

Indigenous Computer Science Study: *Literature Scan*

American Institutes for Research

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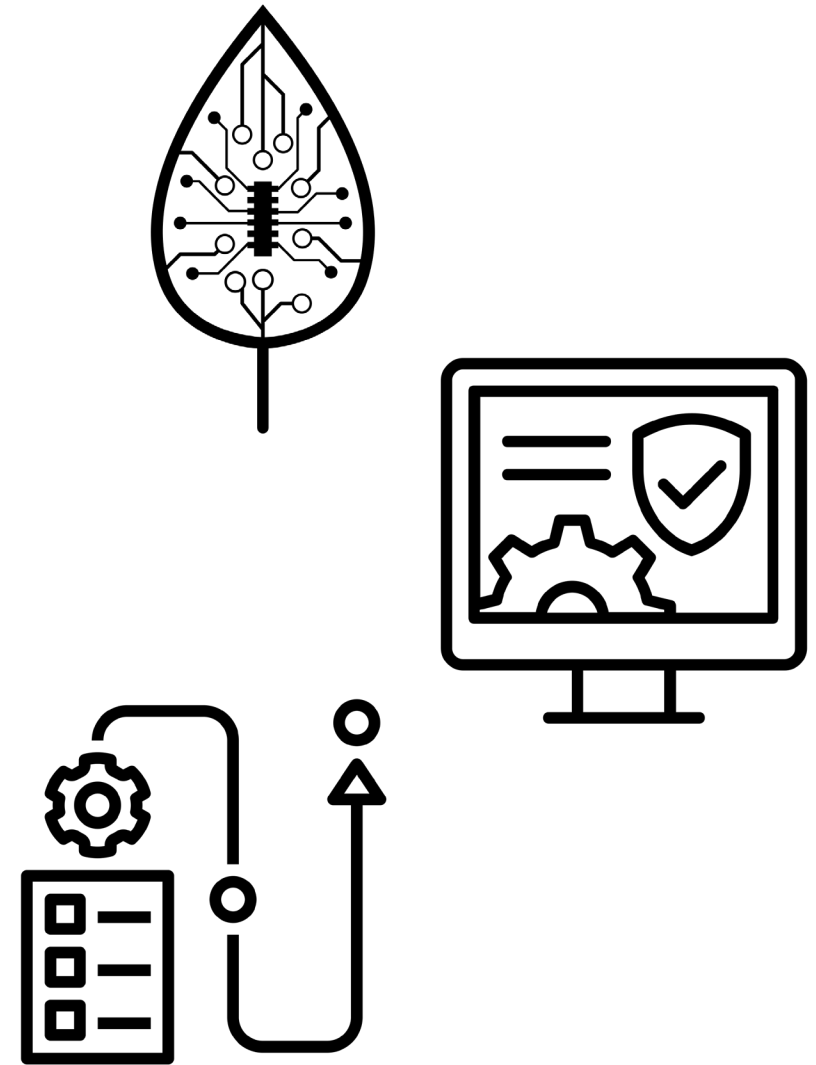
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Agenda

1. What is the purpose of the literature scan?
2. How did we conduct the literature scan?
3. What are our key findings?
4. Considerations and next steps
5. Supplemental slides – demographic overview



What is the purpose of the literature scan?

What is the purpose of the literature scan?



Literature Scan Approach: AIR examined the state of and conducted a scan of the literature on student interest in and access to computer science (CS) for Indigenous youth.

Why is this important?

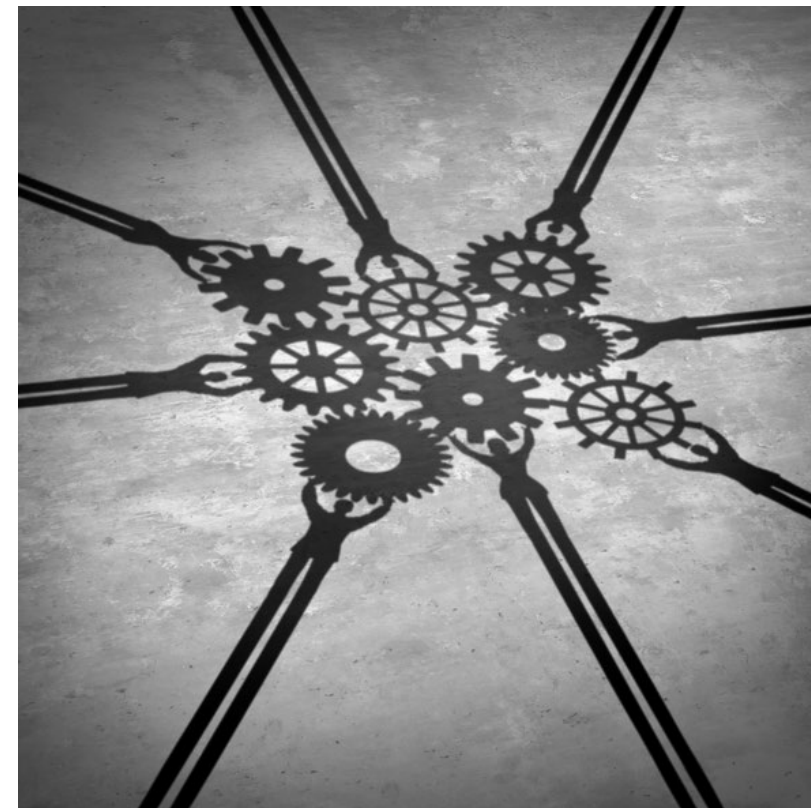
This task is one piece of a larger coalition-based study will explore access to and visions for high-quality CS education centered on and for Indigenous students and tribal communities.



