Informal STEM Learning Environments

Evaluation Guide

Developed by the Nevada STEM Advisory Council's Informal STEM Learning Environments (ISLE) Subcommittee

MESSAGE FROM THE ISLE SUBCOMMITTEE

Greetings from the Informal STEM Learning Environments (ISLE) Subcommittee of the Nevada STEM Advisory Council.

Our group of Informal STEM Leaders has created a document that we hope you'll find helpful. The Informal STEM Evaluation Guide is an evaluation toolbox to help Nevada informal STEM providers create or improve existing evaluation systems for your program. Program evaluation is a critical activity that helps program developers and providers to measure the success and efficacy of your program efforts. There are many benefits to a strong evaluation system, including: maximizing program impacts, building a case for the necessity of your programs, and qualifying for funding opportunities (among others).

We hope that you will find the Informal STEM Evaluation Guide to be a helpful resource for you and your team as you work to build and improve your program outcomes. Our team has commented that we wish we would have had this guidance as we built our programs!

Please reach out to us if you have any questions or comments and best of luck to you!

Continuous improvement is better than delayed perfection.

-Mark Twain

Sincerely,
the Informal STEM Learning Environments (ISLE) Subcommittee
of the Nevada STEM Advisory Council

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For more information about the Informal STEM Learning Environments Subcommittee, please visit OSIT.nv.gov.

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Yes, I am an informal STEM program or organization interested in evaluation.

Can this tool help me?

Are you an informal STEM program or organization interested in evaluation?

No, why should I evaluate my program?

My program is…

My program is still in the **idea** stage.

My program is fairly **new**.

My program is well **established**.

I should…

Research evaluation during program design.

Research the STEM ecosystem for **needs** and existing **assets**.

Select an individual **initiative** or activity within my larger program.

Track **ongoing progress** toward program goals.

I want to evaluate…

Impact on participants.

The program.

Impact on the local ecosystem.

Specifically…

Impact on participants	The program	Impact on the local ecosystem
Participant STEM knowledge and skills before and/or after my program.	My program's STEM content.	My program's alignment to local workforce needs.
Participant's STEM attitudes, affect, and identity before and/or after my program.	My program's ability to respond to participant interests, experiences, and cultural practices.	Participants go on to STEM jobs/careers.
Participant engagement or re-engagement in my program.	My program's STEM pedagogy.	Stakeholder engagement and representation in my program design.

Visit OSIT.nv.gov for more information about the Informal STEM Learning Environments Subcommittee of the Nevada STEM Advisory Council.

You may also use the information in this guide to evaluate **organization or mission-specific attributes**.

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Why Should I Use Evaluation?

Evaluating your STEM program is helpful to market your program to the community and funders, but it's also a crucial component of any successful STEM program. Evaluation should not be considered an add-on or bonus element of your program, but rather should be an integral function of program management. Evaluations should be considered at all phases of program implementation, including initial design.

There are many *aspects* of your program that you might evaluate, including:

- What needs your program addresses
- Participation and re-engagement
- Curriculum content and pedagogy
- Impact on participants' STEM identities and STEM interests
- Participant growth regarding knowledge, skills, and interests
- Impact on the STEM ecosystem and STEM workforce
- and more!

Further, there are many ways you might *use* your evaluation findings, including:

- Identifying strengths, deficits, and action steps for your organization or program
- Demonstrating efficacy to the community as a means for attracting more participants or partners
- Demonstrating efficacy to funders to capture, continue, or expand funding to your program
- Demonstrating an identified need to funders to capture, continue, or expand funding to your program

Finally, there are several *methods* for evaluation, including:

- Self-evaluation using proven tools (see Appendix B: Resources)
- Partnering with an institute of higher education to conduct a study
- Contract with an outside evaluator

Scope of Evaluation

Program evaluation may focus on one or several components of your STEM program.

Evaluation may center around the local **STEM ecosystem**. In this case, surveying local STEM opportunities and gaps may help you to identify where your program fits in, who your audience may be, and how you might partner or collaborate with other local programs. You may also find from this survey aspects of your program that may benefit from adjustments, to better meet the local needs.

