential to building pathways in CS education and careers for Native youth and community members in ways that center nation building and Tribal sovereignty. This lack of access to resources negatively impacts not only youth but also parents/caregivers and other family members who may want to continue their own CS learning.

RQ2. What are Indigenous students and their communities' interests in CS education and career pathways?

- A majority of the **youth across both communities indicated interest in CS** and are aware of some of the skills that are needed in the field, such as programming and coding. At the same time, some **youth expressed concerns about the challenges** involved in learning how to be a computer scientist, sharing that they felt intimidated by the level of math or other skills needed, and that they weren't sure if they could get the support they would need to learn about CS or whether they would need to find ways to teach themselves.
- Both communities recognized that CS is the future and felt it was important for Tribal communities to have access to CS opportunities, be leaders rather than just consumers of CS products, and build CS-based opportunities inside their respective communities for nation-building. Relatedly, both Tribal communities indicated the **need for CS pathways for youth** and that **youth need more opportunities to learn about what CS is** and **what CS-related careers look like**. However, educators as well as parents/caregivers and other community members often do not have the foundational knowledge to pass on to youth

who are interested in CS, so much more training and investment in CS education is needed for teachers and parents, as well as for youth.

- Both communities emphasized that **infrastructure and access to technology, tools, equipment is limited,** and that CS resources and education cannot be introduced to youth and the community *without* addressing infrastructure or other basic needs at the same time. Service provider programs are able to access infrastructure in schools, but more challenges exist in creating Internet access and infrastructure in home environments. Due to limited access, youth are less likely to be interested in or see themselves in CS pathways and careers. If they do have an interest, they do not often have consistent access to the tools that would allow them to expand their knowledge about CS or interact with CS in their own homes.

RQ3. What does access to CS education and pathways look like for Indigenous students and their communities?

- Youth in Indigenous communities are **behind in baseline subject matter such as math, reading, and science,** in part due to the COVID-19 pandemic. As a baseline, many youth and community members recognize and can reference the concepts of coding, AI, and robotics as examples of CS, but they do not have deeper knowledge of the CS field due to limited exposure. Furthermore, educators are often encouraged by school leadership to focus on basic academic requirements and subjects such as reading and math, and they do not have the support or opportunities to learn about or teach CS effectively. This can lead to educators feeling intimidated by CS subject matter and not including it in their classrooms.
- To address some of these gaps in access, more **courses in CS subject matter** are needed for youth, and educators desire more **PD and CS resources to better support youth.** An indication of this is the fact that some educators have sought out resources on their own and have tried teaching themselves about CS so they can incorporate this into their classrooms and pass this knowledge on to their students. It is important to consider how Tribal colleges and universities can play a role in servicing their communities in this area by providing opportunities for PD, training, and coursework in CS.
- For Native youth to fully leverage CS education and pathways, **more CS mentors and role models are needed** from within communities rather than from outsiders. Few CS experts currently exist within the Haak'u and Amskapi Piikani communities who can play these important roles for outh. One suggestion shared by participants was to reach out to local businesses that may be using CS technology (e.g., telecommunications companies) to organize job talks, field trips, or career fairs.

- Determining how **infrastructure needs will be met** and **where the financial resources will come** from is necessary. If the goal is for youth and community members to succeed in CS fields and build CS programs in Tribal communities, then finding solutions to solve these challenges should be prioritized. Those with financial resources need to provide these supports for Tribal communities. At the same time, communities and anyone they partner with will need to consider how to navigate **building infrastructure in ways that honor land sovereignty.**
- In Tribal communities, an optimal CS education would be **hands-on, immersive, place-based, relevant, tied to health and wellbeing, and connected to solving real-world issues** grounded in community needs and interests.

RQ4. What are the strengths (assets, resources, opportunities) Indigenous students and their communities bring to CS?

- The **core values of relationships and respect** for cultural knowledge, Indigenous languages, Elders, and one another are strengths that both Tribal communities uphold and would use to inform policy to build an Indigenized CS. That said, more Tribal and school leadership support (i.e., policy at the leadership level) for CS is still needed to grow and nurture these efforts.
- While many participants shared ideas about **possible strengths and opportunities for an Indigenized CS,** particularly about amplifying core values, relationships, and cultural and language revitalization efforts, some participants also shared **reservations about how or whether CS could be Indigenized.** Some concerns that were raised included whether language and culture should be learned through CS tools (versus learning from grandparents, other community Elders, and others), and the data sovereignty concerns noted in RQ1. Furthermore, the question came up about whether or not CS can be truly Indigenized given its extractive and colonialist foundations (i.e., its harmful impacts on the land and natural resources).

Next, we share more detailed findings and key emergent themes for the Haak'u and Amsapki Piikani communities. Themes are accompanied by quotes from the Talk Story dialogue participants to illustrate the themes in their own words; these quotes are taken from both the written reflections and verbal dialogues.

Haak'u Community

This section shares data results based on the Talk Story dialogues with youth (ages 12–17), community members, and educators who teach within the Haak'u community, which includes both Tribal and non-Tribal members. Key themes from these sessions are summarized and the

results are shared in the following four sections: (1) community understandings of CS; (2) youth perspectives on CS; (3) adult perspectives on CS; and (4) educator perspectives on CS.[135]

Overall, the data suggested that youth are interested in CS, particularly the idea of creating games, and that adults and educators in the community recognize that CS is a growing field and that it is important to build opportunities for youth in CS, particularly in ways that align with community needs and core values. Limited exposure, awareness, and internet access (infrastructure) were seen as limiting youth opportunity to spark interest in pursuing CS fields and careers, particularly with few role models in the community and limited understanding of what these fields are or what they look like in practice. Considerations were emphasized regarding data sovereignty, protecting cultural knowledge and identity, supporting nation building and self-determination, as well as the extractive nature of the computer industry and conflicts with core values of protecting and stewarding the land and environment.

Haak'u Community Understandings of CS

As an opening prompt to ignite each Talk Story dialogue, participants were invited to share their definitions, associations, and understandings of CS. Both youth and adult or community members tended to think about coding and programming, as well as the "products" that are created by CS, such as equipment, devices, tools, apps, and programs. These themes are shared in more detail below:

- **coding/programming,** including programming a computer, coding characters for game development, coding bots for a game, building and programming applications, hacking systems, and examining code; and
- **tools and equipment** such as building a computer, using a cellphone, or creating online accounts to access services (e.g., Google, YouTube).

> *"[H]ow I engage with it is there's this one game [where] you get to build stuff in it and like what the certain stuff needs to go to get the program these things to do. Like specific things, […] like programming […] a field to work in the game you have to use specific [things] like coding and stuff. And put specific coding to make the car run to make the car go. Like really stuff like that[']s] how I do it sometimes."*[136]

Adult participants (including educators) also included ideas concerning basic computer skills (e.g., typing and keyboarding); hardware and server maintenance; and navigating technology, applications, and platforms. This theme included examples such as WebX, Zoom to host live

[135] See Appendix C.
[136] Hesitation words and words that linguists refer to as "discourse markers," such as *like, um,* and *y'know,* have been removed from quotes when they inhibit understanding.

lessons and to record lessons, Microsoft Suite (Teams, PowerPoint, Excel, and Word), Virtual Whiteboard for lessons or the use of a document camera, Google Classroom, and Google Meet; using Chromebooks and graphing calculators for instructional use; online portals (e.g., ClassDojo for educators to communicate with parents or other caregivers, add their students' grades, upload assignments, and for students to take online assessments); and financial management tools (e.g., for payroll). Many adults shared examples of using computers in their everyday lives, such as in the classroom or at work.

> *"I would say COVID definitely brought a lot of computer usage into our classroom. We learned a lot 'cause we had to."*

> *"I work with […] a lot of the hardware to get our servers up and running to make sure that they stay running. And if a server goes down, I have to put in all the coding and stuff. So, I guess I never really thought of it as computer science till now."*

Haak'u Youth Perspectives on CS (Rose, Thorn, Bud, Roots)

Youth perspectives on CS are shared below based on the four key dialogue areas of Rose (interest), Thorn (challenges), Bud (new ideas), and Roots (connections to place).[137] The ages of the youth participants ranged between 12 and 17 years.

Rose (interest in CS). When youth participants were asked if they were interested in creating an app, video game, or website, the majority were **interested** in either creating a video game or creating a website. For the youth who were interested in creating a video game, they gave a brief description about what their game would look like, elements it would entail, or, more broadly, what game category it would fall under. Other youth participants provided a description of what information they wanted to include on their website.

> *"I've always wanted to get creative about programming a[n] app or game."*

> *"I'll probably make an art website. [...] And that would also include animation."*

> *"I could make a website about teaching [...]. I'm a cross-country runner so whatever information I know I would like [to] give a website like […] tips."*

Youth participants were also invited to share whether they would be interested in learning more about CS by attending a class, program (either during or after school), or possibly a summer coding camp. Their responses were varied initially due to their concerns regarding logistics, but most said they would be interested if the programs were held within the

[137] See Exhibit 4.

community. One youth participant did indicate they were *not interested* in learning more about CS, despite their interest in creating a website. There are more responses found in the Thorns section that discussed their concerns regarding learning more about CS. However, the youth participants who indicated an interest in creating a game were *very interested* in the possibility of attending a CS class, program, or camp to work on developing their game. A few of the youth participant responses are included below as quotes:

> *"If I want to create the game, yeah […] the things I would see online just about like coding or programming things, that seems really interesting and like I always wanted to do it myself. Just to learn something like that."*

> *"I will [be] signing-up […] after school."*

Thorn (Challenges and Barriers to Learning CS). In this section, youth were prompted to identify potential difficulties or challenges in learning CS. A key theme that emerged from their responses focused on the perceived **difficulty of the subject matter** itself or the processes involved. Youth expressed a belief that proficiency in areas such as mathematics or engineering might be necessary. In addition, they identified several processes as crucial for enhancing their CS understanding, including grasping an understanding of computing systems, mastering coding techniques, and learning specific programming languages, all of which were seen by youth as potentially challenging to learn. Consequently, a number of youth participants shared a **need for more foundational knowledge** in the field of CS. Another area that the youth shared were challenges related to **limited access to CS tools or resources,** such as access to personal computing technology, the costs of technology, or money needed to buy new technology.

> *"I really put that I wouldn't have much of a challenge because I already do like some of that coding and stuff like that […]. I just don't know enough about it."*

> *"I'm pretty good at numbers and stuff for like understanding stuff like that [...]. I'm not sure though. Just learning how to do it more, then probably get the hang of it."*

> *"It's too difficult to understand. Like just too much numbers maybe, like really confusing things that really don't match together. That was it. That's how they see it."*

Bud (New Ideas to Create with CS for the Community*).* Youth were invited to reflect on what they would make for their community, families, or themselves if they knew more about building computer hardware and software. The first key theme that was shared was the idea of **exploring what AI** could offer. Youth participants were interested in exploring ways to improve Tribal infrastructure such as using AI to aid police with ensuring security of homes and businesses, or improving maps, and exploring ways to find better connectivity to Wi-Fi. Another

idea was to explore how AI could help inform the community about local events, news, and the weather. Other responses included using AI as an educational tool to support learning for classes or for learning culture and language. Youth also shared that they were interested in learning more about CS, including **tools, programming, resources, and technology.** Youth also shared that they would be interested in topics such as hacking, building a robot or a drone, or coding competitions. They shared interests in building their coding and programming skills to create applications and websites in the areas of **health and wellness, task management, events and entertainment, and communications.**

> *"Oh, like to help kids get more advanced so they can be better off when they leave this school. [...] So kids won't be caught so off guard in high school. This [school] goes to eighth grade and they don't know how we'll do in high school next year."*

> *"I was gonna say like to help remind the kids of their chores, the parents of their duties. Like the schedules. Basically, their way of roles in the house."*

Roots (Benefits of CS for Tribal Communities). When youth were asked how CS can help Tribal communities, one of the key themes that emerged was about **supporting intergenerational learning.** Youth acknowledged that technology has changed rapidly and suggested the need for providing learning opportunities for community members of all ages, particularly older adults and Elders, to learn how to use technology. Another key theme that emerged in this area was about **amplifying their language and culture.** For example, youth shared that younger generations are interested in understanding more about their culture and are curious to learn how to write and speak their language, and they suggested that CS could be used to support these areas. While they understood that AI might not know the Haak'u Keresan language, the youth participants hoped the AI could be taught this so that it could help younger generations learn their language. Other applications that youth thought would be useful for the community were a website or app that could be used to **strengthen financial literacy.**

> *"The human species is kind of evolving, so like I understand where they're coming from but […] they [Elders] didn't have much technology back then so like get them used to technology, like make things easier for people […], the struggle that they've been through to get their information to get to know these things. Like with technology, it's really easy to get to know these things. So, I figure that they think that we're not gonna have that same trouble or not be as disciplined is really what I'm trying, […] to get to."*

"I'd make a translator app for the language. For like our community. Like for the Acoma[138] language."

"Teaching the language. Know like dances and stuff. Songs and stuff, yeah."

Haak'u Adult Perspectives on CS

This section shares results that engaged community members from the Haak'u community based in the four key dialogue areas of Rose (Strengths and Assets), Thorn (Challenges), Bud (New Ideas), and Roots (Connections to Place).[139] The sessions included parents/caregivers of middle and high school students (youth), other family members, and Tribal leadership. Themes are shared in aggregate, followed by quotes to illustrate the key themes in each dialogue area.

Rose (Strengths and Assets). This area of the dialogue centered on existing CS resources, programs, and career opportunities for Native youth, particularly those that may also support community needs and values. Strengths that adult participants identified included **youths' strong interest in CS** and that the youth have **access to technology and equipment at the school,** including individually issued iPads, a CS course, instructor, and curriculum, afterschool opportunities, and high-end equipment such as 3D printers and PC gaming systems. Outside of school, CS programming is accessible to the public in the library with rotating programming. However, adult participants felt that there were no clear indications of current opportunities for CS-related careers in the community and that strengths and assets concerning CS in the community are still limited.

"We've really increased our student population because we've added electives into the curriculum, computer science being one. Our kids have really taken interest in that […]. They're ready to build those robots and they're like, yeah, we want to test these cars […]. I think right now bringing computer science is reeling our kids back into education. They're excited to go back to school. So yeah, it's good."

Thorn (Challenges and Barriers for Youth in CS). One of the key themes that emerged concerning barriers to CS fields for youth was the **limited opportunities or exposure** that youth have to CS in the community. Adult participants shared that there are few to no opportunities for youth to be exposed to CS fields unless their parents or families engage their youth in off-reservation experiences. They also expressed that there are challenges relating to getting **parent and family involvement** in school and extracurricular activities in general. Others highlighted the **learning and academic challenges** that the youth have, particularly in relation

[138] Throughout the report, the research team employs the community designated name, *Haak'u* (Acoma), except in direct quotes.
[139] See Exhibit 4.

to lasting impacts from the COVID-19 pandemic on learning, which limit their opportunity to study fields such as CS because they are still working on catching up on reading and math skills. Another challenge shared concerned families having **limited access to computer technology or equipment** due to financial constraints and **poor internet connectivity.** It is also important to note that the impacts on the above areas are seeded by the Tribal community being located in a rural area, where the nearest towns are more than 30 miles away (and farther if they live outside the main community housing areas).

> *"So, one of them like when it comes to opportunities for Native youth, I don't think there's really any opportunities for them here. I mean unless they're going to some classes that are outside of the reservation or even outside of the community. I think that's their only way of actually learning [...] about computer science or anything basically. I know that they have their phones […], but they don't use it to research anything or to actually understand a lot of stuff. They use it for YouTube. So, I don't [think] there's a lot of opportunities out here for them to learn a lot about [computer science]."*

> *"I think if you were to get more of the kids involved in it would probably– they get excited to be involved. And the only reason why is COVID took a lot of that from them. They weren't able to engage with things. They weren't able to have a conversation with this. So being hands on and engaging with other people is probably one of their biggest things now [...]."*

Adult participants were also invited to share whether there were any generational barriers that may hinder CS interest, exposure, or learning. A key theme that emerged concerned the **generational differences in perspectives on technology.** Community members highlighted a difference in technology that has changed from their grandparents' to their parents' generation, and the technological change from parents to youth was even more rapid, which they felt was leading to a **clash of worldviews relating to the use of computer technology.** Community members shared that the youth are open and adaptive to learning new technologies, whereas older generations are not as open or quick to learn these new technologies.

> *"I believe some of it also is community based. Like the older generation, those ones that don't understand what computer science is so that's why they feel like, 'Oh, you don't really need that.' […] So, it's a back-and-forth battle that we're trying to bring in 'cause I could see a lot of our kids living with grandmas and grandpas that don't understand what computer science–what are the opportunities, you know? They don't understand the concept of computer science 'cause you could see like they're over there showing 'em*

a tablet or whatever device they have and they're like, 'oh yeah, I don't know what I'm looking at but okay, cool.' You know? Just that little miscommunication of what it actually is."

"The difference between the old generation and new generation is the change. When we had the technology back then, we only had access to so much around the world while the new [generations] are provided with a lot of access that [we] still don't know how to use."

Another key theme that emerged in this area of generational differences was a concern relating to **balancing technology with living traditionally** or culturally. For reference, the Sky City at Haak'u (Acoma Pueblo) is one of the oldest continuously inhabited communities in the United States. There is always a challenge of balancing the use of technology and living traditionally or culturally when it comes to life on "the rock" at Sky City. Although the youth shared their interest in using technology to learn about their culture, there isn't agreement in the community concerning appropriate processes or protocols for the **transfer of cultural knowledge,** particularly as it relates to introducing computer technology into the community environment. Community members also noted **concerns relating to Tribal data sovereignty** and shared that even if youth are interested in pursuing CS fields, there are still cultural protocols that need to be considered and protected.

"I think it's even in our own tradition, it happens. Because, like you said, the grandmas would teach you, the grandpas would teach you. 'Come to us, we'll teach you.' Now […] it's more or less like they're scoping you out to see if you're gonna make any mistakes. Whether they're trying to learn it or trying to like, maybe my grandma [...] was afraid 'cause she grew up at the time that the Franciscans were teaching them [...]. They couldn't speak their language. Stuff like that. So, she would say, 'Oh there's time, there's time.' Well, she's gone now. There's no more time."

"I think the main part of it is getting the data stolen from different companies that are just exploiting Native communities for that data. That's like the main part where that's holding it back too."

Bud (New Ideas for Supporting Youth Pathways in CS). Adult participants were invited to share ideas on how to better support youth pathways (e.g., access, resources at home/school, careers) in CS and how to develop more Native mentors in CS. There was a high interest in CS learning opportunities, including **hands-on, immersive training** for students and staff, **exposure to CS career fields** at job sites, opportunities for **interaction with CS professionals,** and expanding access to technology and equipment to include more community members. The community's desire for training opportunities and exposure to CS professionals highlights the

need for **more Native CS mentors and professionals,** particularly those who are from the community (reflecting the concern of data sovereignty and the transfer of traditional knowledge), to transfer knowledge and spark interest in youth.

> *"I think there needs to be more opportunities when it comes to experiential learning. Opportunities maybe getting our youth engaged. [...] I guess inviting them to these different corporations. Intel, you know, they have their tours in their facilities. Engaging the labs. We have the aerospace down south. But just showing them that there's other ways, you know? The different career choices, and it's not just being an engineer or this or that. Doctors use it. Nurses. Our janitors. You know, there's a lot when it comes to computer science. You just have to find what your [niche] is."*

> *"And I think it's great, and we just need you all to understand that as Native people the way we learn is by our hands, seeing, touching, feeling. And if there's some way of incorporating that into computer science curriculum [...], and it's great with the STEM event that's going on. Our kids are able to see, touch, but to actually have them build. Cause it's really exciting to see our students being hands-on and rebuilding a computer. That's how our people learn. To actually see what they're doing. And the ones that are, especially for our kids, to be really engaged and say, 'Yay, I built this. I accomplished what needed to be done,' you know?"*

When invited to share what supports might be needed to improve CS access and interest, adult participants highlighted **infrastructure needs to support reliable Internet connectivity.** Community members shared that the infrastructure to support the Internet is in need of community-wide improvement. However, there are still **concerns about impacts to the land, environment, and cultural sites** that might result from efforts to improve the Internet infrastructure. Community members shared that there are only two areas, the library and the school, that have access to the Internet via a fiber-optic line, whereas the Tribal Council administration relies on Starlink, and the rest of the community does not have access to these options. Community members highlighted the need for **equitable access to the Internet** because some community areas do have access to alternative internet services, whereas other areas are unable to access these Internet services due to their off-grid locations.

> *"What would that look like in the future and would it be acceptable by the community as well, you know? Especially when the land is so important to us that having to pull wires through our land and disturbing what could be underneath because this is all sacred ground. So, I know we have to go through a lot of the departments, you know? We have to go through [the Tribal] historical preservation [office] to ensure there's no [cultural] sites disturbed. So, we have to go through the process before and so who knows? It may*

be a ten year research for them until we're given approval. So, then it delays them that long. So, it's hard […]."

"We do have internet. Accessibility. Some homes may have it through their satellite or whatnot. But you know, in order for all our youth to be all on the same page and engaged, I think it needs to be equitable across the board. So how do we improve access for our youth within the community? You know, there's places that you get connection. There's other places that you don't. And so, what would that look like in the future and would it be acceptable by the community as well?"

Another support needed concerned **having more CS practitioners or role models** within the community who could share their knowledge and experiences of CS careers with the youth. Community members shared the idea of having guest speakers who could talk about their experiences in CS, which they felt would spark youths' interest in CS fields and careers and help build their knowledge and skills in CS. Participants also shared a need for **more funding and financial resources** to support educational opportunities in CS, infrastructure improvements, and engaging CS practitioners as speakers or mentors. There are challenges to figuring out who would be responsible for finding the funding, where this would come from, and who would carry out grant activities.