Where does the literature scan fit within the larger study?



Overall Study Goal: Results from the study will help improve CS educational pathways for Indigenous youth and support nation building, tribal sovereignty, and self-determination within tribal communities.

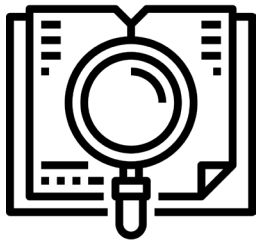


How did we conduct the literature scan?

Steps to conduct the literature scan



1. We searched the known literature for articles, websites, and other documents related to the topic.
2. We screened results to determine which were relevant to the topic.
3. We coded the relevant documents descriptively and qualitatively.
4. We analyzed the coding for common themes and topics.

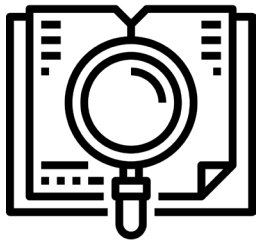


How did we search the known literature?

- We identified four broad concepts to inform and develop our literature scan search terms:
 - Indigenous populations
 - Computer science
 - Access/interest (also included terms related to student identity and culturally relevant education)
 - Middle and high school students
- For each concept, we selected terms to use in searching the databases.
- We also conducted gray literature and snowball searches.
- Our results were limited to articles^a published in English in 2010 or later.

^aSearch results included websites, blog posts, videos, and other types of content as well as traditionally published articles; we did not limit by publication type. We use “article” throughout this presentation for simplicity.

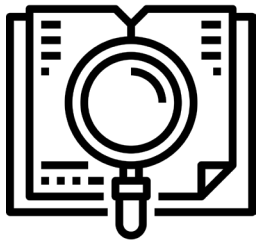
What search terms did we use?



Concept	Search terms used
Indigenous populations ^b	Indigenous OR “Native Americans” OR “American Indians” OR “Alaska Natives” OR “Eskimos” OR “Hawaii Natives” OR “Pacific Islanders” OR “First Nations” OR “Canada Natives” OR Aboriginal OR Maori OR “Native Hawaiian” OR “Samoan”
Computer science	“computer science” OR CS OR “digital technology” OR “virtual reality” OR “gaming” OR “immersive technology” OR “coding OR “programming” OR “robotics”
Access/interest	access OR availability OR interest OR promotion OR recruitment OR attitudes OR “identity” OR “interdependence” OR “Indigenous language” OR “culturally relevant” OR “culturally responsive” OR “giving back” OR “give back”
Middle and high school students	elementary OR primary OR secondary OR “middle school” OR “high school” OR “grade 5” OR “grade 6” OR “grade 7” OR “grade 8” OR “grade 9” OR “grade 10” OR “grade 11” OR “grade 12” OR teenagers OR adolescents OR youth

^b We recognize that not all these terms are considered appropriate in all contexts, but they are or have been in common use as subject terms in article databases.

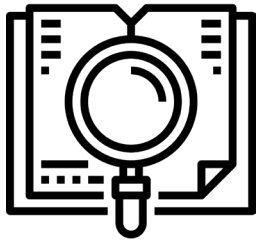
Terms of two or more words were searched in quotation marks so that the databases would return only exact matches.



How did we screen the search results?

First Round

- We answered the following questions for each article:
 - Is the article related to youth interest in and/or access to CS education?
 - Is the article about an Indigenous youth population in the United States, Canada, Australia, or New Zealand?
 - Is the article addressing fifth grade through high school CS?
- Articles were screened based on title, abstract, and additionally full text if necessary.