You may also decide to complete an evaluation at the **organization level**. This type of evaluation may focus on alignment of the organization's mission and vision to local needs, equity policies and practices, employee expertise, efficacy of training available to employees, partnerships with other organizations, and even your organization's evaluation practices. This type of evaluation may help inform organizational structures, beliefs, and practices.

Program-level evaluation is likely what you think of when you hear "evaluation." This type of evaluation analyzes strengths and opportunities related to a specific program within your organization. For example, you might evaluate a specific program's curriculum, participant engagement and growth, or integration of STEM skills.

Most programs already evaluate **participant** growth using pre- and post-assessments. These types of evaluations measure a specific participant's growth in STEM knowledge, skills, identity, and/or interest. Clustering data from these assessments can also help determine if a program is successful as measured against the program's goals. Though these types of assessments are common, it's also important to be reflective and up to date on best practices when designing and updating these assessments.

Finally, evaluation may focus on your program or organization's **impact on the local STEM ecosystem**. Your evaluation may help answer questions such as, "Do my participants go on to STEM careers?" "Does my program align to local workforce needs?" and "Are local stakeholders represented in my program design?"

This guide will explore this scope of evaluation. Remember, use the links to jump to the section you're interested in reading.

Needs Assessment

When designing your program, and when reflecting on your program's relevancy and impact, you must consider the local landscape of offerings. Your organization may evaluate your program's needs internally or may partner with an outside organization to complete a more formal evaluation.

In 2021, The Nevada STEM Networks launched the Nevada STEM Asset Map, housed on OSIT.nv.gov. The Asset Map is a visual representation of STEM programs in Nevada, including informal STEM programs, formal STEM programs, professional development, and on-going community-wide opportunities. (Note that one-time events are not included on the map.) The asset map is a living resource and is updated periodically. The data is self- reported and relies on programs to complete this survey to be added to the map.

Organizations can use this map to survey the STEM landscape and identify programming gaps in their area. Conversely, the map may reveal redundancy and inform an organization of the need to adjust their program to better diversify offerings to the community. Aside from evaluation, organizations can complete the survey to be added to the list and raise awareness for their programs.

The Governor's Office of Science, Innovation and Technology has produced several reports regarding in-demand STEM jobs in Nevada. These reports may be used to align programs with workforce needs.

Organization Evaluation

While much of this guide focuses on evaluating program-level attributes, you may also decide to begin with evaluating your organization. When evaluating your organization, you will be able to analyze and gain an understanding of bigger picture elements such as your mission and vision, audience, and capacity.

Successful organizations consider evaluation before even beginning the design of their programs. When establishing the mission and vision, organizations evaluate the local STEM landscape to determine needs and audience. Organizations work backwards by establishing a mission and vision, developing a scope of work, and establishing SMART goals aimed at reaching the vision. Here, organizations develop an evaluation plan by considering how to purposefully collect data aligned to their goals and vision.
Organizations must determine what type of data to collect, when and how to collect and analyze it, and how to use the results. These evaluations should inform the organization how it's programs, policies, and structures are (or are not) moving toward the vision.

STEMworks at WestEd has a formal evaluation process, which can be used for evaluating your organization on general and STEM Design Principles.

Informal STEM Learning (ISL) also provides a Professional Competency Framework for evaluating an organization across four categories: institutional operations, institutional impact, general expertise, and job-specific expertise.

When an organization begins designing programs, they may already have considered evaluation at the organizational level, but they and their clients will benefit by also incorporating evaluation at the program level.

Program level evaluation will help determine the impact and deficits the specific program has toward the organization's and the program's goals. Read more about this in the "Program Evaluation" sections.

Program Evaluation

In this Program Evaluation section, you'll find information about evaluating a STEM program. Programs might include an initiative or specific opportunity offered by your organization.

When evaluating a STEM program, you can evaluate the accuracy, relevance, and scope of the program's STEM **content**. You may also evaluate the effectiveness of the program's **pedagogy** and instructional practices. Finally, programs might evaluate the degree to which it is **culturally relevant** to the participants.