"I think challenges is access to equipment that will get you engaged in computer science. And infrastructure especially if you need [the] internet, you know? For our youth to be exposed here. So, I think those would be the biggest challenges for our youth."

Roots (Connections to Place, Benefits of CS, Indigenizing CS, and Core Values). When adult participants were invited to share how CS might benefit their community, one of the key themes shared concerned how important it was to **include youth voices** in discussions relating to how to best incorporate their interests and experiences in CS education. They also shared the importance of building more Tribal leadership support for CS. Another key theme was **nation-building,** in which CS fields could help Tribal communities by **providing new career opportunities** and supporting new skill development that could help meet community needs, center community core values, and build career pathways for youth to serve their own community. One specific idea that was shared was **developing CS internship programs** that could be linked to already existing workforce development programs in the community.

"Something that I heard [was] really interesting cause I sat in on the youth in there. So, coding. So, they were talking about coding. So how can we incorporate coding? So, what they talked about was commands. So, if they can teach and create maybe Native children to command it. To speak the language […]. And if we can engage our youth and they can come back and say, I helped create that program, you know? Including them in

what we want to do for our community, we need to hear from our youth. We need for them to be a part of what's going to help them grow in the future […]. To become adaptable to the world because we're not gonna be here forever."

"I think one that we started to bring in and start to understand what are our youth interests is an internship program […]. Not just with the state but with the workforce development. And so, implementing these programs helps us understand what it is that our youth need to move forward. And if computer science is something that is highly needed then that's probably what we need to start focusing on."

Adult participants were also invited to reflect on whether and how CS could be Indigenized. Although they shared some ideas on how CS could be Indigenized, they recognized some concerns relating to whether it should be Indigenized, particularly due to the notion of data sovereignty. One key theme that was highlighted concerned the importance of **connecting to place,** which was tied mostly to igniting **language and cultural learning,** as well as ensuring that learning styles focusing on immersive, hands-on, and holistic approaches are centered in CS education for Native youth.

"[It] can be Indigenized to help solve Indigenous problems. Where I've seen it's already been done in the community but a lot of community members aren't ready to move forward in that direction yet. Like writing the language or creating a website for the kids to learn is what's been made already. But it's kind of been put on the back burner because they don't want kids learning that way yet. But still that's a way that I've seen as being used for Indigenous problems. But we're kind of stuck in that area too. Like they want them to learn but then they only want [them] to learn a certain way. But either way if they're not going to learn the old way then it's just going to be lost. So, I think that's […] kind of a struggle in the community right now."

"I put that [what] I think is important is that it can really help us learn kind of about our past, you know? Learn about how we survived as people, […] so that can help us maybe. Some students can learn about architecture and how to design modern homes with ancient building techniques. Chemistry like we have a lot of traditional medicines that have probably been lost. It could kind of help restore that."

Adult community members were invited to share core values that they would like to see in CS education or programs. One of the core values that was shared most was about **being respectful** in using technology. This discussion tied into data sovereignty concerns and the importance of youth being able to amplify core values in CS and digital technology spaces. Core values relating to identity and family were also mentioned.

"I can only think is just like respect. To just use it respectfully. To not get too out of hand 'cause there's a lot of stuff you can do. 'Cause that's going into one of the things I was gonna show a student too is using AI. But with that I don't know what's going to happen if I would have shown them how to use that. There's a lot of crazy stuff that can be generated with AI nowadays. That's like the new big thing with computer science. 'Cause just from that […] training that me and someone else attended it's like really crazy what you can do with it. You can use somebody's voice to create a whole voiceover [...]. Just using their voice or their picture using audio."

"We're a community where we help one another, you know? Family is one of the biggest core values. [...] Helping sustain our family system. Tying it to our tradition and culture. You know, you're talking about a 'rose,' how can you incorporate computer science to a rose? Meaning, tying it how can you build your farm for farmers? How can you put that in? You have a soil where you can't plant or you're having the hardest time now, how can you use that computer science to turn that soil around and create your flower bed? Just things like that. Helping you build homes that are environmentally safe, you know? Things like that. Things that we are tied to our lands, our mountain. I mean you see it all here and our language addresses who we are, and how do we tie this into computer science? With it not taking away our identity as Native Americans."

Haak'u Educator Perspectives on CS

Educators and school staff perspectives on CS are shared below, based on the four key dialogue areas of Rose (Strengths and Assets), Thorn (Challenges), Bud (New Ideas), and Roots (Connections to Place).[140,141]

Rose (Strengths and Assets). Educators were asked about current CS resources that exist in the community (strengths and assets) and what CS career-related opportunities are like for Native youth that also support community needs and values. One key theme in this area concerned **in-school programming** that is offered at HCA, including all grades having technology and computer classes. Educators also noted some **extracurricular opportunities** to learn about computers and CS, such as at the Boys and Girls club, gaming classes held at the Acoma Library, and a Keres language dictionary app available to community members. Another key theme relating to strengths and assets was that the school provides **access to technology and equipment** for all the students, including Chromebooks and 3D printers.

[140] See Exhibit 4.
[141] *Note.* Educators taught grades PreK–8.

"Every student at HCA are issued their own personal Chromebook and all grades have computer classes. So, from K all the way to eighth [...] all students [...] will get Chromebooks and they get a chance to work on them. iPads or whatever."

"So, the technology class and then like an example, my own kids in technology class, they're coding little robots. So, they're trying to figure out how to make robots move its arm. They really like it. How to do computer stuff and library and life skills."

"Yeah, ours was kinda the same talking about the technology program here, how that's starting. And then just the student laptops. They get used in every classroom, through that they're learning, you know? Just the basic. Even like from Google Docs to Word docs and things like that which is a life skill at this point."

"About the community one I know that there's a Keres dictionary. There's like an app or something out there for people to get on. I don't know if it's still available?"

Educators did not share many specific opportunities to support Native youth in CS careers in the community. One educator did reflect on ways that they model representation of Native Americans in STEM through their teaching, as the quote below reflects:

"Well, one thing I do, it's not really computer related, but we talk about Native heroes in different fields. One of them being in the science field. Like for example we've talked about [John Herrington], who's the first Native American in space. We talk about his work as an engineer first and then being an astronaut [...]. So, then it kind of fits into computer science and being able to see, recognize the people that look like them in the field."

Thorn (Challenges and Barriers Relating to Teaching and Learning CS). In this section, there are two areas to consider in which there are challenges for youth to learn more about CS and the barriers that exist within school and at home with family. The areas listed here are focused on the youth-based barriers at home, which can be due to factors such as a family's **limited financial resources**. One of the key themes was the limited access that many youth have to technology or equipment, which included examples such as internet, bandwidth, computers, and tablets. Educators also shared that the tech or equipment needed to engage in CS are not always available to the youth in the community, in school, or at home, often due to limitations in financial resources. Educators noted that the school does provide access to Chromebooks for youth but that **internet availability varies for each household,** which ties into financial accessibility.

"Student availability to access outside of school. Again, a lot of our students don't have internet at home, don't have computers at home. So, their access to the technology is limited to when they're here at school. Just internet issues."

"Not all students at home have laptops and stuff we have. And certain areas you can't hookup on the internet. Yeah, so I think those are one of the challenges. Just for like COVID it was bad."

Even having increased the accessibility of tech equipment for youth, educators raised concerns about the **misuse of technology,** including equipment not having the appropriate software to monitor site activity and prevent youth from visiting inappropriate websites.

"They get onto things that they're not supposed to. It'd be nice if we had like GoGuardian so we'd be able to see because they're real quick. A lot quicker than us. We walk around and then they can minimize, and we're still thinking they're on their correct screen and stuff like that. But yes, we were saying it'd be a better way to monitor what they're on."

Another challenge that educators shared was about the uncertainty of youth from the community **meeting the academic expectations required for CS.** Educators feel the need to teach to the school's required learning standards in order for youth to develop basic academic skills such as math and reading. Educators also recognize that some youth experience **learning challenges** that may impact requirements for this type of instruction. Educators want to find ways to build confidence in the youth through these learning challenges; however, youth often indicate that the lessons feel boring or that they have trouble paying attention in class.

"And then I also added, especially for like the younger ones, the attention span. So sometimes it takes too long or they think of it as, 'Oh, it's too boring.'"

One other key theme relating to challenges in teaching CS in the community or school was concerning the school's infrastructure. One of the limitations is **access to tech/equipment for youth** in the community. Although the school has a technology program that has been able to purchase equipment, such as gaming computers and 3D printers, it is challenging to find a **dedicated space for the technology classes**. Another challenge related to the school's infrastructure was the **internet not being available to all locations** within the school due to the physical structure of the building.

"Our tech room is basically under construction so that limits some of what they can do."

"And then [in] my program we've been able to purchase the gaming rigs, the gaming laptop, well not laptops but computers. We have six but until our technology classroom

is totally fixed, we can't without the roof leaking on like $2,000 dollar computers we're not putting those down for anything. And then we also have 3D printers. We actually have four 3D printers that they have, that once again, until that room's fixed, we're not using 'em. So, 'cause it's the only one that can probably handle the capacity needed."

Educators also indicated programming needs such as **PD and CS resources for educators.** One of the key themes for these conversations with educators was their need for PD relating to CS curriculum and lessons. Educators also highlighted a **need for Native CS experts from the community to serve as role models** in the eyes of the youth.

"Then I guess one that I've come to realize now too is [that there is] no expertise in the community or in the school setting. A lot of us take on multiple roles or have to take on multiple things and no one's like a clear expert on a lot of things. Everyone becomes a Jack of all trades at some point. Which is nice and it's good but when you don't have an expertise and then you kind of miss out on in-depth in the capacity building that someone [who] is an expert in that field could build the capacity of the others around them in that. And then I think, and it's true for Native Americans across the board, a lack of figure heads that kids can aspire to look at. We have athletes. We have actors and things like that. And scientists but we don't hear [about] them that often."

In addition, there was a key theme related to **workloads, timelines, and capacity constraints** when it comes to PD. Although educators echoed a need for PD, they also recommended that these types of opportunities be provided locally because that would also reduce costs associated with travel.

"I wish when I was younger, I would have paid more attention to computer science. I get by on a computer. I can do what I need to do, but I'm not a tech person. When I got one of my first teaching jobs they were like, I don't know if it was 'cause I looked young or whatever but they said […], 'You'll teach the computer class.' I looked at them like I don't even know how to turn it on. Like it was so bad."

"It would help if it's more locally too. Like in Albuquerque to where it's not putting a big expense on the school so they won't deny us that training."

Educators identified several key needs for Native youth related to CS: **increased exposure** to the field, opportunities for youth to grasp basic CS concepts, and accessible at-home learning resources. They also shared a desire for community-based CS learning opportunities. The consistent theme of limited opportunities and exposure is illustrated in the following quote:

> *"Sometimes those entities, they don't ever get back [...]. I stopped bugging Intel, sending email to their community outreach like a year ago. Maybe a new person [is there] now since they're always hiring, rehiring or laying off. [...] I don't know. Things like that. But I think we do need to. That's like the biggest way. Especially being so remote, you know? And it's [a] big thing to plan a field trip to take [students] to town and come back."*

A key theme aligned to a clash of worldviews concerned how **CS and capitalism are rooted in extractive colonialism.** This raised crucial questions among educators, such as how CS and Indigeneity can be reconciled and whether such a reconciliation is truly possible. Educators noted a shift in cultural values in which a monetary system is valued more than the notion of reciprocity to the community.

> *"Also, a lack of interest of using technology. Even the community, a lot of people if we offer a computer class, they might not be interested in it because they're still thinking of the old ways."*

> *"I think one thing that's important that a lot of people really don't look at is computer science and STEM were all taught as a community-based type of activity […]. Planting the garden. Building a home […], baking, cooking […]. But now nobody wants to do it because they want the money. […] Like there's no longer that sense of passing on knowledge."*

Bud (New Ideas to Create with CS for Their Community). Educators had several ideas when asked how to better support youth pathways in CS and how to develop more Native educators/mentors who can support youth interested in CS. The need for **more opportunities to learn** was brought up frequently, including access to **PD, learning from professionals in the field,** and the desire to **apply the knowledge within their community.** Being that the Haak'u community is a rural Tribe, educators also brought up the need for incentives such as stipends and scholarships to expand opportunity for both educators and students to experience and explore CS education and careers. These ideas are intended to develop mentors within the community and provide a model for Native youth to look up to, being that CS professionals are still scarce within Native communities. Other ideas for supporting CS pathways were about the need for infrastructure to provide internet access within the community first. The idea of internet hubs and mini libraries planted throughout the community was brought up by educators so that families without internet can still access technology and learning tools when not at school. Knowing that not all families have a computer or internet at home, educators mentioned how they currently use cell phone apps so that students without internet or a computer at home can access a learning tool via their cell phone. Below are quotes from educators to illustrate the themes mentioned for buds.

"I think a cool thing we could do as a school is like you know how they would have career fairs? Invite people to show how they're using technology in their working field. And then they can explain that to kids so if they want to pursue a career like that, they can say, 'I want to go this direction in computer science, and maybe I'll get a job in that area.' Then maybe get people that are in the areas that use technology we're seeing like the natural resource. Maybe there's other ways that other departments use technology and they could explain that to the kids."

"[W]e did offer stipends to help educators pay for their course, classes. Offer classes at the local library. We just heard that there's some really nice computers over here at our library that we could use. And maybe hold a professional development day to do something like to where we can help."

"I think a lot of Tribes also, or most Tribes, should have someone, a Tribal member, that has that expertise to come back and somebody has to track them down to bring them back to, 'This is how I did it,' or tell our kids or their kids at each school. 'This is how I went about [it],' and starting to be maybe successful at it."

"Another thing that we're thinking is they're bringing to school guests that support computer science that are mostly– like students could relate to. Like, 'Oh, here she's like me. I can build. One day I could go to that.' Build that career pathway."

Roots (Connections to Place, Benefits of CS, Indigenizing CS, and Core Values). When invited to share how CS could help Tribal communities, educators shared two key themes. First, they talked about gaining **more access to resources and programming** so that youth can explore more career opportunities.

"Computer science can help Tribal communities by engaging the technology […]. Helping and educating the people about computer science, value the culture, stay updated and continue learning."

Another key theme concerned **CS career and pathways and opportunities**, which were often noted by educators as growing opportunities because they are "the way of the future." Educators felt that CS could be supportive in helping their youth explore more career opportunities in a growing field. A career fair was shared as a specific example of how to support youth in connecting to CS careers.

"I think computer science can help our Tribal communities by, I guess, stay up-to-date with everything else that's going on in the world. So, we don't get left behind with just like the old school stuff, like people that aren't using tech at all like we're doing now. We

can progress and help our community, like I said, with careers that offer jobs in tech. I guess whether that'd be an IT person or someone working in natural resources."

"Someone mentioned a career fair. Maybe if you have something like that then the students will be interested in a career in computer science. And what are they? I'm not even sure just what those careers would be like? Where would they work? Would they work at a research center or are they gonna be able to use that in our community?"

Most educators were open to the idea of Indigenizing CS. However, there were a few educators who were concerned about whether CS could truly be Indigenized due to its extractive practices and being embedded in colonialism.

"Acoma Village is a core of the community with [no] power, internet and [is] traditional. So, [the] local community has to decide what it wants, to what level, and how it supports Tribal goals."

Educators also shared a priority for CS to honor and value their Indigenous ways of knowing by **preserving the culture and language.** This theme included ideas of using an app or programming to learn language and culture and to record history.

"The one thing that we haven't had done as a Tribe; [our] council or administration has [n]ever approved or written a standardized written version of Acoma Keres. That's what we don't have. And then if that's done then I'm pretty sure that programming to make workbooks, to make lesson plans out of that follows. But we don't. We have plenty of people in the community that can teach language and whether it's phonetics or their own form of writing in a different way or however this was established before. I think those are kind of our roots and our core value would be I guess the ethics of who we are as a people. But that's kind of hard to also pin down as one thing too."

Educators were invited to share core values that they felt needed to be embedded in CS education and programs in their community. Key ideas they shared were about **responsibility, nation-building, resilience, relevance, and equity.** Specifically, educators raised the importance of teaching youth responsibility when it comes to engaging with CS and computer technology, for example that the youth need to understand how AI can be used as a tool and to support learning while also understanding the notion of plagiarism relating to AI.

"[T]here's a lot of talk around the school [about AI], like don't write your papers using AI. How do we know that you wrote it? So, you have to show more integrity now."

"Not plagiarizing, taking someone else's work and saying it's yours."

The core value of **nation-building** was also mentioned frequently when considering how to use CS for the community, which included examples such as using CS to modernize Tribal operations and grow opportunities to use CS and career pathways for community members. Other core values that educators shared included improving access to CS for community members and making sure that the programming is relevant (i.e., digital storytelling, language apps, historical records) and promotes cultural resilience.

> *"Computer science can help our youth pursue careers in the computer science fields. It'll open up more options for them when they want to find a career. We need to move forward with the whole world."*

> *"Teaches our past in how we survived. Buildings, chemistry, arts, cosmology, music, herbology, farming."*

> *"Help learn to be proud of their heritage – with more information about what's going on in the community."*

Amskapi Piikani Tribal Community

This section shares data results based on the Talk Story dialogues with youth, community members, and educators and school staff who teach or support education in the Amskapi Piikani community. Key themes from these sessions are summarized and supported by quotes shared by the participants as a way to reflect their thoughts in their own words. The results are organized into four sections: (1) community understandings of CS; (2) youth perspectives on CS; (3) adult perspectives on CS; and (4) educator perspectives on CS.[142]

Overall, data suggested that there is interest and excitement about CS education and career pathways among youth, educators, and community members in the Amskapi Piikani community. Youth were interested in learning to code and develop apps and games, and they shared many ideas for how CS could benefit their community—particularly regarding learning and sustaining Amskapi Piikani language and cultural practices. Multiple strengths and assets to support CS in the community were shared, including the Blackfeet Community College (BFCC) courses and programs, businesses in the community that engage with CS and technology, access to computers within the schools and libraries, and some extracurricular programs such as a girls' coding club. Data also suggested some challenges and barriers to fully supporting CS education, access, and interest. These included fears about the difficulty of CS, inequities regarding access to the internet (infrastructure needs), limited financial resources for families to purchase computers, few CS role models and mentors from the community, limited Tribal

[142] See Appendix C.

and school leadership support for CS, and concerns about the link between CS and extractive and colonizing mindsets. Data suggested that the community sees many ways for CS to support community needs and interests and align with core values and worldviews while also being mindful of data sovereignty and ensuring that CS education centers responsibility, relationship, and respect.

Amskapi Piikani Community Understandings of CS

Each dialogue session started off with an opening prompt where participants were invited to share their associations, definitions, and understandings of CS. Data responses are shared below for youth and all adults, including educators.

The youth mentioned CS-related fields, including AI, math, science, and chemistry. They also brought up tools and equipment that are the results of CS, such as rockets and computers. One youth participant said that "laboratories" came to mind.

For the Community Member and Educator sessions, participants indicated that applications or platforms came to mind, as well as systems that may have CS incorporated into them (e.g., hardware or infrastructure). Participants also mentioned coding and programming. These themes are shared in more detail below.

- **Using applications and platforms and/or navigating technology,** such as Excel, Google Classroom, Google Sheets, PowerPoint; the internet, iPads, and smartphones; online portals (e.g., for parents to check on their children's grades); educational platforms; blog sites and TikTok; video editing; data management tools (e.g., for financial recordkeeping, financial reporting, health care records and charts); learning new computer systems and programs (e.g., as a health care worker)
- **Hardware,** for example computers that are built into cars
- **Infrastructure systems** such as telecommunications or power for buildings
- **Coding and programming** concepts, such as binary coding ("zeros" and "ones"), coding and programming robots and apps, the programming that goes into making smartphones, and "coding" in general

> *"I guess setting up schedules, you know? Like using Google Sheets or whatever."*
>
> *"I make blogs. And I post them on TikTok. And I have to edit it all on my phone. And sometimes it's really hard because the software that they use, I'm constantly learning how to cut, add sounds, add effects. And I use the free version as well. So, there's a lot of things that I don't have access to. But it's really cool what you could make. They're just*

really long clips that I take throughout my whole day and I condense them into like 10 minutes. And people really like 'em so I'm glad."

"What about the computer science just behind phones? Every single time the kids want to buy a phone I would say a model like we had iPhones. We had the Samsung Galaxy. Even those. And now I have a Google Pixel which I know nothing about. I have my mom's old phone. Well anyway, each tomorrow and each time you get a new phone it all ties to programming. You have to learn things over every time you get one. So, like the computer science behind them [...]. The way they're made, they're basically the same thing like you press the button and dial a phone, you know?"

"I went to a camp when I was a kid and they would program a robot to follow a black line."

Amskapi Piikani Youth Perspectives on CS

Youth perspectives on CS are shared below based on the four Talk Story dialogue areas—Rose (interest), Thorn (challenges), Bud (new ideas), and Roots (connections to place).[143] The youth session included 13-year-olds. Other youth (14 and up) attended the community member sessions.

Rose (Interest in CS). When the youth participants were invited to share if they were **interested in creating** apps, video games, and so on, well over half of them indicated that they were. Of those youth who showed an interest, most were especially interested in creating new games (video games, game apps). A few ideas they shared were games for kids, a story-telling game, and a shooting game. Other youth mentioned their interest in building websites for creating art, sharing personal knowledge and tips on specific topics, and sharing written stories. One youth indicated they were interested in building a drone.