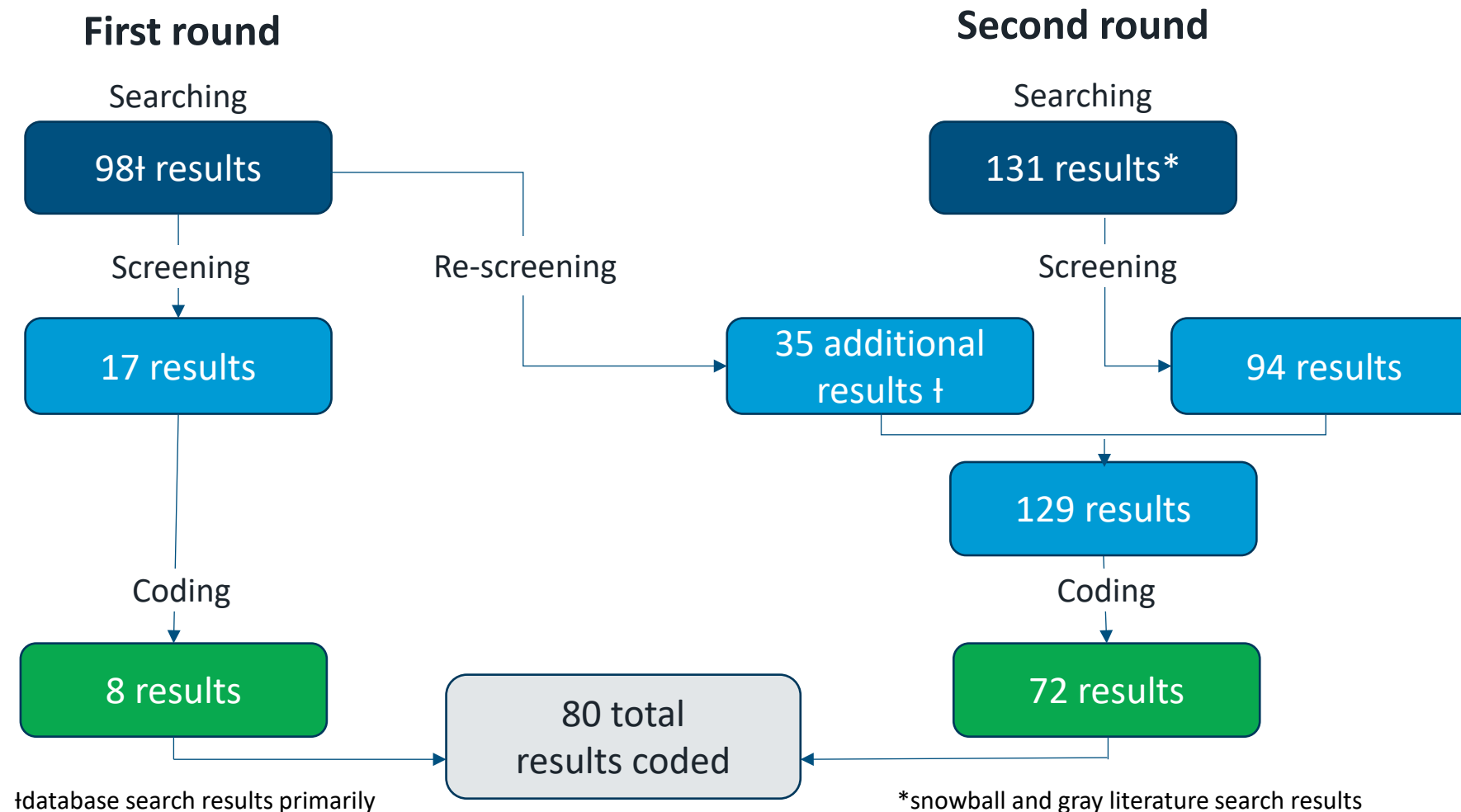


How did we screen the search results?

Second Round

- Relatively few articles passed the first screening, so we rescreened the results with the following expanded criteria:
 - STEM (generally) as well as technology and engineering
 - Indigenous populations located anywhere in the world, including Hispanic/Latinx populations in the Americas
 - An expanded age group to include kindergarten through fourth grade
- The gray literature and snowball searches were conducted with search terms that included the expanded criteria.

Literature Review Scan Counts





How did we code the results? Descriptive Codes

- Is the article a research study? If so what kind?
- Population covered
 - Nation/tribe/pueblo/other group
 - Age group
 - Do students live on a reservation?
- Setting
 - Region, locale, location
 - In school/outside school time/nonschool setting
 - Reservation school or other?
- Is the article about an intervention? If so, describe.
- Indigenous sources
 - Do researchers/authors identify as Indigenous?
 - Research/organization sponsored by Indigenous source?
 - Indigenous publisher?
 - What approach, if any, is taken toward working with Indigenous populations?

How did we code the results? Qualitative Codes



Code category	Definition/instructions
Student identity	Encouraging students to develop their identity as Indigenous people: developing a good relationship with the natural world, giving back to the community, defined not just as other people but places and all living creatures.
Student interest in CS/related fields	Efforts to encourage students to take CS/STEM classes and/or pursue these interests outside class time, as a career, and so on.
Student access to CS/STEM courses	Offering new courses in these areas and/or improving placement policies to allow more students to take them (such as programs encouraging counselors to enroll students in CS courses), especially with an eye toward equity and inclusion for these students. Also includes whether courses encourage Indigenous learning strategies such as Ways of Knowing or Traditional Ecological Knowledge.



How did we code the results? Qualitative Codes

Code category	Definition/instructions
Student learning in CS/STEM courses	Measurement of student learning outcomes in CS courses or programs (e.g., grades, test scores, academic progress).
Providing students with CS/STEM role models	For example, mentoring programs that connect Indigenous students with Indigenous college students or professionals in the field.
Family/community support for CS/STEM education	Involving parents, other family members, and/or members of the wider community in students' CS/STEM education, particularly anything related to Indigenous family and community support strategies.
CS/STEM content knowledge	Focusing on particular content/topic areas within CS, such as algorithms and computational thinking.



How did we code the results? Qualitative Codes

Code category	Definition/instructions
Learning strategies in CS/STEM	Updating CS/STEM curricula, coursework, pedagogies, and/or program content to include Indigenous pedagogies, knowledges/sciences, languages, methodologies and values (e.g., story, oral tradition, language revitalization, giving back to one’s human and more-than-human relations).
Student engagement in CS/STEM courses	Defined as engaging students who are already taking CS/STEM courses.
Gender gaps in CS/STEM	Anything related to encouraging Indigenous girls, women, and other gender minorities (e.g., nonbinary/Two Spirit students, transgender boys/men) to pursue CS/STEM coursework and/or careers.



How did we code the results? Qualitative Codes

Code category	Definition/instructions
Teacher cultural responsiveness	Teacher cultural understanding in how to work with Indigenous students. Also includes the cultural understanding of teachers, administrators, and other adults.
Institutional cultural responsiveness	Academic/community institutions being responsive to the needs, learning styles and experiences, and languages and culture of Indigenous students.
Student CS/STEM self-efficacy	Encouraging students to think of themselves as CS/STEM learners, professionals, and/or scientists and/or to be confident in their ability to learn CS/STEM. Includes students thinking of themselves as Indigenous scientists (versus Western scientists): being a “good ancestor” or “good relative”, taking identity and positionality, for example, into account.
Access to technology	Providing student and community access to the Internet, broadband, computers, software, and technology in general.