The Regional STEM Networks and OSIT have collaborated on the STEMList rubric which defines high quality STEM programming. Visit OSIT's STEMList page for more information and to find the rubric.

Program Evaluation: STEM Content

It may be helpful to differentiate between school-day and out-of-school informal STEM learning experiences. **School-day informal STEM learning experiences** include informal programs that partner with a school to supplement in-school learning. This type of experience happens during school hours, and often includes a formal evaluation of student learning.

Out-of-school informal STEM learning experiences include any STEM experiences that happen outside of the school day. Examples include but are not limited to after-school clubs, camps, museum programming, events, park installations, media.
These types of experiences focus on building participant STEM identities and interests, and enriching students' STEM experiences by providing diverse and engaging experiences outside of school settings.

Informal, school-day STEM evaluation: Should adhere to NGSS or NVACS-S
Content is 3-Dimensional: Students learn big ideas by engaging in Science and Engineering Practices and organizing their thinking with Crosscutting Concepts. Experiences align with NGSS Evidence Statements: Experiences are structured to support students toward performance expectations.
Should be STEM, rather than based on one or more of the STEM disciplines STEM content is integrated: students use knowledge and skills from multiple subject areas to investigate phenomena or solve problems.
Focus is on increasing STEM content knowledge and skills, while STEM identity may be secondary.

Informal, out-of-school STEM evaluation: Should be three-dimensional
Can align more loosely to NGSS or NVACS-S or may align to grade-bands. Should evaluate integrated STEM applications, rather than siloed S-T-E- or -M knowledge or skills
Experiences should be relevant to participant's interests and culture.
Focus is on developing the student's STEM identity and love of learning, while STEM content knowledge and skill building may be secondary.

Tools to measure STEM content

- NGSS Screener Tool
  - A condensed version of the Equip rubric. The screener tool involves six criteria.
  - Use to determine if a learning sequence is on track toward high-quality instructional attributes.
- EQuIP for Science and EQuIP for Mathematics
  - In-depth evaluation of lessons and units. Describes high-quality science or mathematics curricula attributes, including 3D integration, learning scaffolds, and performance assessment.
- NextGen Time
  - "NextGen TIME is a suite of tools and processes for curriculum-based professional learning that supports educators to evaluate, select, and implement instructional materials designed for next generation science."
- EdReports
  - Tools to evaluate grades K-5 science and grades 6-8 science.
  - Measures 3D learning, phenomena-/problem-based learning, coherence and scope, and instructional supports.
- STEMList Rubric
  - Describes the attributes of high-quality STEM programming.

*Whether the user has an interest in what STEM content should be included in their program, understanding such content more deeply, or looking for areas to improve for full STEM content integration, these tools are useful for evaluating STEM content of school-day STEM experiences.

Out-of-school STEM experiences may value participant STEM identity over qualities such as standards alignment and content knowledge development. In such instances, these tools may be used more informally by programs to inform curricular decisions, rather than to rate or show success of the program.

Additional Resources from STEM Teaching Tools
#20 - Getting their hands dirty: Engaging learners in authentic science practices outside the classroom
#73 - Connecting science instruction to neighborhood life through collaborative design with community
#38 - What is the role of informal science education in supporting the vision for K-12 science education?

Program Evaluation: STEM Pedagogy

Attributes of high-quality STEM pedagogy describe how students engage in the learning. Below, you'll find information about these attributes, which can also be found in the Nevada STEM Framework (for school-day programs) and the Nevada STEMList rubric (for out-of-school-day programs or supplemental STEM programming that occurs during the school day).