Several of the responses also reflected **uncertainty** about their interest in CS, primarily due to being concerned about the level of challenges (i.e., understanding coding languages) or the commitment of time needed to engage in this type of work, because they were more interested in other topics or fields, they "didn't like science," or they indicated feelings of general ambivalence (not having strong feelings either way). In one instance, the participant's interest was conditional, and they shared that they would be willing to help someone else build a website that centered on Blackfeet language and history, but they were otherwise uninterested.

[143] See Exhibit 4.

A few youth participants indicated that they were **uninterested in creating** or engaging with anything related to CS such as creating video games or apps while often not providing a specific reason. One participant just said, "No, I'm not a science guy."

> *"I'm not really interested in making my own apps besides [...] what I have done—a lot of stuff for websites such as translating Blackfoot sign language history. I've done many stuff like that, but me, myself, I really have no interest in making it my own. But if somebody would have like a website, and they need more Blackfeet speakers, especially ones with the youth and once you know the history, then I'll be down to help you, but no. Other than that, I have no interest in making my own."*

> *"No, 'cause I don't want to make my own video game or app, cause I want to be a[n] author [...], cause it is my dream."*

Youth participants were also invited to share if they had an **interest in participating** in CS classes, programs (e.g., after school), or camps to learn more about CS, with the majority of the youth indicating they would be interested. A few reasons they shared for their interest included wanting to try something new, because they weren't involved with other extracurricular programs, it sounded fun, they wanted to learn more about graphic design, and to learn more about computers. One participant expressed strong enthusiasm and said that they have been waiting for an opportunity to learn more about CS that would enhance what they have already learned about coding in a coding club.

A few youth participants indicated that they might be interested or expressed conditional interest, depending on, for example, whether the CS program conflicted with sports they were involved in. One youth participant indicated some ambivalence, stating, "I guess, I'd join," even though they are not very interested in the topic.

A couple of youth participants explicitly indicated they were uninterested in attending CS classes, programs, or camps because participating in sports was a higher priority or because they were more interested in other subject matter.

> *"I've been interested in making my own game these past couple of years, and I would totally be interested in a camp, afterschool program, etc. I've actually been looking for something like this, which is why I joined coding club. RPG [role-playing game], or others. I think websites are equally interesting and I'd totally be up for it."*

> *"Yeah, maybe 'cause it would be fun, but I don't really like science, but I guess I would join a camp."*

"I'm not really interested in computer science, so I don't see myself signing up for a camp."

Thorn (Challenges and Barriers to Learning CS). For this area, youth participants were invited to reflect on and share their thoughts about potential barriers or challenges that they have or might encounter when learning about CS. A key theme that emerged from the youth participants' responses was **subject matter and processes,** and feeling that they needed more knowledge in order to engage in CS. This theme encompasses coding, programming, and the language around CS (i.e., jargon) and the CS concepts. Some participants indicated that they found CS generally confusing, especially all the "numbers and letters" that are involved, or that learning about or doing CS seems like too much work. A few youth participants also indicated that the science involved seemed difficult. Several responses also indicated that **navigating technology** was a challenge. For example, one participant shared that they didn't use computers very often and, as a result, they didn't know how to work with computers very well. Others indicated that sometimes knowing which files to select or how to navigate the "controllers" was challenging. Based on personal experience, one youth participant indicated that robots were difficult to work with. Another theme reflected some of the **learning challenges** shared by the participants, such as feeling intimidated by CS, not knowing where to start, or feeling a sense of being overwhelmed if they had to learn on their own without guidance. Other themes included **physical challenges,** such as looking at the screen for too long, which impairs their vision or causes headaches; and **limited access to tools and resources** due to high costs or a lack of funds that are needed to participate in CS. A few youths shared that CS was not challenging.

"The only problem I had to do was coding and when I had no guidance and stuff like that. But other than that, it's confusing to have nothing, like no guidance or anything."

"[L]ike actual coding [...], that would be hard. [...] Too many numbers. [...] I feel very intimidated thinking of it just because I'm not experienced with it."

"Yeah, there are challenging and hard times. Like it's difficult to understand like some of the languages that they do and direction is a little challenging too."

"I don't use computers often so I can't work them well."

"It's not really hard. It's pretty easy to do computer science [...] and do things on the computers."

Bud (New Ideas to Create with CS for the Community). The youth participants were also invited to share what they could build or create for their community, families, or themselves if

they had the necessary knowledge and skills to build computer software or hardware. The majority of youth responses were about sustaining the Amskapi Piikani way of life, reflecting the theme of **language and culture.** Ideas included creating apps for youth to learn about their Amskapi Piikani culture and that can support sustainability of the language. One youth participant was interested in creating some type of technology tool or application that can be used for cataloging existing information about the Amskapi Piikani confederacy, mostly to preserve the Elders' stories and knowledge that has already been shared. The following youth participant quote shares this idea:

> *"[T]here's tons of apps of Blackfeet knowledge and Blackfeet language, all from different parts of our confederacy. But what we really don't have is a catalog of all of our Elders who helped work on said apps. If I had the ingenuity to make codes and stuff like that, I'd make a catalog of all of our Elders and their stories with their culture and knowledge […]."*

Another key theme was centered on **creating technology for entertainment,** such as virtual reality (VR) video games, combining existing themed video games to create a new game, a robot for family use, and a website that provides a portal for video games. Other ideas included being innovative in designing technology and equipment, such as designing the lightest VR headset or developing a phone that doesn't break or can't be lost.

Youth participants also shared ideas on designing applications to help **support tools for everyday tasks,** such as creating a robot to help support family chores and remind parents of their activities, duties, and obligations; and developing educational learning supports for helping youth with their academic learning, such as designing an app that would explain complex systems/language in simpler ways.

Two youth participants shared ideas in the area of **nation-building,** such as creating their own income stream through designing apps that would not only support the community but also provide them with job security, such as creating a tool to help print Native-designed cloth that they can outsource for income.

Roots (Benefits of CS for Tribal Communities). When youth were asked how CS might help their Tribal community, the key theme that emerged in this area centered on **strengthening internal systems/infrastructure for the Tribe**, such as the following:

- Housing development/programming (efficient housing through effective engineering)
- Health care systems, such as supporting solutions for health disparities and health education

- Tribal education systems, such as growing access to tools to enhance STEM knowledge and research opportunities in K–12 education and at Tribal colleges, and resources and educational pathways for providing youth in the community with opportunities to be innovative with their learning and create positive technologies to support the community that seed job security for Tribal members
- Communication for the Tribe, such as being innovative with how programs engage and provide outreach/news within the Tribal community, providing safe spaces for Elders to learn how to communicate with technology and to grow their understanding of the CS environments
- Homeland security—for example, creating apps and tools to prevent hardship regarding home break-ins and to help support safe travel
- Creating more workforce opportunities for Tribal community members that bring in CS technology programs that influence nation building, job security, and economic development for the community

The following quote from a youth participant speaks to a few of the areas above:

> *"Computer science can help Tribal communities in a lot of ways. Here at the college, it is used mostly for preserving our language and heritage and sense of community. Yeah, we need to preserve our history and culture but in a wider sort of way of looking, we need computer science for better health care, a better education. Preserving our language is an important aspect of having computer sciences but there's a lot more stuff that can be done, especially within our communities with computer science."*

Amskapi Piikani Adult Perspectives on CS

This section shares results across the two sessions that engaged adults/community members from the Amskapi Piikani community. These sessions included parents/caregivers of middle school and high school students (youth), other family members, community college staff, Tribal government staff, college students, and teenagers (14–18). Themes are shared in aggregate across the two sessions, followed by quotes to illustrate the key themes in each dialogue area.

Rose (Strengths and Assets). When invited to share existing programs or opportunities for youth to connect to CS in the community, adult participants were most likely to talk about **computer programs, platforms, or apps** that are commonly used both in and outside of the classroom. This included ways in which youth use social media (e.g., Facebook, TikTok, and YouTube), Google searches, online learning programs (e.g., Khan Academy), and school-based platforms (e.g., Google Classroom and Class Dojo for parents and caregivers). Another key theme in this area concerned the **computer technology and equipment** that are available to

youth, such as all youth in the community having iPads in school, as well as access to computers that they can use in the classroom and/or take out on loan. A few participants mentioned **in-school opportunities** related to CS education, such as a high school CS course and a middle school coding club. Participants also mentioned a couple of **out-of-school activities,** such as a game design program held at the Medicine Spring Library. A couple of participants shared that fiber optic and broadband efforts to **improve infrastructure** were a "rose" or strength of CS in the community, including efforts by Siyeh Communications to extend internet access into remote and rural areas. The following are a few quotes from participants to help illustrate these themes:

> *"Girls Coding Club [at] middle school is a great program, but we don't have a computer she can use daily to practice."*
>
> *"In the schools they all use Google for classroom work and homework. The Blackfeet Community College helps you seek computer science at universities."*
>
> *"In high school–there is a subject where you can go into computer science."*
>
> *"The Medicine Spring Library […], some folks come in from a game designing company for the youth. There's not much else."*
>
> *"In Cut Bank [school] you have to pass a full year of computer science class to graduate. So, they won't let you graduate unless you pass that class."*

For the Rose area, participants were also invited to share their thoughts about opportunities for Native youth to go into CS-related careers in ways that support community needs and values. A key theme in this area centered on **secondary/higher education opportunities,** primarily surrounding the BFCC, including CS courses and a program, opportunities to use computers on the campus, and guidance and mentoring for community college students on building pathways to CS programs at universities. Another theme in this area concerned **PD and training for CS-related careers** provided through local businesses and industry, such as Glacier Electric, Siyeh Communications, and Blackfeet Manpower. Participants emphasized the benefit of these types of programs because they build pathways for Amskapi Piikani youth and community members to find careers that allow them to stay home and serve their communities, which was shared as a core community value. Participants also shared the desire for Tribal leadership to advocate more for CS-related careers and opportunities within the community.

> *"Now on the second point there for opportunities for Native youth to go into computer science related careers and to support their community's needs, by the college here, the math and science department. We offer a lot of STEM based scholarships that promote*

things such as electrical engineering that promote going into computer-related fields, 3D design, architecture, whatever. It's just a vague STEM field approach but it's still there."

"And another one I brought up was Glacier Electric. They have that opportunity for a career based in computer science. And even here this college is an amazing spot where they'll teach you the skills you need to go into these careers. And the great thing about all three of these places is that you don't have to leave, you know? You don't need to go anywhere off the reservation. You could do it all from here. And you can choose to leave, you know? But we do need that here. We need people like that here to teach those people, kids, you know?"

Thorn (Challenges and Barriers for Youth in CS). In the area of possible challenges and barriers for youth in CS, a key theme was the **need for more equitable access to computer technology and internet services** for youth and families in the community. Participants shared that many youth lack access to computers and/or internet services (either due to infrastructure and/or financial limitations), which limits youths' ability to gain knowledge, experience, and interest in CS. Related to this theme, another key barrier shared was **limited opportunities** to be exposed to or learn about CS, as well as the need for mentors to spark their interest in pursuing CS education or careers. Another barrier mentioned was about **meeting academic standards** to pursue CS, such as meeting grade-level reading and math proficiency, as well as CS not being prioritized by some school leaders. For example, one participant mentioned that CS is an elective and that youth are not able to choose that elective if they haven't met other academic requirements. Other challenges mentioned were the need for more communication and awareness concerning CS as a field, CS being intimidating or seen as a field for "nerds," and the need for more Tribal leadership support and funding. One participant also noted that the **lack of access to CS knowledge** prevented the community from understanding how CS tools are created, thereby sustaining their role as consumers.

"I think that the first question is maybe we don't understand what each thing is. Like they're interested in programming. They don't understand exactly what programming means. So if someone could just tell 'em what it means, like what they do. And then the process of learning it, I think, like breaking down how they would learn about it and stuff […]. This is what you'd be doing and this is how you're gonna do it. More detail."

"We need funding for more computers like laptops. We all have iPads that they learn in schools, the iPads. But that's not always compatible with all the stuff that they need for different programs and things to work. I mean even understanding how a computer works and even how to build it."

"My daughter wanted to, she found a program […]. But in that coding class they were talking about this program where they're able to develop games. And she's like, I think I could do this. And I was like, yeah. And she's like, but I need a computer at home 'cause it takes hours."

"Like there's a lot of poverty with families here that don't have internet access and don't have computers. That they probably don't want to learn if they don't have the access to, or if they never think they will."

"We don't understand the channels, the pathways that it requires for something. I'll use food as an example. Kid might understand the potato comes out of the ground. They don't understand that a machine took it out of the ground, a truck transported it to a facility to be processed and then it became one of a thousand products. [...] So just be strictly consumption without understanding production is applying to this as well. All we know is to put our face to our screen. To put an ear bud in my ear to watch a screen for 16 hours a day. Put a controller in my hand or keyboard at my fingers. We don't understand the process that makes that a possibility."

Participants were also invited to share generational barriers that might hinder interest, exposure, or learning about CS. In response, participants described several generational barriers that may create barriers for youth pursuing CS education or career pathways. One key theme was that **parents and caregivers often have limited computer knowledge and skills** so are not able to support their children in learning at home or in out-of-school settings. Related to this, participants shared that the **older generations are often intimidated by or distrustful of computer technology and CS fields.** This includes the idea that computer technology can clash with community core values such as relationship and respect, and that it can negatively impact the holistic health and well-being of the community. Another barrier mentioned in this area was about how quickly technology changes, which makes it difficult for parents to keep up with what their children are doing or being exposed to on the internet or through apps and social media. The following are a few quotes from participants to help support these themes concerning generational differences:

"That's like almost a road block because you have to like, yes, computers and they're going to make life easier but you have to have the patience and the knowledge in order to get over that hump of learning all of those things in order to make it easier. And as like kids are growing up they're learning a little bit at a time […]. But when you're like 50 and you have all of this information sort of dumped on like now you've got to learn this and it's like a roadblock […], it's daunting. I don't even try anymore to learn my phone, I just give it to my kids and say, 'Put more minutes on there.'"

> *"On the last point we have the generation gap. I have one point I didn't get to cover here was complacency and accountability […]. We get complacent that because you can communicate with somebody clear across the world or across the room from you without putting in any effort, there's a level of complacency that starts to kick in that kills innovation. And I don't just mean innovation like, 'Hey, when is the next iPhone coming out.' I'm talking about innovation of mind. Innovation of thought of pushing genuine thought forward. And when you fall into a complacent rut, accountability is one of the first things to go because there is no direct interfacing because it's through a screen. You can't see me. You can't reach out and hit me."*

Bud (New Ideas for Supporting Youth Pathways in CS). The community participants shared new ideas about ways to support youth pathways in CS. Their thoughts reflected the key theme of **programming and resources** for youth as well as the community. For youth, participants suggested the following: afterschool programs, competitions, workshops, and a CS camp that is centered on health and well-being; remote learning opportunities about CS; creating a curriculum that is engaging and meaningful to youth; and scholarships and other funding resources to support the costs of internet and the purchase of materials for youth to engage in hands-on learning, for example how to build a computer. One participant emphasized the importance of providing programs to support mental health and suggested bridging learnings about CS and mental health. For the broader community, ideas included a community CS workshop to strengthen community knowledge and understanding of CS, and opportunities for Elders to learn about the potential ways that CS can be used to meet their personal needs (e.g., medication reminders).

Participants also shared a number of ways that CS could be used to build **tools for the community.** Some specific ideas they shared were: a calendar app just for the community that would help everyone keep track of events; using AI to document Elders speaking the Blackfleet language or to create VR experiences with Elders, as well as building Google Translate for the language of the Amskapi Piikani; and health and wellness apps to support mental and emotional well-being.

Other themes included new ideas for strengthening youth **exposure to career pathways,** such as inviting CS practitioners into the classroom to teach or hold talks, holding CS and STEM fairs at school, and setting up job-shadowing opportunities; building **hands-on and immersive learning experiences,** for example a summer course in which youth design a Native game or app that incorporates the Amskapi Piikani language; the need for the **core value of respect,** namely encouraging youth to have more face-to-face interactions as a way to strengthen their respect and understanding of one another, which some felt was the opposite of what

technology encourages; and the **need for technology and equipment,** especially better internet access.

> *"I think they need to do [...] youth fairs, you know? Like a computer science fair, STEM fair. Bring it to their school. Set up in a gym. Bring your fancy technology. Get 'em excited they wanna– When we first saw that computer we thought it was really cool. Like you need to show them what they can work with. And, you know, they're gonna get excited because they saw that 30,000 dollar drone in there just now [...]."*

> *"So, if we have a program that focused on mental health but also taught you computer science, I think that would be really helpful and would [...] create a bunch of buds."*

> *"And then talking about language preservation and culture. [Somebody] had mentioned that he thought that a good idea with our Elders that are actually speaking [the Blackfeet language] [...], preserving that. Making it kind of where you digitalize that person so they're forever there that you can interact with that Elder in a sense of like, we're incorporating AI or something like that. Or even using VR where you have that experience where they're there. I thought that was a really, really cool concept."*

At an invitation to share ideas for developing more Native CS mentors, a key theme included **building relationships** between high school 12th-graders and younger youth. For example, older youth from the community could help expose the younger ones to technology in a way that ties to culture; in this way, the older youth would also play a part in the transfer of knowledge. Adult participants emphasized the importance of building relationships that are healthy, safe, and authentic, and finding and sharing the success stories of those who struggled but were able to succeed despite the barriers.

Another key theme reflected ideas about **inviting CS practitioners** from other parts of the community or outside of the community to share their experiences and knowledge in the classroom so that the youth can see real-life examples. Suggestions included people from colleges, other schools, Siyeh Communications, and the Indian Health Service. One participant noted the importance of inviting people from CS fields into the classroom, especially for those youth who do not have access to a cell phone or other technology for their learning.

> *"[M]aybe suggesting to have our [...] graduating seniors where you have to have so many volunteer hours? But if they were to volunteer into the younger grades for whatever amount of time [...]. Like the technology stuff that's fun, you know? [...] To even [...] a small group of kids maybe like three or something. And if they were to come back once a week, they'd get all their [volunteer] hours, but they'd also be teaching kids at the same time. [...] And you could tie that to culture because then, I just did the high*

school planning workshop. [...] The students from that class that are passing their knowledge, they're gonna teach the next class, you know? That's how we work, that's how we've taught and that's [...] the way we're kind of procreating our culture like that."

"[F]ind people who had all of these barriers and broke through those. So, like these success stories so they could tell people like, 'Look I struggled with that same thing and this is what I did to get out of that,' you know? Not be a victim to it anymore. So, if you just provide that space and give those success stories a platform, they will inspire other people to do the same. It's almost like when you break through it you give other people permission to break through it as well."

"[H]ow can we get more Native mentors is maybe invite them into our classrooms. That way we can engage our students to be interested in it."

Roots (Connections to Place, Benefits of CS, Indigenizing CS, and Core Values). For this area, participants shared a number of thoughts about how CS could help Tribal communities. A key theme centered on **nation-building** and ways that CS could potentially strengthen people's skills or careers and, in turn, the needs of the community. Some ideas that participants shared were providing free community classes on basic CS concepts to support learning and personal growth. A couple of participants also emphasized the importance of members from the community to grow innovators of CS rather than only being consumers. **Improvements to infrastructure** was another key theme. Participants' reflections centered largely on the need for access to reliable internet for everyone, including Elders, indicating that a lack of stable access led to a disconnect and gap in knowledge, skills, and access to information between the Amskapi Piikani community and more urban areas. Participants also noted that improvements to infrastructure would support remote job opportunities and the digitization of paperwork. In the area of **health and wellness,** CS could support access to information for research, maintaining health records, and supporting physical and mental well-being (such as health reminders) through the use of health apps for the community.

"Classes on basics available to community members (free?) different times."

"So, I think we just really need to encourage [youth] that [...] instead of just consuming, like encourage creators."

"I was gonna say that same thing is access. Cause if you go from like a city and it's like you have to learn that. Like there's no choice, 'ifs,' 'ands,' or 'buts.' Like that's your job. And so, but there's people there to teach you. But then you come back to the rez and it's so slowed down. It's almost like you don't need a lot of those skills and then one day you do. And so, there's a disconnect [...], where it's just kind of like you don't know what you

don't know. [...]. And I think that here it's just a big gap between. And I think that the first foundation or the root should be infrastructure. [...] You can't even get internet for a straight hour that is not interrupted. So, like the very foundation of any computer science is probably, you know, internet."

"I believe CS can help by bringing our language back to our people. It could help. It could help all people catch up with what our world is becoming."

Participants were also invited to share their thoughts on how CS could be "Indigenized" and also whether it should be Indigenized. A number of participants shared thoughts about how an Indigenized CS could play a role in **language and cultural learning,** such as revitalizing the Amskapi Piikani language and culture, improving accessibility to "basic *Piikani* knowledge," building a website or AI that teaches how the Amskapi Piikani language works (its structure or grammar), building a Amskapi Piikani version of Google Translate, modernizing Amskapi Piikani dictionaries that already exist but have become technologically outdated, and creating apps for Native stories, recipes, and histories of place on Amskapi Piikani traditional territory. One individual also indicated the need to look to their Elders to develop an Indigenized CS.

"Have the culture like integrated. Cause I know both my kids, they go around the ranch with us all the time so they get to see when you hear the stories of like, 'Well, on this hill they used to always look for arrowheads. And I remember as a kid that there'd be tons of tourists around that hill looking forever. Go out here and you can see the teepee rings, the wagon trail wheels and stuff like that. It's like they get to hear it verbally and [...] that visual [...]. But it's like to see the computer part of it, you know? I think it would be pretty interesting."