How did we code the results?

Qualitative Codes

In all categories, coders also looked for findings related to the following:

A focus on Indigenous cultural traditions:

- Use of Indigenous language
- Use of Indigenous cultural practices



How did we code the results?

Qualitative Codes

In all categories, coders also looked for findings related to the following:

- Use of Indigenous learning strategies, such as
 - storytelling,
 - oral tradition,
 - language revitalization,
 - giving back to one's human and more-than-human relations,
 - Indigenous Ways of Knowing, and
 - Traditional Ecological Knowledge.





How did we code the results? Qualitative Codes

In all categories, coders also looked for findings related to the following:



- The development of Indigenous identities and values for students, teachers, family, and/or the wider community.
- Improving equity and inclusion for Indigenous students, such as
 - Indigenizing curricula;
 - cultural diversity training for teachers, administrators, and non-Indigenous students; and
 - increased hiring and/or welcoming environment for Indigenous teachers.



How did we code the results? Qualitative Codes

- Coders entered findings about STEM in general only if the article had no findings on CS specifically.
- Coders did not enter findings about specific STEM fields, except for CS, robotics, computer technology, or engineering.
- If the source included both Latinx and other Indigenous populations, coders noted whether the findings related to the Latinx population, other Indigenous populations, or both.

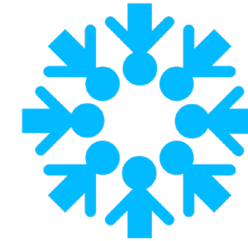




How did we analyze the results?

We grouped the findings into six themes:

- **Theme 1:** Indigenous student interest in CS
 - Student interest in CS and related fields
 - Family/community support for CS/STEM education
 - Student engagement in CS/STEM courses
- **Theme 2:** Indigenous student access to CS
 - Student access to CS/STEM courses
 - Gender gaps in CS/STEM
 - Access to technology

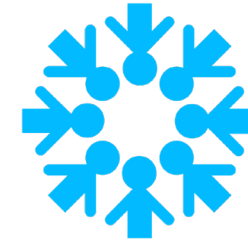




How did we analyze the results?

We grouped the findings into six themes:

- **Theme 3:** Indigenous student learning in CS
 - Student learning in CS/STEM courses
 - Learning strategies in CS/STEM
 - CS/STEM content knowledge
- **Theme 4:** Indigenous student self-concept as CS learners
 - Student identity
 - Student CS/STEM self-efficacy

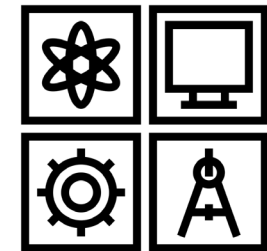


How did we analyze the results?



We grouped the findings into six themes:

- **Theme 5.** Use of culturally responsive practices in CS education with Indigenous students
 - Teacher cultural responsiveness
 - Institutional cultural responsiveness (i.e., how institutions support Indigenous students)
- **Theme 6:** CS career preparation for Indigenous students
 - Providing students with CS/STEM role models
 - Connecting students with CS/STEM career pathways
 - Preparing students for college-level CS/STEM courses



What are our key findings?

What are our key findings?



1. Many strategies used with Indigenous students are not necessarily specific to them; rather, they are best practices for working with all communities of racialized minorities. More research is needed that focuses specifically on Indigenous students and their unique needs.



2. Although research in this area is limited, Indigenous students are more likely to connect with science lessons when they include content and concepts relevant to their lives.



3. Indigenous students respond well to a student-centered environment.

What are our key findings?



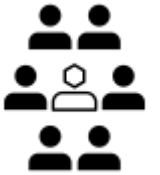
4. There is a notable focus on increasing access to CS for Indigenous girls.



5. Some common challenges relating to Indigenous student access to and interest in CS:

- Lack of exposure to technology and CS, especially for younger children
- Lack of familiarity/resources for non-Indigenous teachers
- Treating all Indigenous cultures as the same when they are not
- Not all Indigenous practices are appropriate for the classroom or sharing with those not from the Indigenous community
- Not enough data on the current status of Indigenous computer scientists

Finding 1: Not Enough Resources and Research Specific to Indigenous Students



Many strategies that we found in the research literature were not designed to meet the specific needs of Indigenous students.

- Culturally responsive teaching
- CS training and application programs
- Mentoring
- Community outreach
- Family engagement



These strategies are all evidence-based practices for teaching racialized minorities according to Western educational research.

More research is needed to focus on what is most effective with Indigenous students specifically.



Finding 2: Relevance and Cultural Specificity

Indigenous students are more likely to connect with science lessons when they include content and concepts relevant to their lives.

Perhaps this statement seems obvious, but in practice, Western science is the default in CS/STEM education, and instructional content and pedagogy rarely reflects the lives and culture of Indigenous students.



Finding 2: Relevance and Cultural Specificity: Examples

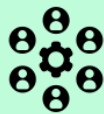
Promotion of Indigenous values

Storytelling/storywork
(25 mentions)



- » One of the most common strategies used; this strategy is perhaps the most often associated with Indigenous learners by non-Indigenous researchers and educators.
- » This strategy includes using stories as a teaching tool and encouraging students to tell their own stories.