- Ensure **the curriculum is equitable** by evaluating aspects such as: diversity of author pool, cultural representation within the contexts, how it addresses social justice, and supports available for users.
    - The Culturally Responsive-Sustaining STEAM Curriculum Scorecard was created by the NYU Metro Center to assist programs in evaluating their curriculum.
- The NGSS Science and Engineering Practices describe how students engage in the learning, and mimic real-world **STEM practices**. Informal STEM programs provide an opportunity for students to apply and build proficiency with the practices.
- STEM learning experiences should be **integrated** naturally, rather than having students learning about a topic in an isolated way. When integrated, participants experience the complex nature of STEM and can better find a relatable access point into the learning.
- STEM is not done in isolation, rather participants should work **collaboratively** to experience STEM and apply it to **real-world problems**.
- STEM experiences must be **culturally relevant** to participants and incorporate **social-emotional** learning skills.
- High-quality STEM experiences allow students to be **creative**, make decisions based on their understanding of the topic, and **iterate** to refine their thinking. The Engineering Design Process is an effective way to incorporate creativity, while providing an opportunity for students to **apply** their learning.
- Learning is **experiential** and allows participants to "do" the work of STEM professionals.
- Experiences are **connected** in explicit ways to home or school experiences.
- Programs should help participants identify relevant **college and career pathways** in STEM.
- **Assessment** is key for formal and informal programs but should be woven authentically throughout the participants' experiences as much as possible. See the "Participant Evaluation" section for more information.

Additional resources:

Education Development Center's Systemic Equity Review Framework: A Practical Approach to Achieving High Educational Outcomes for All Students outlines a process for evaluating your program for equitable practices and outcomes.

Program Evaluation: Cultural Relevance

What is culturally responsive teaching?
In the book, Culturally Responsive Teaching and the Brain, Zaretta Hammond states Culturally Responsive Education:

- "Focuses on improving the learning capacity of diverse students who have been marginalized educationally.
- Centers around the affective and cognitive aspects of teaching and learning.
- Focuses efforts to accelerate learning.
- Concerns itself with building cognitive capacity and academic mindset by pushing back on dominate narratives about people of color."

Hammond, Z. *Distinctions of Equity.* 2020.

During an interview with Kristin Burnham of Northeastern University, Cherese Childers-McKee describes the need for culturally responsive teaching:

"Over the past few decades, students, their experiences, upbringings, and backgrounds have changed. Classrooms now reflect families of varying races, cultures, and socioeconomic statuses. As a result, the way teachers educate these students must change, too, says Cherese Childers-McKee, assistant teaching professor in Northeastern University's College of Professional Studies. One of these shifting approaches to education is known as culturally responsive teaching.

'Teachers have more diverse classrooms today. We don't have students sitting in front of us with the same background or experience, so instruction has to be different,' [Childers-McKee] says. 'It needs to build on individual and cultural experiences and their prior knowledge. It needs to be justice-oriented and reflect the social context we're in now. That's what we mean when we talk about culturally responsive teaching.'"

Burnham, K. *5 Culturally Responsive Teaching Strategies.* (2020).

Effective informal STEM programs attend to cultural relevance by ensuring their program responds to participant interests, experiences, and culture. This is a very reflective process that continually evolves. When evaluating if your program is culturally relevant, expect to evaluate:

1. Institutional (organization) beliefs and practices.
2. Personal (staff) beliefs and practices, and
3. Beliefs and practices promoted through the instruction.

Surveys such as the "Is Science Me" survey can be an effective way to collect feedback from participants about how well the program, organization, or staff affected their individual STEM identities and interests. Interviews can provide much more insight, though admittedly are more time intensive.

Cultural Relevance Resources:
Harvard's Project Implicit online test can be used to identify implicit bias among staff.

Fires in the Bathroom by Kathleen Cushman describes how to get to know your students and design instruction around them.

STEM Teaching Tools has developed relevant PD sessions, "including slides, speaker notes, facilitator guides, and embedded resources."

Additionally, many design and evaluation tools have begun incorporating culturally relevant attributes. Criterion D of the NGSS Lesson Screener Tool can be used to evaluate the extent to which a lesson activates prior knowledge, has an interesting and relevant context, and encourages student voice. Programs should also consider how things such as physical and procedural structures and relationships impact participants.

Case Study: Sierra Nevada Journeys Shares the Community Needs Assessment Results, used to Enhance their Classrooms Unleashed Curriculum's Cultural Relevancy

Sierra Nevada Journeys completed a Community Needs Assessment in 2021 to identify community needs and align the Classrooms Unleashed program to those needs. Read the full report here, and the report's front matter on the following pages of this guide.