"Maybe make a more modernized app? Whenever people make an app that relates to Blackfoot language it's very outdated. It's very slow. [...] There's a lot of our youth that are integrated with the Elders and the people, language. If they become more modernized in that way with the, like you said, Indigenized, I think it could help those who are trying to get into language but don't know where to start. [...] I wouldn't know where to start, sadly, and it's 'cause I live on the reservation. That's even sadder cause, well, I don't even know where to look. And I think that if there was an app that was integrating language, culture, stories and was regularly updated I think that would really help the Tribal community with assessing who we are as a people."

"Ask our Elders to develop culturally relevant computer science programs."

Participants also shared their thoughts on core values that they would like to see integrated into CS education and programs. These included the following: **centering relationships** by

bringing families together and connecting children with community Elders; creating a curriculum with cultural relevance in mind and integrating cultural protocols into the youths' learning; **building spirituality** into learning programs and practices; **addressing equity, inclusion, and access** in the classroom for all types of learners (visual, hands-on, others); and the need for upholding the **core value of respect**—for Elders, cultural knowledge, and the language.

> *"I think one of our values are to not only share but to be in relationship with each other and to be in relationship with the things that we do as if they're a part of us too. And so, when I'm thinking about this, I'm kind of thinking of like, okay, say an Elder or grandmother can take care of their great grandkid or their grandkid. How do you build that bridge between them? And having learning opportunities to like if you feel wanted, if you feel needed, if you feel appreciated. And say this [...] five-year-old is able to teach their grandma how to use their phone or to create an interactive type of experience [...]."*
>
> *I was thinking that with any education we need to be able to cater to people who don't all learn the same. So, some people can just read something and go off of it. Some people are hands-on. Some people are more visual learners. So, I was just thinking about how do we incorporate all of that into computer science?"*
>
> *"[I]n my room I say, gotta be respectful. When you come in you need to sit down. You can't come in and just work, work, work, work. [...] Like we came here, and I told my nephew, 'I see an Elder sitting over there.' So that's the first thing we need to do, is we need to go over there and shake their hand. 'Oh, glad to see you' [...]. We need to go over there and tell him hello. But we lost a lot of our storytellers. [...] We're losing our storytellers. So, like for the youth, you need to start asking Elders, 'What do you know?'"*

Amskapi Piikani Educator Perspectives on CS

This section shares results from one session that engaged educators and school staff (Grades 6–12) who teach or play a supportive role in education in the Amskapi Piikani community. Key themes are shared, followed by supportive quotes for each dialogue area.

Rose (CS Programs in the Community). When educators from the community were asked about strengths or existing CS programs in the community, **school programming** was frequently cited as a strength. School programming includes CS courses and afterschool activities that are offered at grade schools and BFCC. Another strength in the Amskapi Piikani community is that educators have implemented a CS curriculum in the classroom, although it is not required by current education standards. Educators also indicated that although there are some opportunities for youth to go into CS-related fields, there are no specific CS programs or careers

that are tailored for the Amskapi Piikani community, even though **exposure to careers in the CS field** is important to gain youth interest.

> *"We've got a teacher that does some really cool computer science in our building. They program robots to move around the room and they build 3D models. And he has a 3D printer and they do some other coding."*

> *"Opportunities for Native youth, GEAR UP [Gaining Early Awareness and Readiness for Undergraduate Programs] [...], it's kind-of a pipeline stuff for kids to go to universities. They have summer camps and stuff too that will offer kids to go, like the universities […] I don't think there's anything that it's like specifically for our needs."*

> *"We are also working with a programmer company out of Maryland where we're getting drones. So, we're gonna start that. Hopefully we'll be resource that can grow over the next couple of years. But that's another one that kinda focuses not so much on females but jobs in the field. And so that's a huge one I think for me is showing the students that there are actual jobs that you can strive for."*

Thorn (Challenges and Barriers Relating to Teaching and Learning CS). When invited to reflect on possible challenges and barriers to CS for youth, educators shared thoughts that reflected the key theme of **limited opportunities and exposure to CS** in terms of possible CS pathways and careers, not having basic knowledge about navigating technology, and not having access to CS programs. One educator explained that this was due, in part, to the school district's focus on math and reading. Another key theme was challenges with **infrastructure and technology and equipment needs** due to the rural location of the reservation and limited funds. Educators noted the slow internet across the reservation and shared that some youth do not have internet access at home or access to a computer outside of school, which limits opportunities to gain experience and interest in CS. Educators also indicated **the need for Native CS practitioners and role models**—for the youth to be able to see other Native people like them in CS fields so that they can be exposed to CS knowledge, including CS language or jargon. Other themes that were reflected in the dialogue included **improving health and wellness with technology,** such as establishing a balance between time online and face-to-face interactions and protecting the youth from advertisements and spam. A couple of educators indicated that their students were struggling with mental health and feelings of isolation, due in part to the overuse of technology to communicate and interact with the world.

> *"Challenges for youth is just not having the knowledge to navigate the technology. No availability or access to programs in computer science."*

"I think that our district needs to be revamped, and they feel that math and reading is the most important thing. But today, technology is the way, and I feel like our students are being left behind. Because us as educators and our students do not have that support or that interest to show that computer science is the way of the world today and not enough exposure."

"I think some barriers to students is [...] not necessarily seeing it being used by other adults, [...] not having that role model that's like, 'Oh, this is actually really easy,' you know? Cause they're coming in and they're like, if this is so hard then it's really not that hard. But it's just like language, right? It's a different language that they have to learn. And so, if they're not seeing that language used outside of school, and they're not necessarily using it on a daily basis at home or anywhere else, then it's almost like we create our own barrier that's just like, this is really hard. And it's like, well, actually you can really do this."

"We have an extreme crisis with the mental health in our youth. And I think technology's a huge contributing factor to that and computers makes them ill. [...] How do we [imbue] real connection into what we're trying to do so that we don't even have to worry about that, right? I think that's what's happening is there's no emotional connection, right? They're looking at their phones and it's empty."

In terms of challenges in teaching CS in schools or in the community, educators indicated that there is a **need for more educators with CS skills and knowledge** to teach CS subject matter. Educators said that there were too few people who could teach tech knowledge or that those with CS knowledge leave the school and may not be replaced, leaving behind a teaching gap. Another key theme was **PD needs.** Educators indicated that most teachers had little foundational knowledge of CS but would like more opportunities to learn about CS and technology, including support when questions arise in relation to new learnings. At the same time, some questioned when educators would have time for PD with everything that is already on their plate **(workloads and capacity).** An individual also noted the **need for full Tribal sovereignty** because, without it, their community was prevented from fully enacting decisions on behalf of their community.

"Yeah, those are kind of some of the same things I had [written] down, like lack of resources or the lack of access to like, high tech programs or technologies. And then just the lack of understanding too, even for myself, I feel like there's so much I can learn [...]."

"[A tech director from Apple] would come to your room and they'd say, 'Well what questions do you have?' We didn't even know what questions to ask [...]. And so, you know, it was really like, 'Well heck, I don't know.' And you know, you had to be really

humble and say, 'I don't know.' And said, 'Well, what are you doing in the other rooms?' Or like, 'What would you like to show?'"

"And then that continuous support in it too when you learn something new and you're stuck somewhere. Who do I go to, you know? It's just like, 'Uh, I don't know this program. I'll just go back to what I do now that's worked in the past.'"

Bud (New Ideas to Create with CS for Their Community). For this dialogue area, educators shared many ideas about how to support youth in the Amskapi Piikani community in CS education and career pathways. A key theme was about **nation-building and educational sovereignty** in terms of centering place, community, language, and culture, upholding self-determination over the education of their youth, and supporting local jobs and infrastructure improvements that create opportunities for youth to build CS pathways in service of their own communities. Specific ideas included providing more **hands-on, project-based learning** that supports youth in identifying specific issues in the community and then figuring out how to problem-solve using computer technology; **partnering with local business** for career talks, job shadowing, and internships; and promoting dual enrollment for high school students in CS at BFCC. Educators also emphasized the need for more **PD and leadership support** for CS education, including trainings and seminars for educators in CS technology, as well as providing computer classes that engage parents and caregivers so that families can learn together (intergenerational learning). Another theme shared was about providing **more CS access and resources in the community,** such as a shared space, computer lab, or coding clubs in which youth can access computer technology and the internet, which many lack at home.

"Educate the educators with a PD of how to incorporate technology. We need to have more focus in our school systems that computer science is impactful."

"Maybe like after school where they can access tech and internet 'cause they can't do a lot of that at home."

"If we could take our educational sovereignty back from the state and then make our own decisions about what our youth need and abandon this industrial model that dehumanizes our students. Then we could use technology at every step to strengthen what we're trying to do with our values and that would be ideal."

"And then going into businesses in my class and doing like a job shadow. And so we're working with you and then coming back to class and saying, 'Okay, what's the problem you feel like could be solved with technology?' And then having them develop the solution in class I think would be really cool."

Educators also shared their thoughts on developing Native mentors and educators in CS. They shared a few ideas for **growing Native CS mentors and educators,** many of which aligned with the themes shared above, such as increasing access to computer technology and the internet, providing hands-on learning opportunities related to place and community, and partnering with the community college and local businesses. In addition, educators shared that supporting a cohort of Native youth or educators, such as through a certificate program or internship, would be a wise practice for building CS education and career pathways in the community. Another key theme was about engaging community members who are in CS-related careers in working as mentors, or having high school students serve as **"near peer" mentors** to younger students, and providing examples of what career pathways in CS could look like for students.

> *"Then of course, along with the internships like having the students come back after they graduate from high school and doing a lesson with their peers. Like not so far peers. Do you know what I mean?"*

> *"I know in our community, a cohort has been really positive. Or are effective I should say. Just take a whole group of people who are interested and then create some type of like, I don't know if it's like a club in a community or what, but it's just like this common time. I mean it could even be like how we have summer school or something, you know? And they just go to that. They attend and then over a certain amount of time or at a certain level of proficiency then broaden it, you know? Maybe start another group but then have a second step for that group where they're out there kind of implementing like the kids. And then, you know, it'd have to be something that just continually grows.*

> *"I think also looking at that as a way of continuity like saying they we're gonna build that foundation here [at the high schoo]), but look they're offering this at like BCC where it's gonna become a career if you should choose […] Showing them a bigger picture."*

Roots (Connections to Place, Benefits of CS, Indigenizing CS, and Core Values). When invited to share how CS could help their Tribal community, one key theme for this was using **CS-based equipment and tools** to enhance and strengthen community infrastructure and available information, and culture and language. Some of the ideas shared by community members included: using drones for search and rescue, identifying areas where there are fires, ranchers using drones to check in on animals, law enforcement using new equipment and tools for collecting evidence for cases, and using VR to interact with Elder interviews.

> *"I'm constantly problem solving with our stuff around here' cause [the equipment is] always outdated or something. You have to go through everything and kind of figure it out. I watch a lot of videos, you know? In order to do stuff."*

Other key themes included **exploring and building job opportunities in CS** such as building career opportunities in CS or CS-related fields that are within the community or potentially jobs that would improve **data management systems.** Some examples of potential CS-related careers within the community include criminal investigation and cybersecurity.

> *"Jobs are pretty limited here. And so, we need a whole 'nother different way to create jobs where people don't have to leave."*

> *"Cybersecurity would be really important for our education for our kids. Getting into that career direction of becoming a criminal investigator, you know? Criminal investigations technology with computer science is really important that I think we're subject. Especially if you're searching and getting all the things you need for the specific investigation. In cyber security obviously you know what goes down that direction as far as like getting information and intel. Stuff like that that's usually really important and would be good career for kids that are interested in that stuff."*

Educators also shared their thoughts on Indigenizing CS. Educators who supported Indigenizing CS believed that it should be rooted and **based in Indigenous culture and language.** Educators shared **ideas for Indigenizing** CS curriculum programs or resources in the community and would like to see the youth create programs or games that would support the use of the traditional language, plant knowledge, learning about traditional ways of living, and ways of survival.

> *"I think we could use it as a learning tool like as far as Indigenizing it. I mean having students create programs and games where they take adventures like hunting and gathering and incorporate the language and they find specific roots for healing or food, you know what I mean? Like a whole big program that the kids could play cause that's what they do. They play games and creating that with using language and plants and such like that. I think survival ways of survival and things like that would be interesting."*

Another key theme that educators shared was the idea to **improve accessibility to all community members**. Below is a quote that shares more about how the accessibility of CS can be improved:

> *"I don't think it could be Indigenous but I think we could Indigenize it. And my logic of that is like how we take broken down cars and make art out of 'em, you know? Like the exploitation already happened… But I will say like to me we're Indigenized would probably mean like to connect it with your local community and make it tangible and accessible to everyone in the community… So, Indigenizing it means like how do we take what we're talking about and make it accessible to, again, grade school students or*

people in recovery, you know? Things like that. So. I think that's how it becomes Indigenized."

In one instance, an educator was **unsure whether CS could be truly Indigenized** given its extractive and colonialist nature; however, they indicated that trying to build a CS based on holistic well-being and sustainability would help address the basic foundations of Indigeneity.

> *"As far as it being Indigenized I question whether that's possible. Can we make computers without extractive colonialism? I don't know. And if not then it's not Indigenous. And in that sense health, wellness and sustainability, I think that's sort of what I've come to see as being the sort of three foundational values of Indigeneity here now and the goal. And that'd be a great place to start."*

When educators were asked what core values they would like to see in CS education or programs, they shared that the values should focus on addressing Tribally centered needs or **supporting Tribal sovereignty.** This shared vision highlights a strong desire for CS education to serve Indigenous communities directly. Other core values were mentioned in the above areas. As one educator articulated:

> *"Some core values I'd like to see in computer science education and the programs that it has to do with, it's Tribally centered like the needs. It's all centered on our needs and stuff too. If it's a video game. Some of the kids talked about like making it about like know Napi and stuff too and like bringing our stories kind to life. There's cartoons they can use. There's Scratch, there's all different kinds of things they can use now to do that. But then even looking at, we used to do that game, like what is that core value from that Napi story, you know? And that's kind of our teacher […]. So, it's Napi and I think it's kind of finding why you have that guy, you know? What would that guy do and tries to do the good thing. Napi always makes all the mistakes and so we don't have to in a sense. It's the whole point. But being able to do something around that, I think, would be really good as well as, you know? It just has to be our needs centered on what it is. So, I think that's the most core value.*

"Honoring sovereignty cannot undo past wrongs, yet I hope it can help create healing and sustainability into the future."

– *Viewpoints from Coalition Members on Value*

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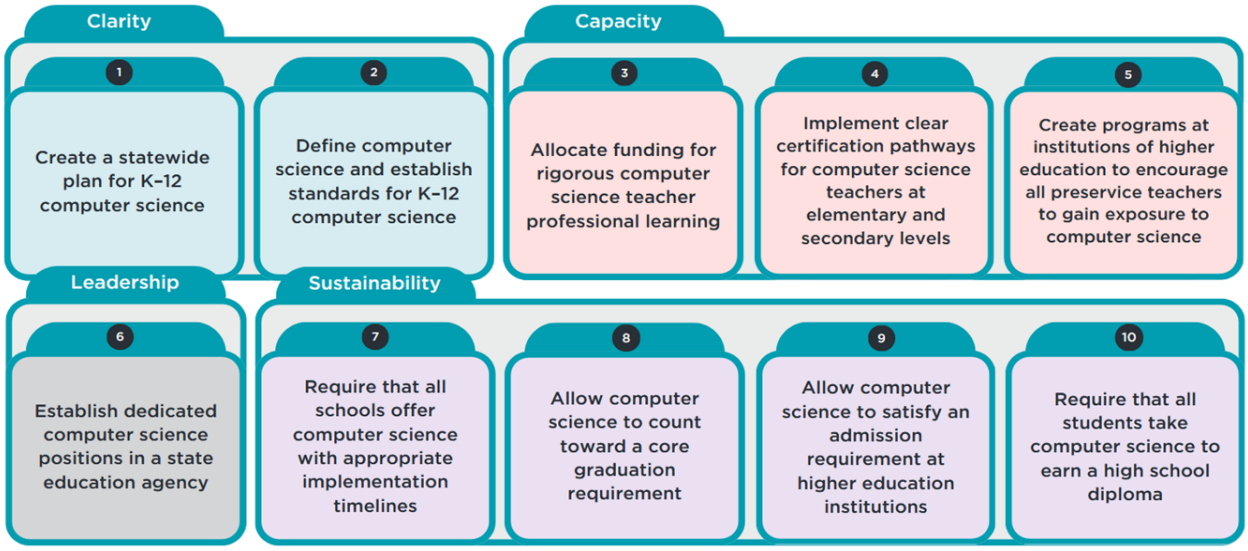
Appendix A. AIR Additional Results and Instruments

Additional Notes on Code.org 10 Policies

Code.org outlines ten key policy recommendations designed to integrate CS as a core component of K–12 education.[144] These policies are grounded in four guiding principles:

1. **Clarity:** Encourages states to define computer science clearly, establish standards, and create comprehensive plans that guide implementation and progress.
2. **Capacity:** Focuses on building a strong teaching workforce through professional development, certification pathways, and preservice teacher training to support CS education.
3. **Leadership:** Calls for dedicated roles and leadership at state and local levels to champion CS and guide its integration into school systems.
4. **Sustainability:** Promotes long-term integration of CS by embedding it into graduation and college admission requirements, ensuring its permanence in education systems.

Exhibit A–1. Code.org 10 Policies to Make Computer Science (CS) Foundational to K–12 Education



[144] Code.org, *Ten Policy Ideas to Make Computer Science Foundational to K–12 Education* (2024), https://code.org/assets/advocacy/making_cs_foundational_2024.pdf.

Code.org tracks the adoption of these policies in an online tracker.[145] Code.org acknowledges that the policies are "designed to provide a framework and a strong starting position for states, although they may need to be modified to best fit individual state needs." It also provides model legislation for each of the policies.

While Code.org also acknowledges that adoption of the policies does not guarantee student success in CS, an analysis by AIR shows correlation between policy adoption and CS access.

Exhibit A–2. Correlational Analysis of Adoption of Code.org Policies with CS Access

Variable	Correlation with number of key policies adopted *(r)*	Strength of relationship	*p*
Percentage of high schools offering foundational CS	0.4972	Medium	0.0002
Percentage of Native American and Alaska Native students who attend a high school offering foundational CS	0.4276	Medium	0.002

Note. The Pearson correlation coefficient (*r*) indicates the strength and direction of the relationship between the number of policies and various CS education metrics. P-values (*p*) less than 0.05 suggest the correlations are statistically significant. Relationship strength is interpreted using Cohen's (1988) guidelines: small (r ≈ .1), medium (r ≈ .3), and large (r ≥ .5).

More Findings from the Indigenous CS Teacher Survey

Exhibit A–3. Tribal Affiliations of Surveyed Teachers

Tribal affiliation	Count
Navajo Nation, Arizona, New Mexico, and Utah	10
Cherokee (unspecified)	2
Lower Brule Sioux Tribe of the Lower Brule Reservation, South Dakota	2
Hopi Tribe of Arizona	1
Keweenaw Bay Indian Community, Michigan	1
Little Shell Tribe of Chippewa Indians of Montana	1
Oneida (unspecified)	1
Otoe-Missouria Tribe of Indians, Oklahoma	1
Ottawa Tribe of Oklahoma	1

[145] Code.org, "State Tracker of Our 10 Policies."

Tribal affiliation	Count
Pueblo (unspecified)	1
Pueblo of Jemez, New Mexico	1
Pueblo of Laguna, New Mexico	1
Turtle Mountain Band of Chippewa Indians of North Dakota	1
Zuni Tribe of the Zuni Reservation, New Mexico	1

Note. A total of 24 teachers identified as Indigenous. Because some teachers indicated multiple Tribal affiliations, the total count does not add up to 24. Tribal names listed reflect the official designations used by the Bureau of Indian Affairs for federally recognized Tribes.