Collaborative learning
(7 mentions)



- » Students who worked together to build a robot showed growth in subject knowledge and team building.¹
- » Families who worked together on robotics and e-textiles projects learned concepts and strengthened their bonds.²



Finding 2: Relevance and Cultural Specificity: Examples

Promotion of Indigenous values

Learning by example from elders (7 mentions)



- » Indigenous role models help students see themselves as computer scientists.
- » The e-textiles project that involved sewing engaged students and families because parents could help their students with science homework for the first time.^{3,c}

“Many of my Latino students have parents and relatives that are expert sewers and expert sewing teachers. For the first time in their academic careers<,> many of my Latino students received instruction and help with their homework from their parents or family members. Many Latino parents in our town do not speak English and often express their frustrations of not understanding their children’s homework, not being able to help their children, and not knowing what homework is due. E-textiles helped generate interest in my students’ schoolwork through something as simple as sewing.”⁴

^cExample is from a Latinx population.



Finding 2: Relevance and Cultural Specificity: Examples

Promotion of Indigenous values

Living in harmony with the
natural environment
(7 mentions)



- » Use traditional stories about weather patterns to connect to meteorological phenomena.⁵
- » A mentoring program provided students with learning opportunities in nature as well as within the computer lab.⁶

Use of heritage languages
(5 mentions)



- » Programming languages can teach students computer programming and their heritage language at the same time.⁷
- » A smudging routine was included in Cree programming language at the start of every new project.⁸

Finding 2: Relevance and Cultural Specificity: More examples



Including Indigenous culture, stories, and cultural symbols in assignments and/or tools



- » A tool to create animations that included image assets related to their culture (e.g., native plants, animals, legendary figures) got students more excited about using the tool to create their own stories.^{9,10}
- » Building a Pit House instead of the typical bridge for an engineering assignment about designing robust structures¹¹

Giving students the choice of projects to work on/create their own stories



- » One student who described herself as a “hater of school science” became deeply engaged in an e-textiles project that she was able to design herself.¹²

Indigenizing curriculum



- » Design a science curriculum from the ground up to incorporate Indigenous perspectives, learning styles, and Ways of Knowing.¹²

Finding 3: Student-Centered Environment



Acknowledge the interchange between student and teacher roles to create a more culturally responsive and welcoming environment.

Teachers as
students

Students as
teachers

Community-
based learning



Finding 4: CS Access for Indigenous Girls

There is a notable focus on making CS and STEM more accessible to Indigenous girls and women.

Girls were the only subgroup among Indigenous students who were the clear subject of any intervention.

Approaches

- Eighteen articles were coded as relevant to closing gender gaps.
- Curricula/lesson plans
- Summer/afterschool programs
- Programming clubs
- Workshops
- Teacher training
- Professional organizations



Finding 5: Common Challenges

Challenges commonly seen relating to Indigenous student access to and interest in CS include the following:

Lack of exposure to technology and CS, especially among younger children

- Nineteen articles were coded as relevant to increasing access.
- Robotics and coding are introduced to White Mountain Apache students starting in fifth grade to increase access at an earlier age.¹⁴

Lack of familiarity with Indigenous culture and student needs/resources for non-Indigenous teachers

- Teachers expressed gratitude and difficulty while engaging with their students in a humanoid robotics curriculum simultaneously focused on coding and the Narungga language.¹⁵

Treating all Indigenous cultures as the same when they are not

- Frieda McAlear, who developed a CS curriculum for Native American girls, discussed how the response from girls improved when she worked closely with their communities to make the courses more relevant to their own lives.¹⁶



Finding 5: Common Challenges

Challenges commonly seen relating to Indigenous student access to and interest in CS include the following:

Not all Indigenous practices are appropriate for the classroom and/or sharing with outsiders

- Some participants from Native Girls Code expressed a desire to keep the Indigenous information they learned secured on an internal site.¹⁷

Not enough data on current representation of Indigenous people in CS and related fields

- The issues with identifying Indigenous people in all types of statistical analysis are well documented, and it is particularly difficult in making an accurate count for representation in tech.¹⁸

Considerations and next steps

What voices are left out of the literature scan using this approach?

- The literature scan provides us one lens to understand what is known about the state of student interest in and access to CS for Indigenous youth.
- This study focused on mainly academic resources found in journal articles, scholarly/academic and/or computer science specific websites.
- Much of the sources did not report or cited a lack of Indigenous involvement in the process (see demographic overview slides).



What voices are left out of the literature scan using this approach?

- Among the studies that reported location, rural setting and other public-school types was most frequently reported (see demographic overview slides).
- Most studies focused on a high school population and most of the interventions were held outside of a school setting (see demographic overview slides).
- The most common label found in the studies to identify participants were general Native American or general Indigenous.



Next Steps

- **Wise Practices** interviews with community members and elders to supplement the literature scan findings
- **Code.org analysis** to provide a national summary of access to computer science
- **Community Research** with Indigenous communities to gain an understanding of computer science within these communities and ways to frame a future study



Limitations

There are some possible limitations with the methodology used to search and identify the literature for the results of the scan. Here is a summary of some of those limitations:

- Some key studies may have been omitted due to the time period specified for the literature scan (2010 or later). The team intentionally choose this time frame to capture current literature and to align with the growth of computer science education, but it is possible some key studies were conducted prior to 2010.
- The grey literature and snowball searches aim to provide a more comprehensive and expanded search outside the confines of a traditional literature scan. But these two methods are not necessarily as systematic in process and overlook potential literature sources.
- CS education is an emerging field, particularly at the middle school level and below. Practitioners and researchers are still building vocabulary, methodologies, and venues for sharing their work. Also, expanding our scope to include STEM in general provided us with more results, but it is hard to know which general STEM strategies are applicable to CS specifically.
- Because of the nature of the literature and the sources available, most of these studies were conducted by non-Indigenous researchers, institutions, and/or funders. Therefore, they may not have been conducted with Indigenous data sovereignty in mind, adequately protected study participants, and/or involved Indigenous communities in research design or the reporting of results.