SIERRA NEVADA JOURNEYS CLASSROOMS UNLEASHED COMMUNITY NEEDS ASSESSMENT

Moving Toward a More Culturally Relevant, Equitable Framework for an Elementary Outdoor Science Program

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SIERRANEVADAJOURNEYS.ORG

MEETING TODAY'S CHALLENGES

Sierra Nevada Journeys recognizes that our local community has shifted as a direct result of both the COVID-19 pandemic and an equity focus to support Black, Indigenous and People of Color in the context of the Black Lives Matter movement. COVID-19 has exacerbated inequities in access to quality education and social emotional learning, particularly our youth and communities previously experiencing an opportunity gap due to systemic racism and inequity. With this in mind, we are modifying our STEM programs by bringing in community stakeholders to amplify the experiences and perspectives of the diverse population of people and families who live in our communities. We'd like to thank our supporters for financially underwriting this effort to initiate our organization's Community Needs Assessment: Renown Health, the Northwestern Nevada STEM Network, and SMUD Sustainable Communities Program.

Methodology

To determine the most salient questions for surveys and listening sessions, we began by conducting empathy interviews with two groups of end users: students and teachers. We interviewed three students in fourth-through-sixth grade and four teachers. From their responses, we developed a series of questions for each of these populations.

For the students, we inserted survey questions into the virtual Classrooms Unleashed webinars and recorded student responses given in the chat, and inserted questions into the post-program survey. For teachers and community-based organizations, we conducted 60-minute listening sessions with one-to-four participants at a time, recording their responses. For all three groups, we then analyzed the transcripts and survey responses to determine themes and patterns.

Classrooms Unleashed

Classrooms Unleashed uses hands-on, experiential and outdoor education as a framework for young people to study, think, and learn. The program was designed to address the Next Generation Science Standards and the North American Association for Environmental Education's Guidelines for Excellence. Sierra Nevada Journeys' team of experienced educators go into Kindergarten-through-sixth grade classrooms to deliver grade-specific, student-centered, inquiry-based science lessons in a multi-day program that culminates with an outdoor science excursion to a local field site. While it has proven to be a popular program, it was conceived and has been revised "in-house," with minimal community input.

FOCUS POPULATIONS

The focus is for the program to be redesigned for the needs of communities that have been historically and systemically excluded from high-quality STEM education and outdoor experiences, namely Black, Latinx, and Indigenous students, English Language Learners and students with special needs in northern Nevada and northern California.

Stakeholders

Teachers: We selected teachers from communities that we work with in Sacramento and Reno who teach in schools with high populations of students in the identified focus population.

Students: To select the students for interviews, we reached out to teachers who teach in schools with majority BIPOC students, and asked them to reach out to the families of one to two students to gain permission for conducting the interviews. For the surveys, the majority of students we surveyed attend schools with high percentages of students receiving free and reduced lunch, and with racial and ethnic demographics of majority BIPOC students.

Community Based Organizations: We reached out to community-based organizations in the Sacramento and Reno area who work primarily with communities in the focus populations, as well as outdoor education organizations outside of these geographic areas that were selected for the centrality of cultural relevancy and equity to their missions and organizational focus (Vida Verde, YES Nature to Neighborhoods, and Camp Phoenix).

Participant Evaluation

STEM Knowledge and Skills
Engagement and Re-Engagement
STEM Identity

In this Participant Evaluation section, you'll find information about evaluating the program's impact on participants. Programs evaluate **STEM knowledge and skills** participants acquire from the program. Programs also evaluate how well they **engage and retain** target audiences. Programs also evaluate how participants' **STEM identities** have been impacted by the program experiences.

Participant Evaluation: STEM Knowledge & Skills

Informal STEM programs have flexibility to determine which knowledge and skills their program will develop, and therefore evaluate. A program may focus heavily on working toward the performance expectations within the Next Generation Science Standards (NGSS). A program may loosely align to the NGSS but focus heavily on attributes not commonly assessed in schools, including growth of participant STEM identity and interests, increased love for the natural world, curiosity, and perseverance.