Exhibit A–4. School Devices

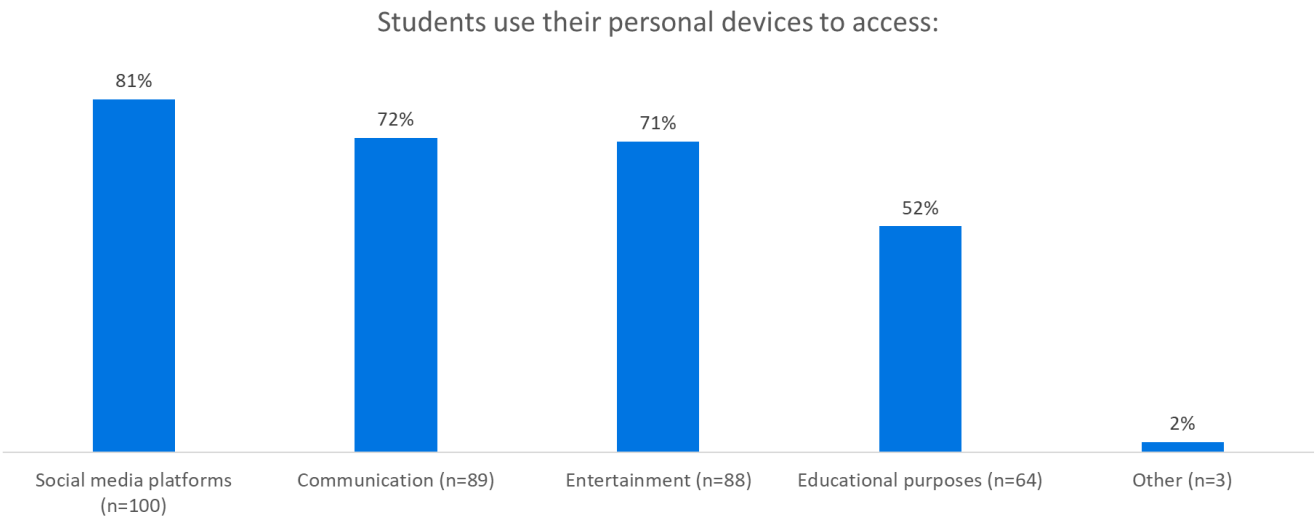


Exhibit A–5. What Students Do with School Devices

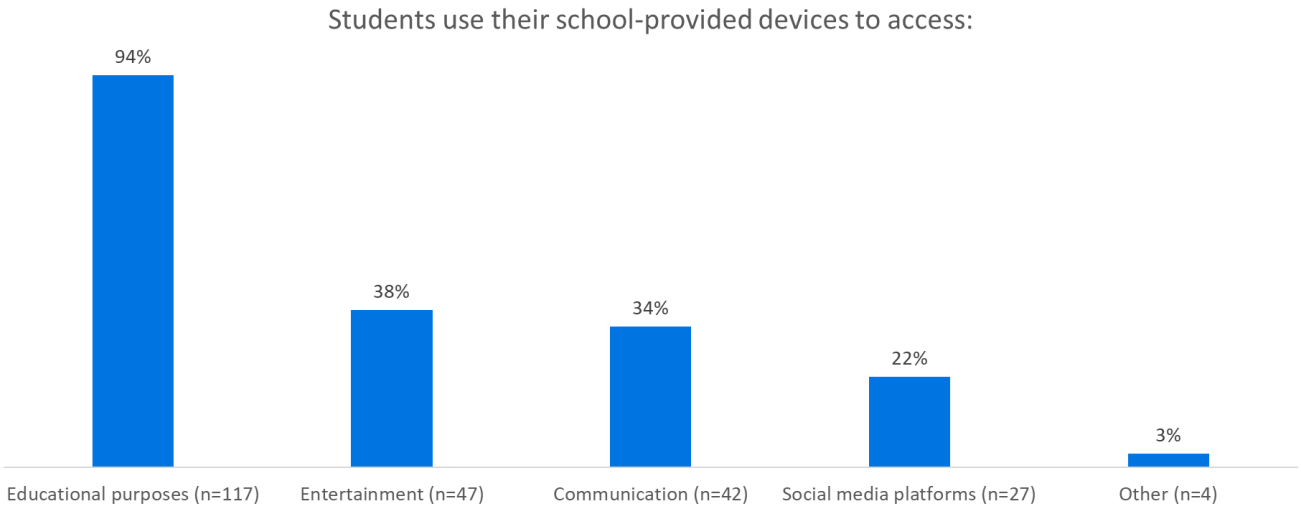


Exhibit A–6. What Students Do with Personal Devices in School

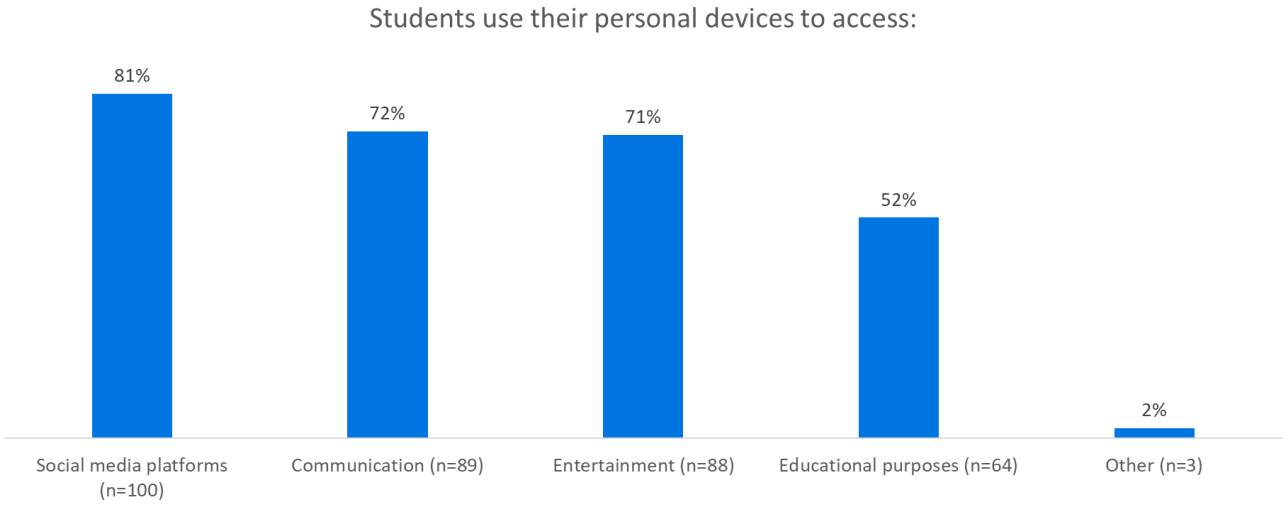


Exhibit A–7. Sources of Influence on Student Interest in Computer Science

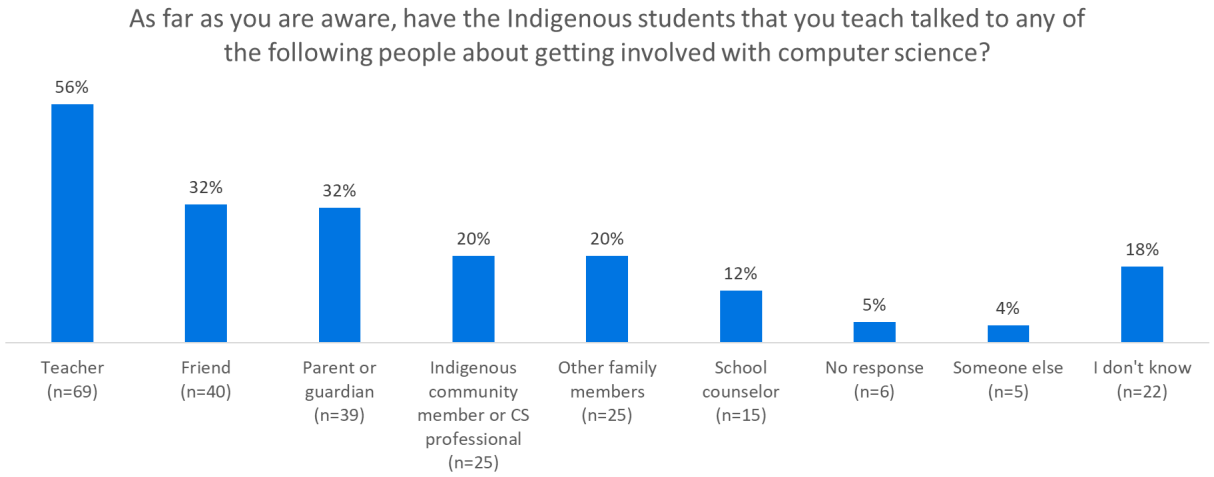


Exhibit A–8. Teachers' Influence on Student Interest in CS

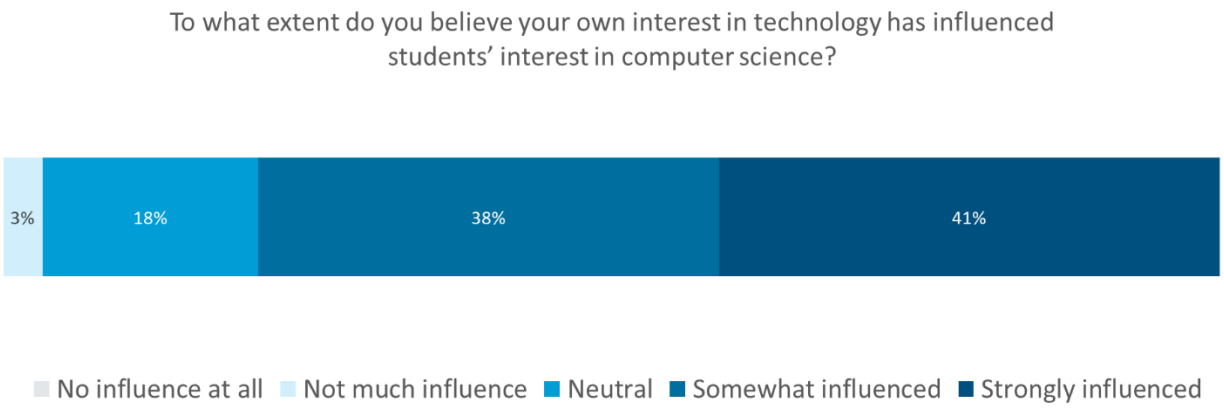


Exhibit A–9. Models

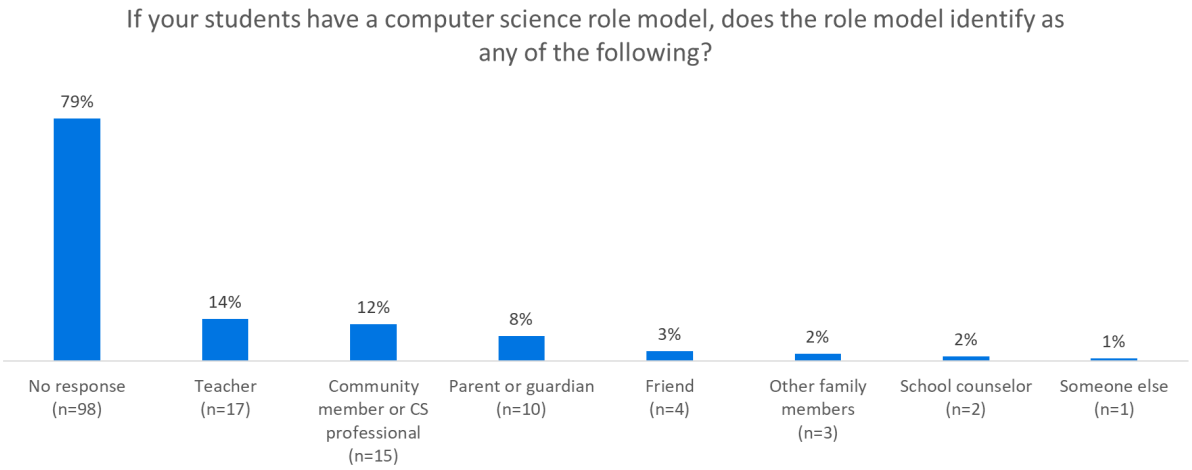


Exhibit A–10. In-School Opportunities to Learn Coding

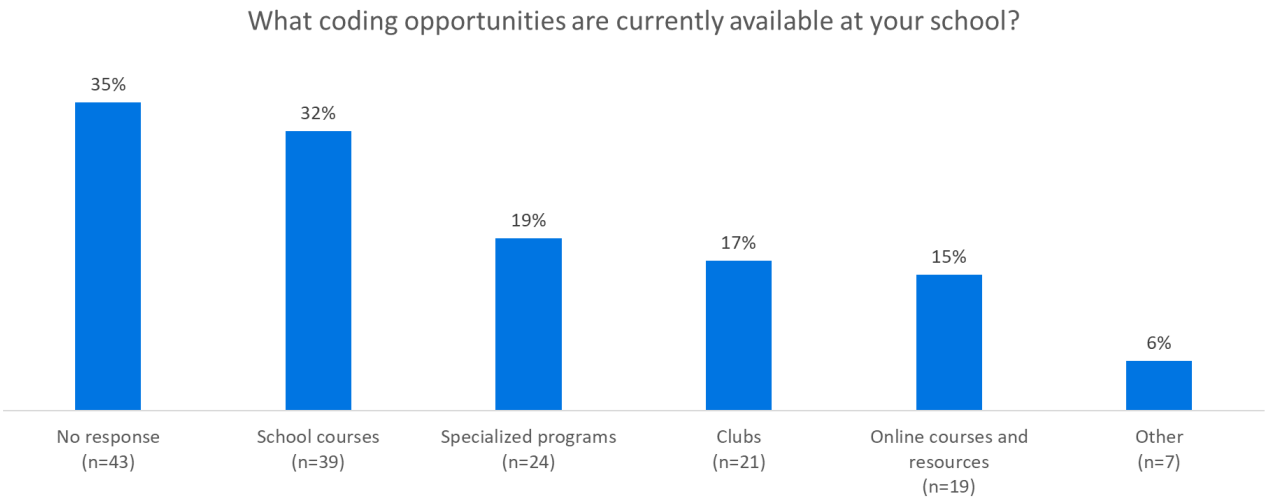


Exhibit A–11. In-School Opportunities to Learn AI

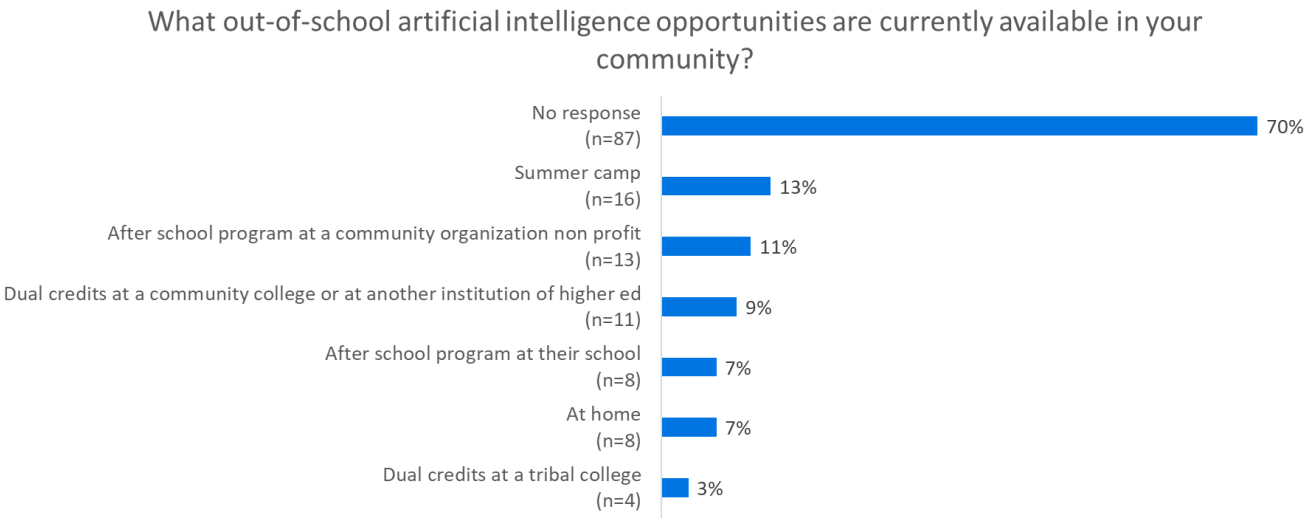


Exhibit A–12. Out-of-School Opportunities to Learn Coding

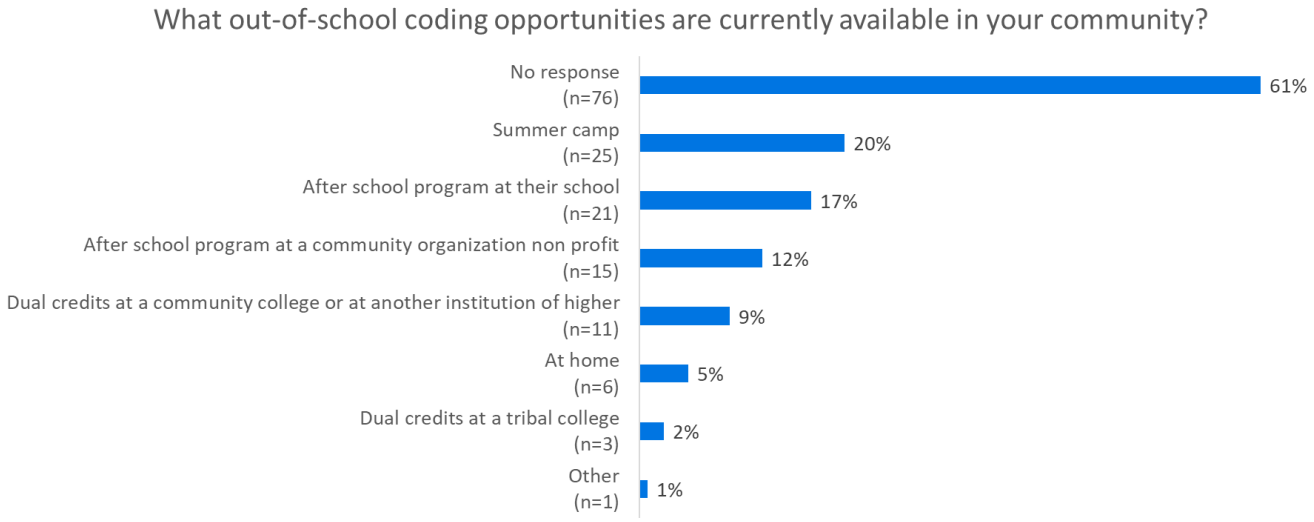


Exhibit A–13. Out-of-School Opportunities to Learn AI

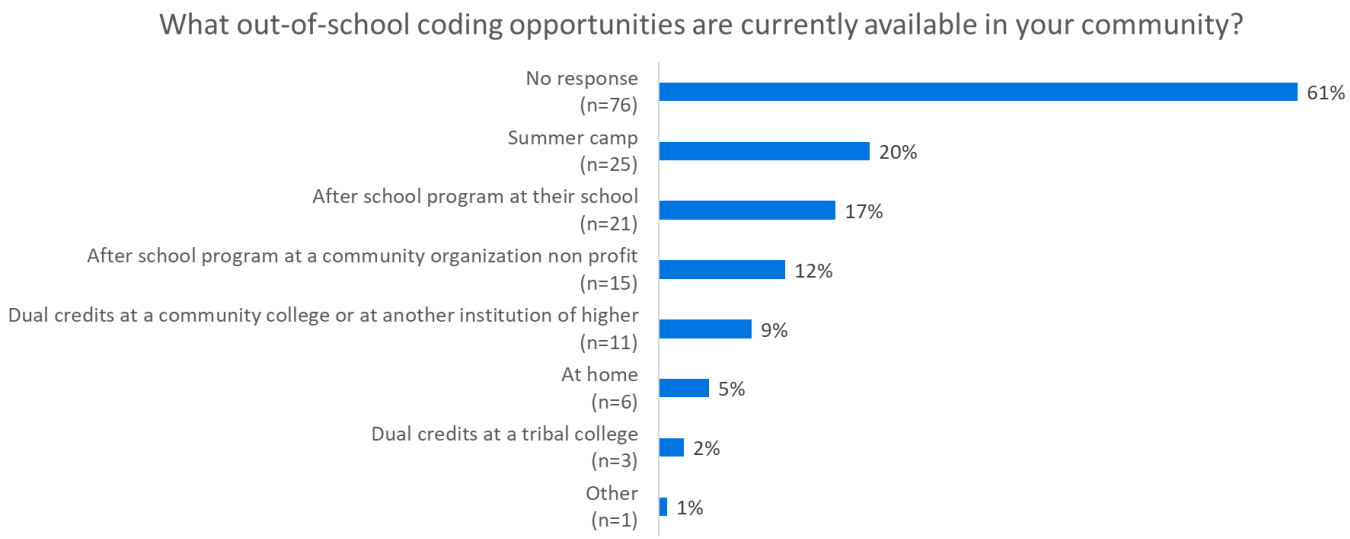


Exhibit A—14. Indigenous CS Teacher Survey

Note for other groups/researchers that would like to utilize this survey instrument in their own research or community studies; you can refer to the survey instrument with the following citation: The instrument was developed by American Institutes for Research (AIR) as part of the Indigenous Computer Science Interest and Access Study and funded by Amazon Future Engineer.

Indigenous CS Teacher Survey

Introduction

This survey is about your understanding about computer science (CS) education and the CS learning experiences of Indigenous students currently in grades 6 through 12. This survey will take 15-20 minutes to complete.

The responses provided in this survey will be used to develop an important report about Indigenous student, parent and community understandings of and access to CS education opportunities.

Your responses will remain confidential. The results will not include your name or identify you. Thank you for sharing your thoughts.

CONSENT

Do you agree to take the survey?

1. Yes
2. No **[TERMINATE]**

Demographic Questions

1. Do you identify as Indigenous?

2. If yes, please list the Tribe(s) you identify with: **[open ended]**

3. What is your gender?
    1. Female
    2. Male
    3. Other
    4. Prefer not to answer
4. Are you currently employed as a teacher?

1. Yes **[skip to teacher questions]**
2. No **[skip to end of protocol]**

Teacher Demographic Questions

5. What is the full name of the school where you are currently employed? **[open ended]**

6. What type of school do you work at?
    - Public
    - Private
    - Tribally Controlled School
    - Bureau of Indian Affairs School
    - Homeschooled
    - Other

7. What grade do you teach? (Please select all that apply)
    - Kindergarten
    - 1st
    - 2nd
    - 3rd
    - 4th
    - 5th
    - 6th
    - 7th
    - 8th
    - 9th
    - 10th
    - 11th
    - 12th

8. What type of school-provided or personal devices, if any, are students allowed to access at school? (Select all that apply).
    - A computer, laptop, or Chromebook
    - A tablet (e.g., iPad)
    - A smartphone (e.g., iPhone or Android)
    - gaming consoles (e.g., PlayStation, Xbox, etc.)
    - None – students do not have access to devices at school

Teachers' Understandings of Computer Science and Student Access

9. In a sentence or two, how would you describe what computer science is to a sixth grader? **[open ended]**

10. Please indicate how much you agree with the following statement: “I am highly skilled when it comes to using computers and computer-related technology.”

- Strongly Agree
- Agree
- Disagree
- Strongly Disagree

11. Based on your observations, how do the Indigenous students that you teach regularly use their school-provided or personal devices (e.g., smartphones, laptops, tablets, gaming consoles)? Please select all that apply.