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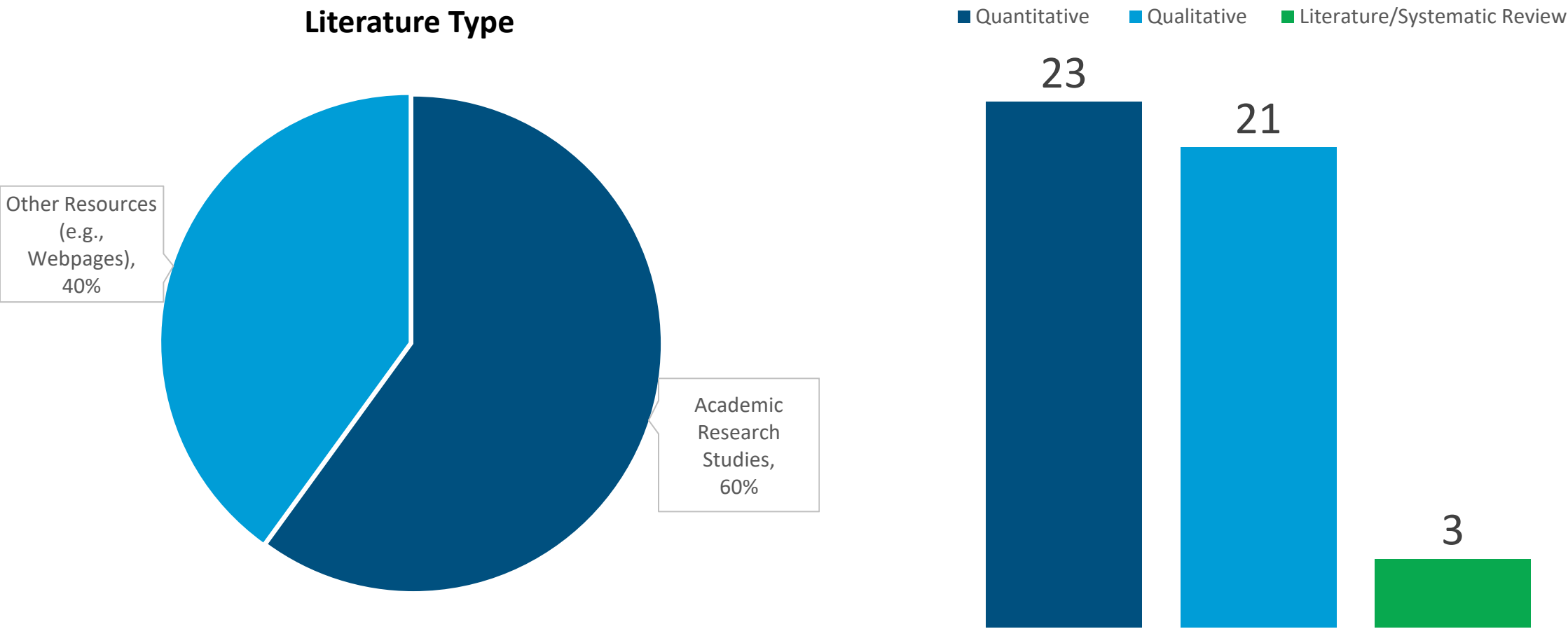
Supplemental Slides

Demographic Overview of Literature Scan

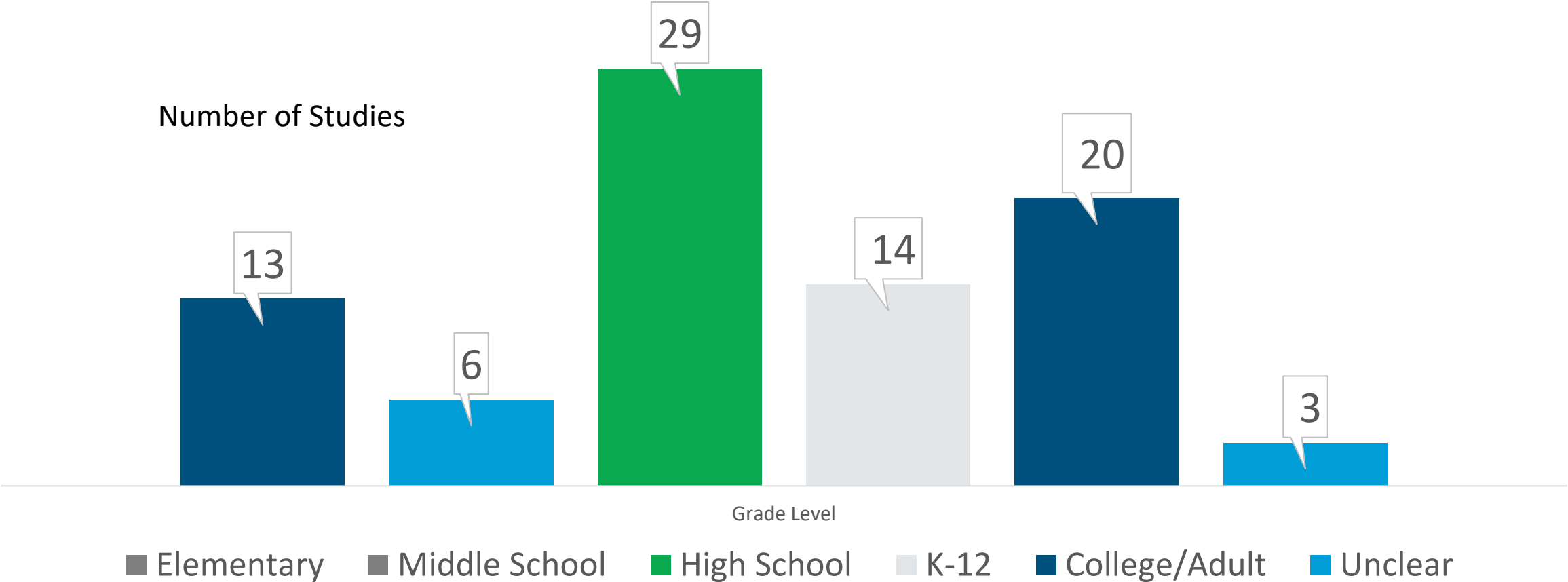
A majority of the literature was conducted in North America.