According to the Center for Advancement of Informal Science Education (CAISE), assessments in informal settings should be:

- Valid - does the assessment measure the target?
- Reliable - does the assessment measure the target consistently?
- Fair - does the assessment lack bias?
- Ongoing - is evidence of learning gathered over time?
- Formative - is information gathered actionable during the experiences?
- Performance-based - can learners demonstrate their knowledge and abilities in meaningful ways?
- Authentic - does the assessment reflect real-world situations/contexts?

If you are designing assessments that measure participants' STEM knowledge and skills in reference to the NGSS, consider using their resources:

- The performance expectation pages from NGSS show which Science and Engineering Practices, Disciplinary Core Ideas, and Cross-Cutting Concepts complement each other during learning. These pages can be used during assessment design (as well as curriculum design) to determine which practice, core idea, and concept should be assessed together.
- The Evidence Statements can be used when developing assessments by providing insight into what you'll see participants doing when they've met the performance expectations.
- The Achieve Task PreScreener helps screen assessments for key attributes.

Keep in mind, students demonstrate STEM knowledge and skills during the STEM experiences, rather than after the experience through a traditional paper-and-pencil format. During STEM learning experiences, you may assess participants by answering questions such as: what types of questions do participants formulate when introduced to a phenomenon? How nuanced are participant explanations of what they discover? Can students apply investigation and problem-solving skills in natural environments?

Check out these resources while designing assessments:

STEM Teaching Tool #16: The Informal Formative Assessment Cycle as a Model for Teacher Practice

CAISE curated an extensive bank of Evaluation Tools and Instruments, many NSF-funded.

Case Study: PBS Reno Ready to Learn shares their experiences with participant evaluation, including lessons learned

PBS Reno provides Ready to Learn workshops in preschool through 4th grade classrooms in seven northern Nevada and northeastern California school districts. The Ready to Learn initiative is a nationwide PBS effort using on-air, online, and print resources to help parents, caregivers, and early childhood educators prepare children for success in school. The STEM-literacy workshops are comprised of an engaging video clip, a read aloud, fun hands-on activities, and a follow-up writing component. Lessons are aligned to Nevada Academic Content Standards, Common Core Standards and Next Generation Science Standards. An educational professional facilitates the 45 to 60-minute workshop with topics that include math, literacy, science, engineering, robotics, and financial literacy.

Programs such as PBS Reno Ready to Learn are resource intensive. Using available resources in the most effective ways is a responsibility PBS Reno embraces, both for the funders and the community. Program evaluation is the key to answering questions such as: “What is the impact of the PBS Reno Ready to Learn program?” “Does the program make a difference? If so, what difference does it make?”

To answer the question, "does the PBS Reno Ready to Learn program lead to improved youth understanding of STEM?" we proposed to conduct a pilot study during the 2018-2019 school year (August-February). The proposed approach was an exploratory pilot study measuring the retention of knowledge delivered in classroom workshops, using a comparison group of students in the same grade level that did not participate in the program. The study participants were students in 4th grade at three elementary schools in Washoe County School District. Two fourth grade classes at each school participated: one class in which the PBS Reno program was delivered, and one in which the program was not being delivered. It was a pre-test, post-test comparison group design. Both the PBS Reno classes, and non-PBS Reno classes were tested at the beginning and end of the delivery of six classroom components, as well as testing after each class for the PBS Reno classes. None of the fourth-grade classrooms selected had participated in PBS Reno Ready to Learn workshops prior to this study. The assessment was short and content-based, related directly to the modules being delivered in the classroom. The study was conducted through collaboration between University of Nevada, Reno Department of Educational Leadership and PBS Reno working together as a team. A UNR doctoral student helped write the instruments; the data was collected by PBS Reno and analyzed by the doctoral student; UNR Professor Dr. Brenda Freeman led the data analysis and reporting. This project received approval from the WCSD Department of Assessment and the

administrators and teachers at each individual school site. No student names or identifying information was used for this study.