- They use their school-provided devices to access:
  - Social media platforms (e.g., TikTok, Snapchat, Instagram)
  - Educational purposes (e.g., school assignments, coding sessions, video games)
  - Communication (e.g., texting, video calls)
  - Other (please specify): _____
- They use their personal devices to access:
  - Social media platforms (e.g., TikTok, Snapchat, Instagram)
  - Educational purposes (e.g., school assignments, coding sessions, video games)
  - Entertainment (e.g., streaming content, playing Roblox or other video games)
  - Communication (e.g., texting, video calls)
  - Other (please specify): _____

Teachers’ Understanding of Student Interest in Computer Science

12. What types of technology-related activities do Indigenous students that you teach seem to enjoy the most? (Select all that apply)

- Playing video games during an elective course or after-school club
- Using apps or websites
- Building or assembling technology (e.g., robots, computers)
- Programming or coding
- Other (please specify)

13. What do you think motivates students to pursue activities related to computer science? (Select all that apply)

- Curiosity and desire to learn
- Desire to solve challenges in the community
- Enjoyment of technology or video games
- Encouragement from teachers or mentors

- Other (please specify)

14. Which of the following do you believe influences the Indigenous students that you teach to pursue computer science? (check all that apply)
- CS or technology-focused classes or lesson activities at school
- After-school clubs or programs with a CS or technology focus
- Summer camps with a CS or technology focus
- Other teachers
- School guidance counselors
- School academic advisors
- Mentor or role models in the community
- Other:

15. As far as you are aware, have the Indigenous students that you teach talked to any of the following people about getting involved with computer science? You may select more than one option.
- Parent or guardian
- Other family members
- Teacher
- School counselor
- Friend
- Indigenous community member or professional in the field of computer science
- Someone else (please specify):
- I don't know

16. To what extent do you believe your own interest in technology has influenced students' interest in computer science?
- Strongly influenced
- Somewhat influenced
- Neutral
- Not much influence
- No influence at all

17. Do you believe your child looks up to any role models who work in computer science?
- Yes **[skip to Question #18]**
- No **[skip to next section]**
- I don't know **[skip to next section]**

18. To your knowledge, do these role models identify as Indigenous?
    a. Yes **[skip to Question #19]**
    b. No **[skip to next section]**
    c. I don't know **[skip to next section]**

19. If yes, do they identify as any of the following individuals? (Select all that apply)
    - Parent or guardian
    - Other family members
    - Teacher
    - School counselor
    - Friend
    - Community member or professional in the field of computer science
    - Someone else (please specify):
    - No
    - I don't know

Teachers' Understanding of Student Access to Coding and Artificial Intelligence

The following questions ask specifically about coding and artificial intelligence:

20. Coding is a part of computer science and can be described as the process or activity of writing instructions for a computer to follow. For example, an Indigenous Computer Scientist can design the software of an app to teach an Indigenous language or design software for a complex game that can be played on Xbox or PlayStation. Another example is an Indigenous Scientist that designs encrypted code to protect digitally stored Indigenous knowledge, such as Tribal enrollment records. With this in mind, do you think coding could be used to solve problems or provide solutions to your tribal community/ies?
    - Yes **[skip to Question #21]**
    - No **[skip to Question #22]**

21. If you answered yes to question 20, can you describe an actual or hypothetical example? **[open ended]**

22. Are there opportunities for students to learn coding at your school?
    - Yes **[skip to question #23]**
    - No **[skip to question #24]**
    - I don't know **[skip to question #24]**

23. Please select the coding opportunities that are currently available at your school (Select all that apply):
    - School courses
    - Clubs
    - Online courses and resources
    - Specialized programs
    - Other:

24. Are there opportunities for students to learn coding outside of school?

- Yes **[skip to question #25]**
- No **[skip to question #26]**
- I don't know **[skip to question #26]**

25. Please select the out-of-school coding opportunities that are currently available in your community (Select all that apply):
    - After-school program at their school
    - After-school program at a community organization/non-profit
    - Summer Camp
    - At home
    - Dual credits at a tribal college
    - Dual credits at a community college or at another institution of higher
    - Other:

26. Artificial intelligence (AI) is also a part of computer science and can be described as a technology that can be trained with human input and data to make predictions and recommendations (e.g., Siri, Google Assistant, ChatGPT). With this in mind, do you think AI could be used to solve problems or provide solutions to your tribal community/ies?

    - Yes **[skip to Question #27]**
    - No **[skip to Question #28]**

27. If you answered yes to question 26, can you describe an actual or hypothetical example? **[open ended]**

28. Are there opportunities for students to learn artificial intelligence at your school?
    - Yes **[skip to question #29]**
    - No **[skip to question #30]**
    - I don't know **[skip to question #30]**

29. Please select the artificial intelligence opportunities that are currently available at your school (Select all that apply):
    - School courses
    - Clubs
    - Online courses and resources
    - Specialized programs
    - Other:

30. Are there opportunities for students to learn artificial intelligence outside of school?
    - Yes **[skip to question #31]**
    - No **[skip to question #32]**
    - I don't know **[skip to question #32]**

31. Please select the out-of-school artificial intelligence opportunities that are currently available in your community (Select all that apply):
    - After-school program at their school
    - After-school program at a community organization/non-profit
    - Summer Camp
    - At home
    - Dual credits at a tribal college
    - Dual credits at a community college or at another institution of higher education
    - Other:

Teachers' Beliefs on Computer Science

Please indicate how much you agree with the following statements:

	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree
32. It is good for students to learn coding					
33. It is good for students to learn artificial intelligence					
34. Indigenous knowledge and computer science can be used to solve problems in the community					
35. I support efforts to teach Indigenous knowledges through computer science					
36. I support efforts to teach Indigenous languages through computer science					
37. If students pursued a career or education in computer science, they could get a job in the community					
38. Schools should provide coding education during the school day					
39. Schools should provide artificial intelligence					

education during the school day					
40. Schools should provide coding education during after school activities					
41. Schools should provide artificial intelligence education during after school activities					

Teachers' Understandings of Student Strengths and Contributions

42. Based on your understanding and engagement with computer science and computing technologies, what unique perspectives or ideas do you think Indigenous students can bring to the field of computer science? (Select all that apply).

- Indigenous knowledge and cultural perspectives
- Problem-solving approaches rooted in community values
- Creativity and innovation informed by traditional practices
- A desire to use technology to benefit Indigenous communities
- Other (please specify): _____

43. If you were to design a computer science education activity for Indigenous students that centers Indigenous values and knowledges in computer science. Please describe in a few sentences:

a) What type of activity or project would you create (e.g., developing a grocery delivery app, designing an Indigenous language translation app, creating digital tribal IDs, etc.)? **[open ended]**
b) Who would need to be involved in designing and developing this activity or technology (e.g., teachers, school faculty, students, tribal community leaders, etc.)? **[open ended]**

Closing:

44. Below is Indigitize's working understanding of what Indigenized computer science is:

a. *Computer science is a broad field that can mean many things. Yet, said simply, an Indigenized computer science can be described as a creative journey to make and use computers in ways that align with the Indigenous cultures and*

lifeways students come from. This includes the design of the actual hardware (e.g., laptop, smart phone, tablet, robots, servers) and software (e.g., video games, databases, apps, operating systems).

In a few sentences or less, please share how this definition resonates with you. For example, what do you agree with? Is there anything you don't agree with? Does anything about this definition surprise you? Are there any words that stand out to you or any words that you would change? **[open ended]**

45. Is there anything else you would like to share about Indigenous student interest and access to computer science that we have not asked you about? **[open ended]**

Appendix B. Indigitize Additional Results and Instruments

Exhibit B–1. Verbal Assent Script, Protocol, and Questions

Indigenous Computer Science Interest Study Tribal School Student Focus Group Discussion Protocol

Introduction:

Hello, and thank you for taking the time to speak with us today! My name is _____, and I am part of the research team led by Indigitize, One Generation (OneGen), and the NACA Inspired Schools Network (NISN).

Indigitize is a project of OneGen and is an organization that wants to work with Indigenous youth and provide different CS learning opportunities. Indigitize creates, supports, and advocates for CS education grounded in language, culture, and Indigenous values. We come to this work with good intentions, good hearts, and good minds.

We want to learn and understand how Indigenous communities describe their connection to CS and identify challenges that limit access to CS education.

We would like to know more about your experiences as students to improve supports for other Indigenous students, including within your school here. There are no right or wrong answers to any of these questions. If there is something that you don't understand, please ask us to clarify or to help you better understand what we are asking.

Your participation is completely voluntary, which means it is up to you. If you decide not to participate in this focus group discussion, it will not negatively affect you or your school in any way. Just let us know, and you are free to leave the discussion at any time.

If you decide to participate and then change your mind, you may leave the group discussion at any time.

I want to let you know that all information received today will be kept confidential. We will not use your name and will not assign any quotes to individuals. The final reports will include school names but not individual students.

The group discussion today will last about 30–45 minutes and include a break. We will be talking about Indigenous/Native people today. Do you prefer that we use the term

"Indigenous" or "Native" during our discussion? Or if you all are from a specific Tribe, are you open to our using the specific Tribal Nation?

We would like to audio-record the interview/interactive discussion so that we are able to capture everything you tell us accurately. No one will hear the recordings except for the research team at our organizations. We will only be using the information collected today in combination with the other conversations we have to look for common themes and patterns about CS education opportunities and experiences for Indigenous/Native children and communities.

Do I have your/the group's permission to audio-record? **[Pause for response.]**

Do you have any questions before we start? **[Pause for response.]**

Okay, let's begin. **[Start recording.]**

Introductions:

Let's start by introducing ourselves. Please tell us your name, your Tribal community, your grade, and a fun fact about yourself (e.g., "I can speak or understand my Tribal language. I enjoy beading. I like to read. I like to drum. I like to sing.").

Icebreaker:

Beach ball icebreaker game—fun way to get to know the students, helps students relax before the focus group begins, and allows students to ease anxiety or nervousness when meeting new people (i.e., the research team); activity—write questions on each panel of a blow-up beach ball, then throw the ball around the group, and each person answers a question from the beach ball.

CS Interest and Utilization:

To start, I'd like to ask you questions that explore your ideas as someone who identifies as Indigenous [Native] regarding the field of CS.

1. Computer science is a broad field that includes many different areas. If someone asked you what CS is, how would you explain it?
2. Here is our team's and research study partners' working definition of what Indigenized CS is [show a copy of the definition]:
    a. *Computer science is a broad field that can mean many things. Yet, put simply, Indigenized CS can be described as a creative journey to make and use computers in ways that align with students' Indigenous cultures and lifeways. This includes the design*

of the actual hardware (e.g., laptops, smartphones, tablets, robots, servers) and software (e.g., video games, databases, apps, operating systems).

b. We want to share this definition with you right now because we will be asking you questions about Indigenous [Native] access to and participation in CS. After a bit, we will come back to this definition and get your thoughts on this definition.

c. Include example(s) of CS specific to the particular Tribal school/Tribal Nations represented at the school [Note: to be developed with the school staff].

3. Can you please tell me how you and your fellow Indigenous [Native] peers use computing technologies (e.g., smartphones, laptops, tablets, Xboxes, PlayStations)? Probe: What platforms do you use (e.g., Roblox, TikTok, Scratch, Snapchat)? Where do you use them (e.g., coding night at school, playing video games with friends)?

Access, Pathways, and Supports:

Thank you for sharing. Now I would like to ask you about your Indigenous [Native] peers' experiences with existing CS education opportunities in your school and community. Again, there are no right or wrong answers because we are most curious about *your* experiences.

1.

a. What CS learning opportunities do you and other Indigenous [Native] students have the chance to participate in within school (whether or not you actually participate)? This could include electives such as tech education, computer programming, or coding classes, dual enrollment courses, afterschool clubs, or volunteering opportunities. This could also include units in science, math, or space within a language and culture class.

b. What CS learning opportunities do you and other Indigenous [Native] students have the chance to participate in outside of school (whether or not you actually participate)? This could include afterschool clubs, volunteering opportunities, or internships (for the older students in the focus groups).

2. How would you describe your involvement in these opportunities?

a. What kinds of CS learning opportunities did you participate in at school?

b. What kinds of CS learning opportunities did you participate in outside of school?

c. Probe: For the opportunities that you are aware of, and for any that you have been involved in, do you feel that you have been able to express your Indigenous [Native] culture and community within the CS learning activities? If so, in what ways?

3. If you are involved in CS activities currently, what made you and your classmates want to get involved?
    a. Probe: For example, is it the influence of mentors, the encouragement of friends, the excitement of creating something enjoyable, or the opportunity to give back to your community in culturally meaningful ways?
4. If you aren't involved, what has prevented you from getting involved (not interested, doesn't seem fun, not knowing enough about them, or not having time)
5. What can teachers and others in your school or community do to make CS opportunities relevant and exciting for Indigenous students (e.g., create an afterschool club, incorporate CS into current lessons through a cultural and linguistic lens)?
    a. Probe: What would it take to be excited about CS by the end of the school year or in the future?

Strengths and Contributions:

Thank you for all your great responses. Now I would like to get your perspectives on how the field of CS can benefit from the participation and engagement of Indigenous [Native] people, communities, and cultural knowledge.

1. [If they are currently involved in CS activities/skip otherwise] Let's think back to the CS learning activities we talked about earlier. What did you like about them?
    a. Probe: What are some of your favorite projects or assignments that you have done?
    b. Probe: What have been your biggest successes or accomplishments in CS projects or activities (e.g., designing an app, programming a computer)?
    c. Probe: What fun can you have with CS classes?
    d. Probe: Can CS help your Tribe/Tribal community learn your Tribal language, help the Tribe/Tribal community in different ways (e.g., if your Tribe has a buffalo range, assist the buffalo range), or affirm the Tribe/Tribal community's independence (i.e., Tribal sovereignty)?
2. Are there ways that you think CS skills or computing technologies can help or be used in your community (e.g., creating an app to help preserve your Native language, preserving documents electronically for school systems and Indigenous community organizations, or building websites for Indigenous entrepreneurs and businesses)?
3. Are there ways you think you could use CS in school, in lessons, in afterschool activities, or in community events?

Specific Research Questions:

1. Include questions specific to a particular Indigenous [Native] student population/Tribal school/Tribal community that meet their research needs concerning Indigenous [Native] CS. [Note: to be developed with the Indigenous community]

Closing:

Thank you for sharing your experiences with CS.

1. Is there anything that you would like to share about your experience as an Indigenous [Native] student and CS that we have not covered?
2. Earlier, we shared with you our working definition of Indigenized CS. If we could look at that again, we would like to ask you about that definition. As a group of adults in this study, we tried to define what CS means [read/show definition]. Does this make sense with what you think CS is? Does anything about this definition surprise you? Are there any words that stand out to you?
3. As we consider making improvements to this process to learn about CS experiences and supports for Indigenous [Native] students, are there any questions you wish we had asked or things about the interview/interactive discussion that you think could be improved?

Exhibit B–2. OSCA Focus Group Transcript Codebook

This codebook was developed to support the analysis of the AFE-Indigitize Computer Science Interest and Access Study, a 2-year research study focused on understanding how Indigenous students experience CS learning across multiple educational and community-based contexts. This codebook was specifically developed based on a focus group conducted at OSCA in Rapid City, South Dakota, in March 2025.

The coding process was conducted using a hybrid approach, combining both inductive and deductive qualitative analysis strategies. Prior to transcript review, deductive codes were developed based on the study's research questions and existing literature on CS education, culturally sustaining pedagogies, and Indigenous education. Inductive codes emerged directly from the data themselves—from students' language, experiences, and relational interactions within the classroom.

The final codebook includes seven (7) parent codes and forty-four (44) child codes. Each parent code represents a key conceptual category related to CS access and interest, whereas child codes capture specific patterns, behaviors, or ideas. To support clarity and consistency in the coding process, each parent code (and its corresponding child codes) is assigned a specific color, which is visually represented in the code chart below and the coded version of the focus group transcript.

Exhibit B–3. OSCA Parent Code×Child Code×Research Question Matrix

Parent code	Child code	Description
Authority, Power & Oversight: Captures moments when students are corrected, guided, or monitored by adults, facilitators, or others, especially relating to learning and tech use	Adult or Parental Oversight	Monitoring, rules, or structure imposed by adults
	Technological Oversight	Instances of discipline, monitoring, or control
	Facilitator/Teacher Correction	Explicit corrections or feedback from adults
Community Ecosystem & Access: Reflects the broader network of people, organizations, and infrastructure that support students, including internet access and resource availability	External Organizations	Mentions of external schools, afterschool programs, churches, etc.
	Community Roles	References to leaders, Elders, or peer roles
	Resource Access	References to tools, programs, or supports that expand CS access
Computer Science (CS) & Technology: Evidence of how students relate to or make sense of CS content	Examples of Technology	Specific tools, platforms, or devices mentioned
	Imagining CS	Imagining CS or technology for personal or community benefit
	CS in Community	Descriptions, perceptions, or experiences related to how students encounter, use, or think about CS and technology in the community
	CS in School	Descriptions, perceptions, or experiences related to how students encounter, use, or think about CS and technology in school
	CS at Home	Descriptions, perceptions, or experiences related to how students encounter, use, or think about CS and technology at home
	Perceptions of CS & Technology	What students think CS or tech is or how they are used
	Personal Use & Relevance	When students connect CS to their own life or interests
	Cross-Subject Connections	When CS is connected to other academic subjects
	CS Material Perception	Tactile understanding or description of materials using basic senses

Parent code	Child code	Description
	Technology as a Medium	This code captures instances where technology is used as a vessel or medium, whether for communication, learning, sharing, etc.
Cultural & Relational Context: How culture, family, community, and relationships shape students' experiences, values, and perceptions related to CS	Cultural Responsiveness	References to Native culture, language, protocols, or values
	Cross-Cultural Responsiveness	Moments where facilitators or students engage in cross-cultural learning or sharing, highlighting moments where cultural knowledge, practices, or perspectives from different groups are exchanged or integrated
	Empowerment	Highlights instances where individuals or groups gain confidence, agency, and control over their own actions, decisions, or circumstances
	Identity	Focuses on how individuals express, explore, and navigate their personal, cultural, and social identities
	Family & Community Connections	Mentions of family, community, or intergenerational learning relating to CS or technology
	Reflection & Self-Awareness	Moments where individuals engage in introspection or self-examination, considering their own experiences, actions, and beliefs
	Cultural Perceptions of CS	Describing, framing, or interpreting CS or technology in relation to cultural, knowledge, practices, values, language, etc.
	Ways of Being	Implicit or explicit demonstrations of cultural values, habits, or ways of knowing/existing
Facilitation Moves & Relational Pedagogy: Actions designed to engage students, build relationships, or support student learning	Modeling Vulnerability	Sharing about personal learning processes, abilities, differences, etc.
	Relating	Drawing connections between the facilitator's life and the student's life
	Inviting Contextual Examples	Asking for local, personal, or culturally relevant examples
	Humor	Use of jokes, teasing, or playfulness
	Scaffolding	Direct support, hints, prompts, and breaking down tasks
	Sense of Safety & Belonging	Language or practices that promote student comfort or risk-taking

Parent code	Child code	Description
	Positive Reinforcement	Verbal or nonverbal affirmation from a facilitator or teacher intended to encourage, praise, or celebrate student contributions
Interactional Moves & Student Ingenuity: How students engage with ideas, each other, and CS concepts creatively or critically	Noticing	Observations of patterns, features, problems, or solutions
	Naming & Defining	Students giving language or framing to new ideas
	Curiosity & Excitement	Expressions of interest, awe, or eagerness
	Experiences & Expertise	Sharing prior knowledge or skills
	Questioning	Asking thoughtful or clarifying questions
	Shutting Down	Student withdraws, losing confidence or interest
	Hesitation	Engaging, then pulling back from participation
	Tactile or Kinesthetic Approach	When facilitators or students use or suggest using physical, hands-on, or movement-based approaches or strategies to support understanding
Peer Dynamics & Gendered Interactions: How students relate to or treat each other, including power and gendered dynamics	Interruptions	Talking over or cutting off
	Gendered Interactions	Dynamics tied to gendered
	Physical Disruption	Instances of physically disruptive behavior
	Dismissal or Teasing	Discounting, teasing, or ignoring peers
	Peer Support	Helping, building on ideas, and affirming one another

RQ1. In what ways could CS support Indigenous language revitalization, nation building, Tribal sovereignty, self-determination, and other forms of Indigenei
RQ2. What are Indigenous students' and their communities' interests in CS education and career pathways?
RQ3. What do Indigenous students and their communities have access to for CS education and career pathways?
RQ4. What are the strengths (assets, resources, opportunities) Indigenous students and their communities bring to CS?

Parent Code	Child Code	RQ1	RQ2	RQ3	RQ4		
Authority, Power & Oversight	Adult or Parental Oversight			X			
	Technological Oversight			X			
	Facilitator/Teacher Correction				X		
Community Ecosystem & Access	External Organizations	X	X	X	X		
	Community Roles		X	X	X		
	Resource Access			X	X		
CS and Technology	Examples of Technology		X	X			
	Imagining CS	X	X				
	CS in Community	X	X	X			
	CS in School		X	X			
	CS at Home			X	X		
	Perceptions of CS & Technology	X	X	X			
	Personal Use & Relevance		X	X			
	Cross-Subject Connections		X				
	CS Material Perception		X	X			
	Technology as a Medium	X	X				
Cultural & Relational Context	Cultural Responsiveness	X	X				
	Cross-Cultural Responsiveness	X	X				
	Empowerment	X	X				
	Identity	X	X				
	Family & Community Connections	X	X				
	Reflection & Self-Awareness		X		X		
	Cultural Perceptions of CS	X	X	X			
	Ways of Being	X					
Facilitation Moves & Relational Pedagogy	Modeling Vulnerability		X		X		
	Relating		X		X		
	Inviting Contextual Examples		X				
	Humor		X				
	Scaffolding		X				
	Sense of Safety & Belonging		X		X		
	Positive Reinforcement		X		X		
	Noticing		X				

RQ1. In what ways could CS support Indigenous language revitalization, nation building, Tribal sovereignty, self-determination, and other forms of Indigenei
RQ2. What are Indigenous students' and their communities' interests in CS education and career pathways?
RQ3. What do Indigenous students and their communities have access to for CS education and career pathways?
RQ4. What are the strengths (assets, resources, opportunities) Indigenous students and their communities bring to CS?