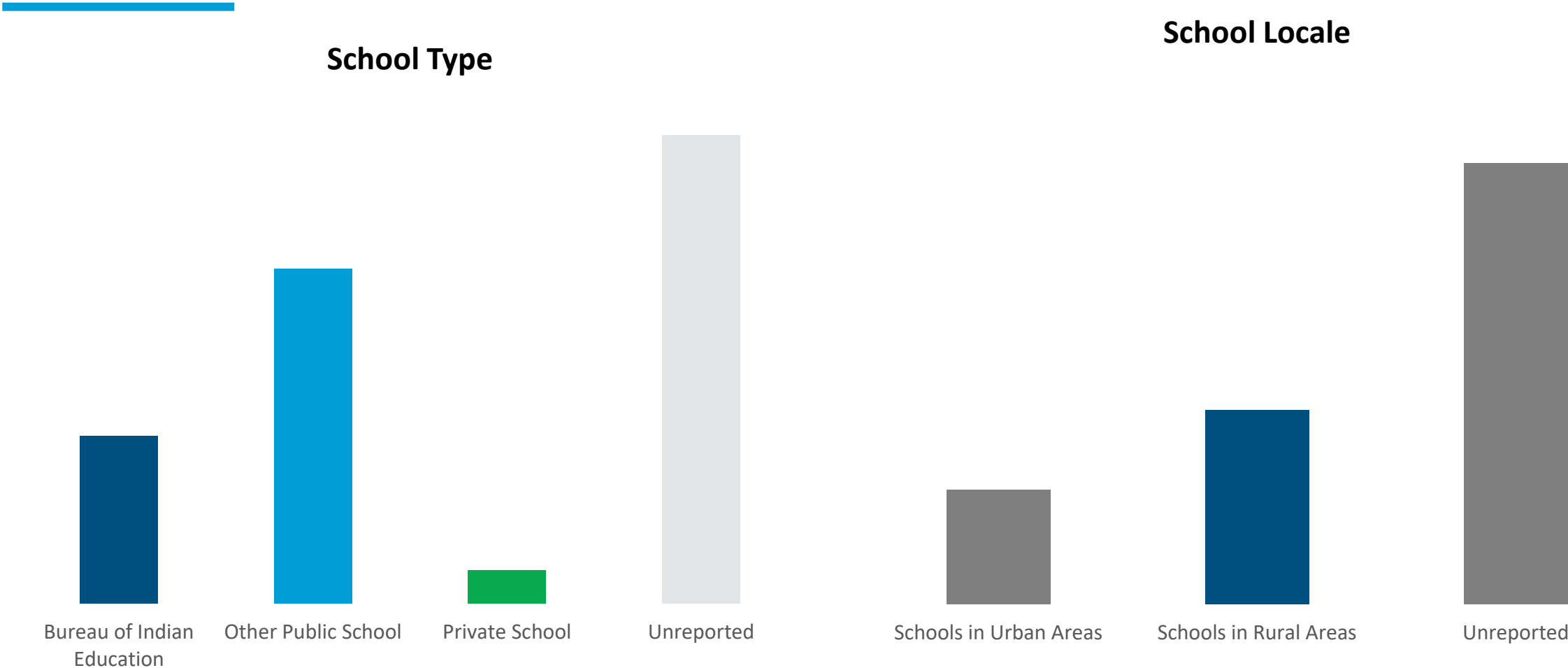
Most of the literature examined was academic studies that used quantitative methods.



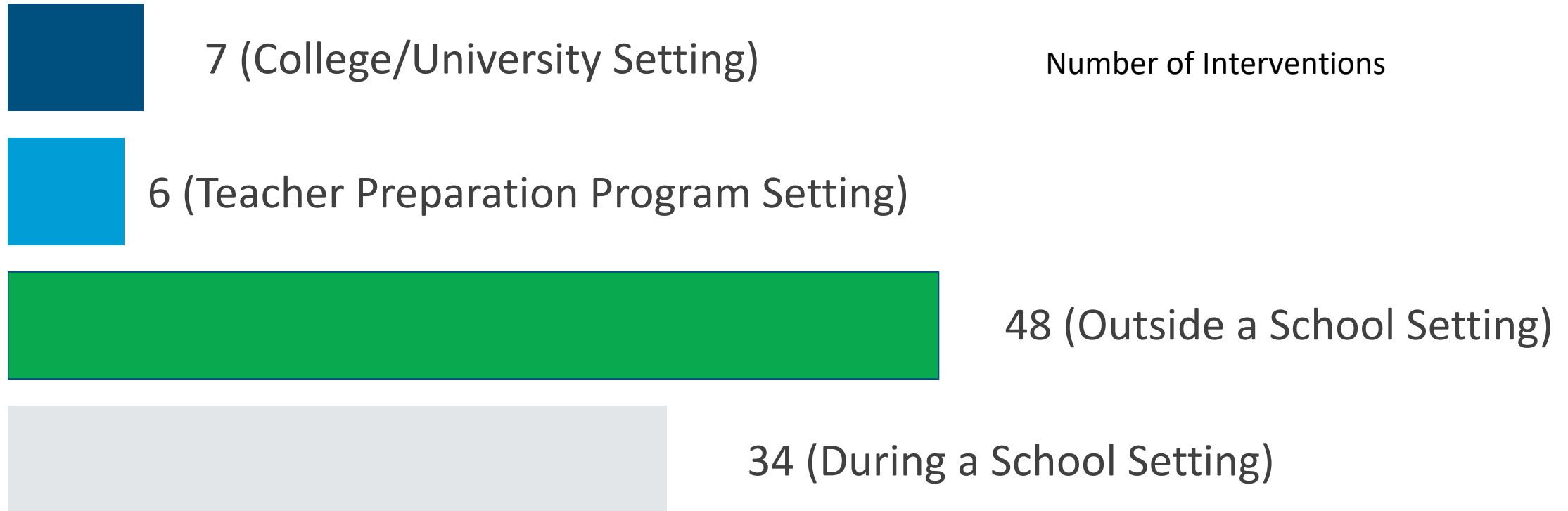
Most of the literature focused on high school students.



Among the studies that reported school information, most were rural public schools.



A majority of the interventions cited in the literature scan were held outside school classrooms.



A majority of the literature either did not report on or reported a lack of Indigenous involvement in conducting the research.



» 50 of the 80 sources did not report whether an Indigenous researcher was involved.



» 37 of the 80 sources did not report whether there was an Indigenous sponsor.
» 27 of the 80 sources reported not having Indigenous sponsors.

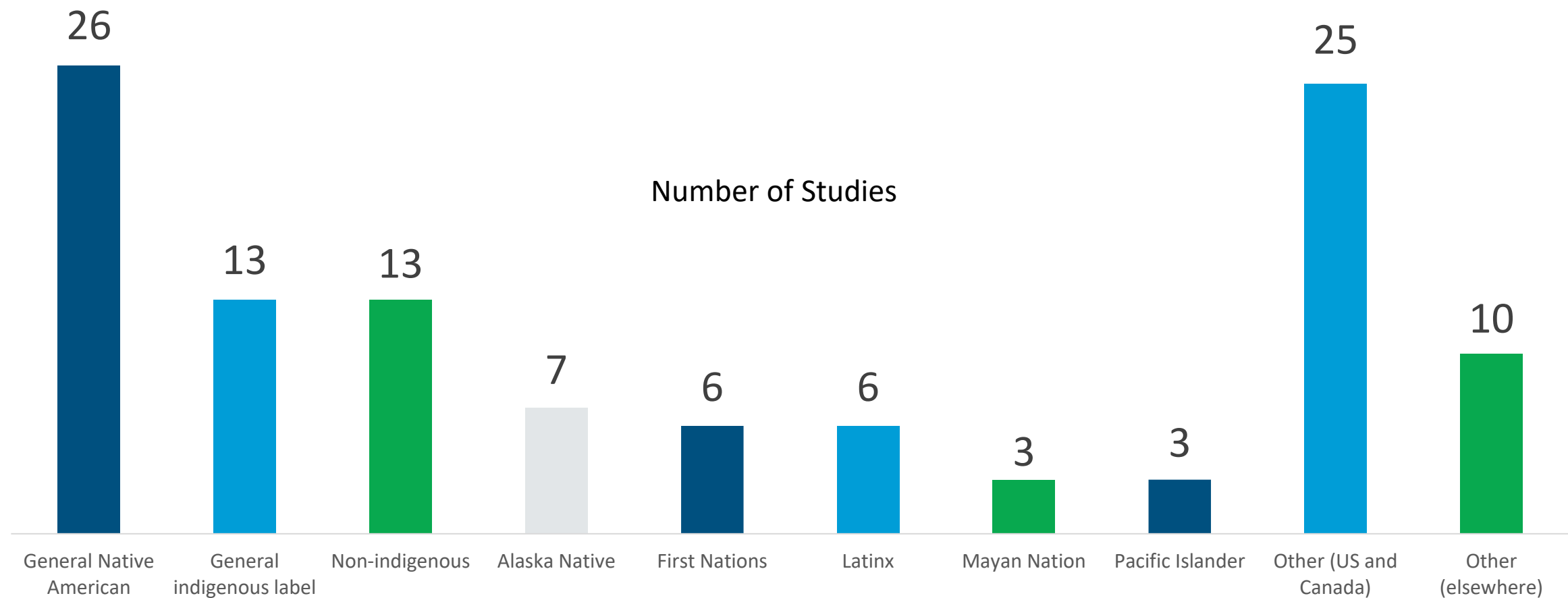


» 63 of the 80 sources did not have Indigenous publishers.



» 37 of the 80 sources did not report whether the participants were from reservations.
» 16 of the 80 sources reported not having Indigenous sponsors.

Participants were primarily labeled under a general Indigenous or general Native American label.



A majority of the findings focused on teaching content knowledge, learning strategies, and updating STEM curricula.

Number of Studies