Parent Code	Child Code	RQ1	RQ2	RQ3	RQ4		
Interactional Moves & Student Ingenuity	Naming & Defining		X				
	Curiosity & Excitement		X				
	Experiences & Expertise		X		X		
	Questioning		X				
	Shutting Down		X				
	Hesitation		X				
	Tactile or Kinesthetic Approach		X				
Peer Dynamics & Gendered Interactions	Interruptions		X				
	Gendered Interactions		X				
	Physical Disruption		X				
	Dismissal or Teasing		X				
	Peer Support		X		X		

Exhibit B–4. OSCA Identified Themes

A Note on Theme Development

The following themes emerged from our qualitative coding and analysis of OSCA. Each theme is grounded in the school's codebook and is aligned with our research questions.

One: Feeling Safe Enough to Try

Description:

In the Oceti Sakowin focus group, students' willingness to engage with new ideas was closely tied to feeling encouraged and safe enough to try. Emotional safety, which was cultivated through facilitator modeling, positive reinforcement, and a caring environment, gave students the confidence to take risks, share ideas, and push their thinking. When these supports were present, students leaned into learning; when they were absent, students often hesitated or shut down. Feeling safe wasn't just about comfort—it created the conditions for genuine intellectual exploration. This was especially important when engaging students with the concept of CS, a subject that can often feel intimidating without strong relational support. Feeling safe made students more willing to explore and experiment, and to reflect on and imagine possibilities for their education and community.

Associated Research Questions:

- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- Facilitation Moves & Relational Pedagogy

Key Child Codes:

Sense of Safety & Belonging; Positive Reinforcement; Modeling Vulnerability; Relating

Two: Learning Through the Tools We Know

Description:

Students often made sense of new ideas by connecting them to technologies and experiences they already knew. Whether it was talking about tools they used at home, devices in the classroom, or community examples of technology, students grounded their learning in familiar

contexts. These touchpoints made CS feel more approachable and less abstract, helping students recognize CS as something already connected to their everyday lives. Facilitators supported this process by inviting students to share their own examples and providing scaffolds that were built from students' existing knowledge. Recognizing and validating these tools strengthened students' confidence and curiosity, creating more pathways for them to engage deeply with CS content.

Associated Research Questions:

- **RQ1:** In what ways could CS support Indigenous language revitalization, nation-building, Tribal sovereignty, self-determination, and other forms of Indigeneity?
- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- CS & Technology
- Facilitation Moves & Relational Pedagogy
- Community Ecosystem & Access

Key Child Codes:

Examples of Technology; CS at Home; CS in School; CS in Community; Personal Use & Relevance; Inviting Contextual Examples; Scaffolding

Three: Wonder, Discovery, and New Ideas

Description:

Students expressed strong moments of curiosity, excitement, and discovery when engaging with new ideas. Interest and excitement were especially evident when students were encouraged to notice details, name concepts, ask questions, and draw on their personal experiences. Rather than seeing CS as rigid or out of reach, students often approached it with a sense of wonder—framing learning as an opportunity for imagination, experimentation, and growth. These moments highlight the importance of fostering open-ended, student-driven exploration in CS education, in which new ideas are welcomed rather than dismissed.

Associated Research Questions:

- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- Interactional Moves & Student Ingenuity
- CS & Technology

Key Child Codes:

Curiosity & Excitement; Personal Use & Relevance; Experiences & Expertise; Imagining CS; Tactile or Kinesthetic Approach; Examples of Technology; Noticing; Naming & Defining; Questioning

Four: Learning in Community

Description:

Students' experiences at Oceti Sakowin revealed that learning was never just an individual process—it is deeply rooted in relationships with each other, family, community, and culture. Students regularly connected their understanding of technology and CS to the world around them, including home, school, and community settings. Cultural values, cultural expectations, and ways of being shaped how students interpreted new concepts and made meaning out of their learning. This communal lens expanded what "learning" could look like: not just mastering skills but thinking about how knowledge serves the broader community. For students, technology was most powerful when it stayed connected to people, place, and purpose.

Associated Research Questions:

- **RQ1:** In what ways could CS support Indigenous language revitalization, nation-building, Tribal sovereignty, self-determination, and other forms of Indigeneity?
- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ3:** What do Indigenous students and their communities have access to for CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- CS & Technology
- Cultural & Relational Context
- Community Ecosystem & Access

Key Child Codes:

Tech & Environmental Impact; Perceptions of CS & Technology; Technology as a Medium; Reflection & Self-Awareness; Internalized Beliefs; Empowerment; Family & Community Connections; Cultural Responsiveness; Cultural Perceptions of CS; CS at Home; CS in Community; External Organizations; Community Roles

Five: Peer Support and Peer Barriers

Description:

Students' learning experiences were shaped not just by the facilitators' tactics but by their interactions with one another. At Oceti Sakowin, peer relationships played a powerful role in either encouraging or discouraging participation. Moments of peer support—in which students helped explain ideas, validated each other's contributions, or collaborated—boosted students' confidence and willingness to engage. However, peer dynamics also created barriers: students, especially girls, sometimes faced interruptions, teasing, or dismissal that made it harder for them to participate fully. The quality of peer relationships mattered deeply, influencing who felt seen, heard, and capable of contributing in CS learning spaces.

Associated Research Questions:

- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- Peer Dynamics & Gendered Interactions

Key Child Codes:

Interruptions; Gendered Interactions; Physical Disruption; Dismissal or Teasing; Peer Support

Subtheme: Early Messages About Who Belongs

Description:

Small moments, such as who is interrupted or whose ideas are valued, send early messages about who belongs in CS spaces. These dynamics matter for shaping confidence, identity, and long-term engagement in CS fields, particularly for Indigenous girls and other students who are often marginalized in STEM spaces.

Associated Research Questions:

- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

Peer Dynamics & Gendered Interactions

Key Child Codes:

Interruptions; Gendered Interactions; Dismissal or Teasing; Peer Support

Six: Safe Boundaries for Big Ideas

Description:

Students' engagement with technology and new ideas was strengthened when adults set clear, caring boundaries. Thoughtful oversight—such as modeling responsible tech use, correcting gently, and offering guidance—helped students feel safe to explore without fear of punishment or getting lost. These boundaries not only encouraged creativity but also taught students how to use technology responsibly, especially when it came to completing assignments, managing incentives, and thinking critically about their digital presence. Students shared reflections on their awareness of surveillance and the importance of setting personal boundaries with tech. Learning how to navigate freedom and responsibility was central to how students approached CS and digital tools.

Associated Research Questions:

- **RQ1:** In what ways could CS support Indigenous language revitalization, nation-building, Tribal sovereignty, self-determination, and other forms of Indigeneity?
- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?

- **RQ3:** What do Indigenous students and their communities have access to for CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- Authority, Power & Oversight
- Facilitation Moves & Relational Pedagogy

Key Child Codes:

Questioning; Honest Uncertainty; Personalized Learning Preferences; Peer Support; Noticing; Naming & Defining; Adult or Parental Oversight; Technological Oversight; Sense of Safety & Belonging; Modeling Vulnerability

Exhibit B–5. ENCS Focus Group Transcript Codebook

This codebook was developed to support the analysis of the AFE-Indigitize Computer Science Interest and Access Study, a 2-year research study focused on understanding how Indigenous students experience CS learning across multiple educational and community-based contexts. This codebook was specifically developed based on a focus group conducted at the Endazhi-Nitaawiging Charter School in Red Lake, Minnesota, in March 2025.

The coding process was conducted using a hybrid, line-by-line analysis. Prior to transcript review, deductive codes were developed based on the study's research questions and existing literature on CS education, culturally sustaining pedagogies, and Indigenous education. Inductive codes emerged directly from the data themselves—from students' language, experiences, and relational interactions within the classroom.

The final codebook includes seven (7) parent codes and sixty (60) child codes. Each parent code represents a key conceptual category related to CS access and interest, whereas child codes capture specific patterns, behaviors, or ideas. To support clarity and consistency in the coding process, each parent code (and its corresponding child codes) is assigned a specific color, which is visually represented in the code chart below and the coded version of the focus group transcript.

Exhibit B–6. ENCS Focus Group Transcript Codebook Question Matrix

Parent code	Child code	Description
Community Ecosystem & Access: Reflects the broader network of people, organizations, and infrastructure that support students, including internet access and resource availability	Community Roles	References to leaders, Elders, or peer roles as resources, leaders, teachers, etc.
	External Organizations	Mentions of external schools, afterschool programs, churches, etc.
	Internet Access	References to the presence, absence, or quality of internet access
	Resource Access	References to tools, programs, or supports that expand CS access
Computer Science (CS) & Technology: Evidence of how students relate to or make sense of CS content	Cross-Subject Connections	When CS is connected to other academic subjects
	CS at Home	Descriptions, perceptions, or experiences related to how students encounter, use, or think about CS and technology at home
	CS in Community	Descriptions, perceptions, or experiences related to how students encounter, use, or think about CS and technology in the community
	CS in School	Descriptions, perceptions, or experiences related to how students encounter, use, or think about CS and technology in school
	CS Material Perception	Tactile understanding or description of materials using basic senses
	Examples of Technology	Specific tools, platforms, or devices mentioned
	Financial Barriers	References to cost, affordability, or lack of financial resources as a barrier to accessing technology, programs, or learning opportunities
	Imagining CS	Imagining CS or technology for personal or community benefit
	Internalized Beliefs	Beliefs or social narratives about what kind of person does or doesn't engage in tech—sometimes reinforcing stereotypes relating to intelligence, or access
	Perceptions of CS & Technology	What students think CS or technology is, how it can be used, by whom, etc.
	Personal Use & Relevance	When students connect CS to their own life or interests
	Prior Educational Experiences	References to prior schooling—especially elementary school—in ways that shape current perceptions of CS, technology, or learning

Parent code	Child code	Description
	Tech & Environmental Impact	Expressing awareness of or concern about the environmental consequences of technology
	Tech & Safety	Expressing concerns, questions, or reflections about safety related to technology use
	Tech & Wellness	Reflections on the impact of technology on wellness
	Technology as a Medium	This code captures instances where technology is used as a vessel or medium, whether for communication, learning, sharing, etc.
Cultural & Relational Context: How culture, family, community, and relationships shape students' experiences, values, and perceptions related to CS	Community	References to the broader community, including Elders, neighbors, local mentors, and community values or traditions
	Cross-Cultural Responsiveness	Moments where cultural knowledge, practices, or perspectives from different groups are exchanged or integrated
	Cultural Perceptions of CS	Describing, framing, or interpreting CS or technology in relation to cultural, knowledge, practices, values, language, etc.
	Cultural Responsiveness	References to Native culture, language, protocols, or values
	Empowerment	Highlights instances where individuals or groups gain confidence, agency, and control over their own actions, decisions, or circumstances
	Identity	Focuses on how individuals express, explore, and navigate their personal, cultural, and social identities
	Family	References to family members (e.g., parents, grandparents, siblings, cousins) and their influence on a student's identity, learning, or engagement with technology and school
	Reflection & Self-Awareness	Moments where individuals engage in introspection or self-examination, considering their own experiences, actions, and beliefs
	Ways of Being	Implicit or explicit demonstrations of cultural values, habits, or ways of knowing/existing

Parent code	Child code	Description
Facilitation Moves & Relational Pedagogy: Actions designed to engage students, build relationships, or support student learning	Humor	Use of jokes, teasing, or playfulness
	Inviting Contextual Examples	Asking for local, personal, or culturally relevant examples
	Modeling Vulnerability	Sharing about personal learning processes, abilities, differences, etc.
	Positive Reinforcement	Verbal or nonverbal affirmation from a facilitator or teacher intended to encourage, praise, or celebrate student contributions
	Pressuring Participation	When a facilitator continues to prompt, push, or otherwise pressure a student to participate after the student has expressed—verbally or nonverbally—a desire not to engage
	Providing Context	Offering background information, clarification, or context to help students understand a concept, term, or question
	Recognizing Student Knowledge	Used when facilitators acknowledge or defer to a student's knowledge, experience, or skill
	Relating	Drawing connections between the facilitator's life and the student's life
	Respecting Student Boundaries	When a facilitator recognizes and respects a student's boundaries—whether verbal or nonverbal
	Scaffolding	Direct support, hints, prompts, and breaking down tasks
	Sense of Safety & Belonging	Language or practices that promote student comfort or risk-taking
Guided Facilitation Interactions: How learning is shaped through adult input, including clarification, correction, prompting, or instructional modeling	Adult or Parental Oversight	Monitoring, rules, or structure imposed by adults
	Facilitator/Teacher Correction	Explicit corrections or feedback from adults
	Teacher Input	When teachers provide direct input that shapes student learning or understanding

Parent code	Parent code	Parent code
Interactional Moves & Student Ingenuity: How students engage with ideas, each other, and CS concepts creatively or critically	Asserting a Boundary	When a student sets a clear boundary—verbally or nonverbally—to protect their comfort and autonomy
	Curiosity & Excitement	Expressions of interest, awe, or eagerness
	Experiences & Expertise	Sharing prior knowledge or skills
	Hesitation	Engaging, then pulling back from participation
	Honest Uncertainty	Captures genuine expressions of not knowing, uncertainty, or confusion without fear or embarrassment
	Naming & Defining	Students giving language or framing to new ideas or stances
	Noticing	Observations of patterns, features, problems, or solutions
	Personalized Learning Preferences	Captures when students express a desire to learn in ways that align with their own interests, styles, or strengths
	Questioning	Asking thoughtful or clarifying questions
	Resource Awareness	Used when students demonstrate problem solving by identifying someone or something that can support their learning
	Shutting Down	Student withdraws, losing confidence or interest
	Student Humor	When students use humor, jokes, teasing, or playful language during discussion or activities
	Tactile or Kinesthetic Approach	When facilitators or students use or suggest using physical, hands-on, or movement-based approaches or strategies to support understanding
	Vulnerability	Used when a student shares something personal, emotional, uncertain, or otherwise puts themselves in a position of openness

Exhibit B–7. ENCS Parent Code×Child Code×Research Question Matrix

RQ1. In what ways could CS support Indigenous language revitalization, nation building, Tribal sovereignty, self-determination, and other forms of Indigeneity?
RQ2. What are Indigenous students' and their communities' interests in CS education and career pathways?
RQ3. What do Indigenous students and their communities have access to for CS education and career pathways?
RQ4. What are the strengths (assets, resources, opportunities) Indigenous students and their communities bring to CS?

Parent Code	Child Code	RQ1	RQ2	RQ3	RQ4		
Community Ecosystem & Access	Community Roles	X	X	X	X		
	External Organizations	X	X	X	X		
	Internet Access	X	X	X	X		
	Resource Access	X	X	X	X		
CS and Technology	Cross-Subject Connections	X	X	X			
	CS at Home	X	X	X	X		
	CS in Community	X	X		X		
	CS in School	X		X	X		
	CS Material Perception		X	X			
	Examples of Technology		X	X			
	Financial Barriers		X	X			
	Imagining CS		X		X		
	Internalized Beliefs		X				
	Perceptions of CS & Technology	X	X	X	X		
	Personal Use & Relevance		X	X	X		
	Prior Educational Experiences	X	X	X	X		
	Tech & Environmental Impact	X	X				
	Tech & Safety			X			
	Tech & Wellness	X	X				
	Technology As A Medium	X	X	X	X		
Cultural & Relational Context	Community	X	X	X	X		
	Cross-Cultural Responsiveness	X					
	Cultural Perceptions of CS	X	X	X	X		
	Cultural Responsiveness	X	X	X	X		
	Empowerment	X	X				
	Family	X	X				
	Identity	X	X				
	Reflection & Self-Awareness		X		X		
	Ways of Being	X	X		X		
	Humor		X				
	Inviting Contextual Examples		X		X		
	Modeling Vulnerability		X		X		
	Positive Reinforcement		X				
	Pressuring Participation		X				

RQ1. In what ways could CS support Indigenous language revitalization, nation building, Tribal sovereignty, self-determination, and other forms of Indigeneity?
RQ2. What are Indigenous students' and their communities' interests in CS education and career pathways?
RQ3. What do Indigenous students and their communities have access to for CS education and career pathways?
RQ4. What are the strengths (assets, resources, opportunities) Indigenous students and their communities bring to CS?

Parent Code	Child Code	RQ1	RQ2	RQ3	RQ4		
Facilitation Moves & Relational Pedagogy	Providing Context		X				
	Recognizing Student Knowledge		X		X		
	Relating		X		X		
	Respecting Student Boundaries		X				
	Scaffolding		X				
	Sense of Safety & Belonging		X		X		
Guided Facilitation Interactions	Adult or Parental Oversight			X			
	Facilitator/Teacher Correction		X				
	Teacher Input		X		X		
Interactional Moves & Student Ingenuity	Asserting A Boundary				X		
	Curiosity & Excitement		X		X		
	Experiences & Expertise		X		X		
	Hesitation		X		X		
	Honest Uncertainty		X		X		
	Naming & Defining		X		X		
	Noticing		X		X		
	Personalized Learning Preferences		X		X		
	Questioning		X		X		
	Resource Awareness			X	X		
	Shutting Down		X		X		
	Student Humor				X		
	Tactile or Kinesthetic Approach		X		X		
	Vulnerability		X		X		
Peer Dynamics & Interactions	Disruption		X				
	Peer Correction		X				
	Peer Support		X		X		

Exhibit B–8. ENCS Identified Themes

A Note on Theme Development

The following themes emerged from our qualitative coding and analysis of Endazhi-Nitaawiging Charter School. Each theme is grounded in the school's codebook and is aligned with our research questions.

1. Theme: Learning Through Relationships

Description:

In learning environments designed for and with Indigenous students, relationships are not just a method—they are the medium through which learning happens. In this study, students were more likely to engage, ask questions, and take intellectual risks in settings where they felt emotionally safe, respected, and seen. Facilitators who modeled vulnerability, affirmed student contributions, and offered culturally responsive scaffolding and created climates of trust that reflected Indigenous pedagogies grounded in relationality, humility, and care. In the contexts observed, in which relationality shaped the learning environment, these practices were not optional or supplementary—they were essential to honoring the full presence and potential of Indigenous students in CS education.

Associated Research Questions:

- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- Facilitation Moves & Relational Pedagogy
- Guided Facilitation Interactions

Key Child Codes:

Modeling Vulnerability; Positive Reinforcement; Sense of Safety & Belonging; Scaffolding; Recognizing Student Knowledge; Relating; Teacher Input

2. Theme: Where I'm From Is How I Learn

Description:

Students often connected their interests in CS to school, cultural identity, and family and community. They described learning their language, engaging with culture, and imagining how these interests could be nurtured within their own schools and communities. For some, this meant envisioning future projects that supported cultural knowledge. For others, it meant recalling moments of connection—such as an instructional aide who developed a website to teach the Ojibwe language or reflecting on prior educational experiences. These reflections revealed how students rooted their learning in relationships, values, and lived experiences. For the students, where they're from isn't just context—it's the lens through which they interpret, engage with, and give meaning to CS.

Associated Research Questions:

- **RQ1:** In what ways could CS support Indigenous language revitalization, nation-building, Tribal sovereignty, self-determination, and other forms of Indigeneity?
- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- Cultural & Relational Context
- Community Ecosystem & Access

Key Child Codes:

Cultural Responsiveness; Family; Community; Identity; Ways of Being; Cultural Perceptions of CS; Community Roles

3. Theme: Interest, Curiosity, and Relevance

Description:

In this study, students expressed the highest levels of engagement when CS felt connected to their everyday lives, personal interests, or ways of thinking. Curiosity often emerged when students could imagine themselves using technology for something meaningful—whether for creative projects, exploration, or hands-on experimentation. These moments were shaped by relevance: when CS was framed in ways that felt familiar, exciting, or practical, students leaned in more fully. Relevance wasn't just a hook—it was a necessary condition for sustained interest

and participation. The data show that Indigenous students brought deep curiosity, but it was relevance that sparked and sustained that curiosity in learning environments.

Associated Research Questions:

- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- Interactional Moves & Student Ingenuity
- CS & Technology

Key Child Codes:

Curiosity & Excitement; Personal Use & Relevance; Experiences & Expertise; Imagining CS; Tactile or Kinesthetic Approach; Examples of Technology

4. Theme: Tech as Sovereignty and Possibility

Description:

Students in this study demonstrated a growing awareness of the social, environmental, and ethical dimensions of technology and ideas for how to strengthen language revitalization, identity, and Tribal sovereignty and nation-building. They shared concerns about environmental impact and safety. At the same time, students imagined how technology could be used to empower their communities—whether through creative expression, cultural preservation, visibility, or bridging generations. These considerations reflected a deepening critical consciousness. For Indigenous students, CS was not just a technical skill set—it was a space to explore power, responsibility, and the potential to shape futures aligned with their values.

Associated Research Questions:

- **RQ1:** In what ways could CS support Indigenous language revitalization, nation-building, Tribal sovereignty, self-determination, and other forms of Indigeneity?
- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- CS & Technology
- Cultural & Relational Context

Key Child Codes:

Tech & Environmental Impact; Perceptions of CS & Technology; Technology as a Medium; Reflection & Self-Awareness; Internalized Beliefs; Empowerment

Subtheme: Tech, Land, and Environmental Impact

Description:

Students voiced growing awareness of how technology use affects the environment—from energy use and overheating servers to the broader footprint of AI systems. These concerns weren't abstract; they reflected a deep connection to land and a desire to protect it. For many students, understanding technology also meant understanding its consequences, making sustainability a central part of how they imagined responsible tech use in their communities.

Associated Research Questions:

- **RQ1:** In what ways could CS support Indigenous language revitalization, nation-building, Tribal sovereignty, self-determination, and other forms of Indigeneity?
- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

Tech & Environmental Impact; Perceptions of CS & Technology; Technology as a Medium; Reflection & Self-Awareness; Internalized Beliefs; Empowerment

Key Child Codes:

Interruptions; Gendered Interactions; Dismissal or Teasing; Peer Support

5. Theme: Structural and Material Access to CS

Description:

Although many students expressed interest in CS, their ability to pursue that interest was often shaped by access—access to devices, reliable internet, and opportunities both inside and outside of school. In this study, exposure to CS seemed to be relatively consistent at school, but

there remained significant technological gaps. These gaps weren't the result of individual disinterest or lack of ability—they reflected broader systemic inequities. For Indigenous students, access to CS is not just about the curriculum; it is about whether schools and communities have the structural capacity to support exploration and learning sustainably.

Associated Research Questions:

- **RQ3:** What does access to CS education and pathways look like for different Indigenous students and their communities?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s)

- Community Ecosystem & Access
- CS & Technology

Key Child Codes:

Internet Access; Resource Access; Financial Barriers; CS at Home; CS in School; External Organizations; Prior Educational Experiences

6. Theme: Student Voice and Ingenuity

Description:

Throughout the study, students demonstrated resourcefulness, self-awareness, and agency in how they engaged with CS. Their learning wasn't always linear or traditional—it emerged through exploration, boundary-setting, questioning, and collaborative problem solving. Some students asserted their preferences for how they learn best, whereas others expressed uncertainty or hesitation that still reflected active participation. These were not signs of disengagement but evidence of students navigating complex learning environments on their own terms. When space was made for dialogue, experimentation, and reflection, students' ingenuity became visible—not just in outcomes but in the processes of learning itself.

Associated Research Questions:

- **RQ2:** What are Indigenous students' and their communities' interests in CS education and career pathways?
- **RQ4:** What are the strengths (assets, resources, opportunities) that Indigenous students and their communities bring to CS?

Parent Code(s):

- Interactional Moves & Student Ingenuity
- Peer Dynamics & Interactions
- Facilitation Moves & Relational Pedagogy

Key Child Codes:

Questioning; Honest Uncertainty; Hesitation; Asserting a Boundary; Personalized Learning Preferences; Peer Support; Noticing; Naming & Defining

Appendix C. NaPs-RRG Additional Results and Instruments

Exhibit C–1. Recruitment Script, Email for Adult Participants

Dear <Insert Name>,

We are reaching out to you as part of a research team focused on understanding how to build better educational and career pathways for Native youth and tribal community members in the area of computer science. We would like to invite you to participate in an approximately 2-hour Talk Story dialogue in a focus group setting. The conversation will be centered on Indigenous voices and worldviews in computer science. This includes: 1) interest in computer science; 2) existing educational and community-based programming and tribal support systems that advance computer learning in the community; 3) gaps in existing programming; and 4) ideas for growing and building local computer science programming in ways that support tribal sovereignty and nation-building. Information about the research and the interview are shared below. We can offer you a $50 gift card for your contributions to the project. We will also be providing food and beverages.

The Talk Story Dialogue will take place on ***<insert date>*** *at* ***<insert time>****, at the* ***<insert location>****.*

If you are willing to participate please respond to this email. Upon your response, we will follow-up in another email with an informed consent form for you to look over, fill out, and return to us.

Thank you for your consideration and we look forward to your response.

Sincerely

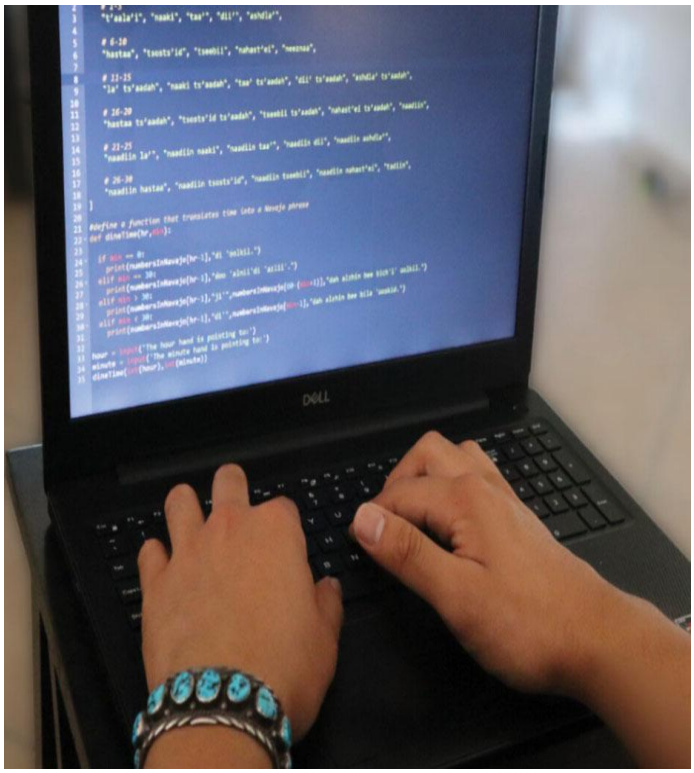
<Insert Research Team Member's Name>

Attachments

Exhibit C–2. Recruitment Script, Flyer

Volunteer to participate in a Talk Story Community Dialogue about Indigenous Computer Science

We will be offering food and beverages!



We would like to learn more about community interest in computer science from *youth*, *parents*, *Elders*, *tribal leadership*, and *knowledge holders*.

Your participation would include a 2-hour, in-person, group activity and dialogue about:

- Opportunities and barriers for Native youth and tribal communities in computer science
- Ideas for growing computer science pathways (education and careers) to support tribal sovereignty and nation-building
- How to bring computer science learning to your community, schools, and informal education spaces

Volunteers will be offered $## / backpacks with school supplies.

To sign up or if you'd like more information, **please contact**:

Xxxxxxx at (###)###-### OR email us at xxxxx@xxxxxx.com

Event Date, Time | Event Location

Exhibit C–3. Recruitment Script,

About the ICS-AFE Indigenous Computer Science Study

The bullet points provide you with more details about the study so you can make an informed decision about your participation.

- *The study is being done by a group of research partners. The study aims to better understand how Native youth can enter computer science education and careers, or what might make it easier for them to enter computer science education and careers.*
- *Your participation is voluntary, which means you do not have to be part of this study and nothing bad will happen (such as not being able to be part of your program or getting a bad grade) if you don't want to participate.*
- *A Talk Story session is a dialogue with a group of people from your community that is led by the researchers. It is similar to a focus group, however, the research team has Indigenized the process to make it more inviting and culturally relevant to Native people.*
- *You are free to skip any questions, you can choose to not participate in any of the dialogue areas, and you can leave the Talk Story group at any time for any reason.*
- *The Talk Story conversation will take about 2 hours and will take place in-person following your community or school's COVID-19 safe practices (e.g. masks, meeting outdoors).*
- *The focus group will be recorded if you and everyone in the group agrees; and we will take detailed notes with flip charts, butcher paper and sticky notes.*
- *What you say will be kept confidential, which means that your name and any personal information will not be used in reporting.*
- *Audio files and transcripts (with names and personal information removed) will be stored in a password protected drive that only the research team will be able to access.*
- *Data will be summarized across the whole group. Key themes will be used to inform future Computer Science programming and further research to understand how to best support Native youth and communities in Computer Science.*
- *The de-identified data (e.g. transcripts, databases) will be stored for up to 7 years in a password protected drive only accessible to the research team and may inform future research or peer-reviewed publications; the data will be destroyed after 7 years.*
- *The Project Sites (e.g. schools, tribal community centers) will be provided a subset of the de-identified data, upon their request. The Research Team will also work with the <Insert Tribe> to identify additional protocols for the protection and archiving of the data based on their own tribal research approval processes.*
- *Findings from the study may be included in internal reports, presentations to other researchers, educators and community members, and peer-reviewed articles.*
- *All tribal communities will be acknowledged in authorship for any publications emerging from this study.*

For more information contact:

Dr. Shelly Valdez, PI _____at or Jill Stein, PI at _____.

Exhibit C–4. Assent Form, Adult

Indigitize Computer Science, Amazon Future Engineer

Community-Based Talk Story Dialogues on Computer Science Pathways in Indigenous Communities

Adult Consent Form

The Native Pathways and Reimagine Research Group (NaPs-RRG) are doing a study in your community. The goal of the research is to find out how Native youth can learn and gain interest in computer science. For this research we are asking you to join in a Talk Story session with a group of parents, Elders, community leaders, and knowledge holders, teachers, and practitioners. The Talk Stories will discuss some of the following questions: *What are community strengths (individual, family, community) that can help Native students succeed in computer science education and careers? What are youths' interests in computer science? What are some of the challenges and barriers to computer science learning for students? How can computer science benefit Native communities?*

The Talk Stories are interactive and will take about 2 hours. The session will take place in the community. If you allow us, we will audio record the session. We will also take notes with flip charts, butcher paper and sticky notes. We will keep what you share with us private. We will not share any of your individual statements, or ideas with others outside of the research team. Your information will be combined with others when we report about what we have learned. Individual names or personally identifying information will be removed from all audio files, transcripts, and notes. The deidentified transcripts will be stored in a password protected drive for at least 7 years.

We do not expect any risks to your safety or wellbeing during your participation in this study. There are no direct benefits for taking part in this study. But, we hope to learn how the computer science education can better support programs in Native communities and help address community needs. To thank you for taking part, you will be provided with a $50 gift card.

You should know that:

- You do not have to be in this study if you do not want to.
- You do not have to answer any question you do not want to answer.
- You can ask any questions you have, now or later. If you think of a question later, you or your parents can contact Dr. Shelly Valdez, PI _____at or Jill Stein, PI at _____.
- You can also contact the AIR Institutional Review Board (IRB) at **IRB@air.org**, toll free at **1-800-634-0797**, or in writing **c/o IRB, 1000 Thomas Jefferson St. NW, Washington, DC 20007**.

Sign this form only if you:

- have read the study information shared above

- have had all your questions answered,
- agree to take part in this research,

_____

Your Signature Printed Name Date

Exhibit C–5. Assent Form, Parent/Guardian

Indigitize Computer Science, Amazon Future Engineer

Wise Practices Community-Based Talk Story Dialogues on Computer Science Pathways in Indigenous Communities

Parental/Guardian Permission Form

The Native Pathways and Reimagine Research Group (NaPs-RRG) are doing a study in your community. The goal of the research is to find out how Native youth can learn about and gain interest in computer science. For this research we are asking for your permission (as the parent or guardian of a youth participant) to allow your youth to join in a Talk Story session with a group of other youth. The Talk Stories will discuss some of the following questions: *What are youth strengths that can help Native students succeed in computer science education and careers? What are youths' interests in computer science? What are some of the challenges and barriers to computer science learning for students? How can computer science benefit Native communities?*

The Talk Stories are interactive and will take about 2 hours. The session will take place in the community. If you allow us, we will audio record the session. We will also take notes with flip charts, butcher paper and sticky notes. We will keep what the youth share with us private. We will not share any of their individual statements, or ideas with others outside of the research team. For example we will not share the youth's individual statements with parents/guardians, teachers, mentors, or peers. The information gathered from the session will be combined with others statements when we report about what we have learned. Individual names will be removed from audio files, transcripts, and notes. The deidentified transcripts will be stored in a password protected drive for at least 7 years.

We do not expect any risks to the safety or wellbeing for youth during their participation in the study. There are no direct benefits for taking part in this study. But, we hope to learn how computer science education can better support programs in Native communities and help address community needs. To thank the youth for taking part, they will be provided with a $50 gift card.

You should know that:

- This study is voluntary. You do not have to give permission for your youth to take part in this study if you do not want to.

- The youth who take part do not have to answer any question they do not want to answer.
- You can ask any questions you have, now or later. If you think of a question later you can contact Dr. Shelly Valdez, PI at 505-550-4189 or shilaguna78@gmail.com, or Jill Stein, PI at 541-740-1311 or jill@reimagineresearchgroup.com.
- You can also contact the AIR Institutional Review Board (IRB) at **IRB@air.org**, toll free at **1-800-634-0797**, or in writing **c/o IRB, 1000 Thomas Jefferson St. NW, Washington, DC 20007**.

Sign this form only if you:

- have read the study information above
- have had all your questions answered,
- have talked to your youth about this project, and
- agree to allow your youth to take part in this research

_____

Your Signature Printed Name Date

Name of youth: _____

Exhibit C–6. Assent Form, Youth

Indigitize Computer Science, Amazon Future Engineer

Community-Based Talk Story Dialogues on Computer Science Pathways in Indigenous Communities

Youth Assent Form

The Native Pathways and Reimagine Research Group (NaPs-RRG) are doing a study in your community. The goal of the research is to find out how Native youth can learn and gain interest in computer science. For this research we are asking you to join in a Talk Story session with a group of other youth. The Talk Stories will talk about some of the following questions: *What are youth strengths that can help Native students succeed in computer science education and careers? What are youths' interests in computer science? What are some of the challenges and barriers to computer science learning for students? How can computer science benefit Native communities?*

The Talk Stories are interactive and will take about 2 hours. The session will take place in the community. If you allow us, we will audio record the session. We will also take notes with flip charts, butcher paper and sticky notes. We will keep what you share with us private. We will not share any of your individual statements, or ideas with others outside of the research team (for example with your parents/guardians, teachers, mentors, or peers). Your de-identified information will be combined with others when we report about what we have learned. Individual names will be removed from audio files, transcripts, and notes. Deidentified transcripts will be stored in a password protected drive for 7 years.

We do not expect any risks to your safety or wellbeing during your participation in this study. There are no direct benefits for taking part in this study. But, we hope to learn how the computer science education can better support programs in Native communities and help address community needs. To thank you for taking part, you will be provided with a <insert incentive agreed upon with the tribal site or community-based program>.

You should know that:

- You do not have to be in this study if you do not want to. You won't get into any trouble with the research team, your parents/guardians, teachers or peers if you say no.
- You don't have to answer any question you don't want to answer.
- Your parent(s)/guardian(s) were asked if it is OK for you to be in this study. **Even if they say it's OK, it is still your choice whether or not to take part.**
- You can ask any questions you have, now or later. If you think of a question later, you or your parents can contact Dr. Shelly Valdez, PI at 505-550-4189 or shilaguna78@gmail.com, or Jill Stein, PI at 541-740-1311 or jill@reimagineresearchgroup.com.
- You can also contact the AIR Institutional Review Board (IRB) at **IRB@air.org**, toll free at **1-800-634-0797**, or in writing **c/o IRB, 1000 Thomas Jefferson St. NW, Washington, DC 20007**.

Sign this form only if you:

- have read the study information above
- have had all your questions answered,
- have talked to your parent(s)/legal guardian about this project, and
- agree to take part in this research

_____

Your Signature Printed Name Date

Name of Parent(s) or Legal Guardian(s): _____

Exhibit C–7. Talk Story Protocol and Dialogue Guide

The research team will conduct the Talk Story dialogue sessions following the RTBR process, developed by the YAKANAL: Indigenous Youth Culture Exchange and the Cultural Conservancy partnership. This technique is commonly used in design thinking projects[146] and was Indigenized by the YAKANAL team and shared with our research team. From an Indigenous worldview, the process reflects nature as our guide: "learning from our oldest teachers, the plants." The research team will work with the Tribal points of contact and school or community-

[146] Woods et al., "Partnering in Digital Health Design." Woods et al., "Partnering in Digital Health Design."

based program partners to cocreate additional study questions that the Tribal community or partners may have related to CS education pathways and careers.

Depending on the community members we are engaging, the interview discussion may use a variety of data gathering techniques to administer the following Talk Story guide; for example, rather than a typical focus group interview, the research team may use sticky notes as a tool for people to write down their reflections to the questions, then ask some of the participants to share their reflections. Similarly, the participants may be invited to discuss the questions in small groups and provide group feedback. Participants may also be invited to draw a rose (individually or in a group), put their responses to the questions on their drawings, and later discuss their drawings with the larger group. These data collection techniques are more interactive, allow for multiple learning styles, and can be more inviting for and inclusive of participants who may be less inclined to speak up in a group setting.

Talk Story Guide

We would like to invite you to engage in a dialogue, using a process called Rose, Thorn, Bud, and Roots. This technique is commonly used in design thinking projects and was Indigenized by the YAKANAL team and shared with our research team. From an Indigenous worldview, the process reflects nature as our guide: "learning from our oldest teachers, the plants." (Note that the questions shared in each area are a **menu of options;** researchers would not ask all of the questions of any one individual or group.)

Before we begin, we'd like to ask:

- Have you heard the term "computer science" before?
- When you think of the term "computer science," what comes to mind?
- How would you describe your/your community's connection to CS?

*Just so we are all on the same page, we'd like to share **how our team understands CS in relation to Indigenous communities:***

Computer science is a broad field that can mean many things. Yet, put simply, Indigenized CS can be described as a creative journey to make and use computers in ways that align with students' Indigenous cultures and lifeways. This includes the design of the actual hardware (e.g., laptops, smartphones, tablets, robots, servers) and software (e.g., video games, databases, apps, operating systems).

One example of an Indigenized CS could include the creation or use of an app to learn one's Indigenous language. Another example could include the creation or use of a video game that

relies on traditional stories for the game storyline and objectives. Both examples could take place on a laptop or smartphone.

Other examples are the use of drones in a natural resources office to help with overseeing environmental caretaking, such as wildlife management and data and Tribal historic preservation areas, or an app for Indigenous plant identification and/or medicinal uses.

Rose Flower (Strengths)—*We are interested in learning about strengths and assets that individuals and/or communities bring to support CS learning and CS careers for Indigenous people. We invite you to share your thoughts in the following areas:*

- *Have you ever had an interest in CS classes or future careers in CS?*
  - *What interested you the most about CS (e.g., careers, academic courses, applications, how it can be used to help the Tribal community)?*
  - *Have you ever pursued your interest in CS (e.g., signed up for a class, spoken with a mentor or school counselor about CS, attended a CS camp or afterschool program)?*
- *What are some ways that you have been exposed to or had access to CS (e.g., through school, work, or at home)?*
- *What programs or practices already exist in the community to support youth's education and community-based learning relating to CS?*
- *What opportunities are there for Native youth to go into CS-related careers, especially in a way that supports community needs and values (nation-building and Tribal sovereignty)?*
- *What are some youth strengths that can help Native students succeed in CS education and careers?*
- *What community strengths can help support Native students succeed in CS education and careers?*
  - ***(Q for Teachers/Admin)****: How are Indigenous worldviews, core values, and ways of knowing a part of current policymaking and decision making (e.g., regarding CS coursework, curriculum, learning environments)?*

Thorn (Gaps and Challenges)—*The thorns on a plant are its protective mechanism and serve an important purpose; they teach us to be mindful and aware. In thinking about CS pathways (education and careers), we invite you to share your thoughts concerning:*

- *What are some of the barriers or challenges that might limit youth from pursuing CS?*
- *What are some of the barriers or challenges that might limit access to CS learning for students in your community?*

- *What are some of the barriers or challenges that might limit Native people from going into a CS career?*
- *What supports, mechanisms, or elements might be needed to improve access and interest in CS education and careers?*
- *What generational barriers exist that may hinder CS interest, exposure, or learning (e.g., generational knowledge about CS)?*

Bud (New Ideas, Emerging Needs)—*The bud area represents new ideas or emerging needs. In thinking about CS pathways (education and careers) for Indigenous youth and communities, we invite you to share:*

- *What are the needs of Indigenous students and their communities to fully access CS education and pathways?*
- *What kinds of resources do youth need at home and school (college) to be able to engage in CS learning?*
- *What ideas do you have for growing CS learning and careers in your community or for Native youth and community members more broadly?*
  - *What ideas do you have for CS tools that you could build for your community (e.g., Indigenous community social platforms, language learning and storytelling apps, Indigenous well-being apps, Indigenous Google Maps)?*
  - *What are ways to get Native youth interested in CS education or careers?*
  - *What factors influence or support Indigenous students' choices to pursue CS?*
  - *What are the best ways to expose youth to CS (at home, school, other environments)?*

What support is needed to respectfully engage parents, community members, and Tribal leaders in CS?

How can we grow more Native mentors who can support youth interested in CS?

Roots (Connections to Place and Core Values)—*Roots attach a plant to a place and community. Thinking about CS and technology and Indigenous communities, we invite you to share:*

- *What would CS immersed in Indigenous core values look, sound, or feel like?*
  - *How can CS be Indigenized? Should it be Indigenized?*
  - *What are the core values you would like to see in CS education or programs?*
- *How can CS education support and incorporate Indigenous ways of knowing?*

- *What ideas do you have for CS, community-based programming, educational environments, and tools that can help with nation-building from a cultural lens to support community lifeways and strengthen Tribal sovereignty?*
  - *How do you think CS programming and careers can benefit Tribal communities (i.e., nation-building, Tribal sovereignty)?*
  - *How can CS benefit urban or rural Indian populations (e.g., careers)?*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Research Group