Lessons learned from this evaluation process:

1. First attempts at evaluation can be rough.
2. One of our assessment tools was poorly written so the results from that tool had to be thrown out; the wording allowed for two possible answers.
3. Conducting an evaluation is time consuming
4. It is absolutely necessary to have thorough conversations and agreement about what is being measured and how it is going to be measured before beginning the evaluation.
5. We found we wanted to know more! Gender, ethnicity, length of time enrolled in the school, etc.
6. Evaluation seems to be something we keep wanting to do more of!

Next Steps:

Currently we are analyzing data from another evaluation of our Ready to Learn program with 3- to 5-year-olds enrolled in Head Start preschool.

Wanting to learn more, we have had ongoing discussions with two evaluation "experts," Dr. Part (UNLV) and Claire Parker (DRI) around topics including qualitative evaluation vs quantitative and Expectancy Value Theory.

Quantitative, Qualitative, or Mixed Evaluation?

Quantitative, qualitative, or mixed (i.e., the combination of quantitative and qualitative) methods can be used when conducting research and evaluations. Quantitative and qualitative methods are used to answer different types of questions.

Quantitative methods can be used to answer how or to what extent change occurs over time (i.e., How do students' motivational beliefs about STEM change over the course of their engagement in a program?), whereas **qualitative** methods can be used to answer questions about why or in what way change occurs (i.e., In what way does the classroom context influence students' motivational beliefs and engagement in a program?). Alternatively, a **mixed** method approach to evaluation can be really useful to leverage the complementary nature of both quantitative and qualitative methods.

PBS Reno plans to extend the evaluation of the Ready To Learn program by studying its impact on student learning and socio-emotional outcomes using an iterative mixed methods design.

An iterative mixed methods design means that the evaluation will include the continual analysis (i.e., iterative) and integration of both quantitative and qualitative data (i.e., mixed methods) over the course of data collection.

Importantly, another component to consider when conducting educational research and evaluations is the theoretical underpinning of the processes under investigation. Continuing with the example above, the extension of PBS Reno's Ready To Learn evaluation will be guided by **Expectancy-Value Theory** (Eccles et al., 1983), which is a theory of achievement motivation. Expectancy-Value Theory describes students' (1) expectations for success on a specific task and (2) how much students' value of that task impacts student engagement, academic performance, choices, and well-being. Students' value of a task includes how important the task is, how much they enjoy the task, and how useful the task is, as well as how much students sacrifice to engage in the task (e.g., time and effort). Using Expectancy-Value Theory as a guide, the evaluation of the Ready To Learn program will investigate these specific pathways of student motivation and learning, that are theoretically and empirically driven.

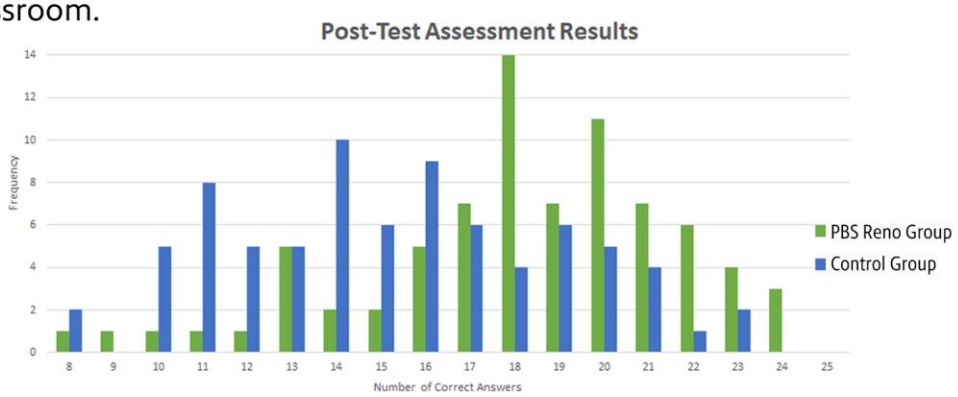
PBS Reno

THE RESULTS ARE IN!

PBS Reno's Ready To Learn STEM based workshops make a positive impact for student learning!

PBS Reno's Ready To Learn workshops improve student performance. A recently completed study of 4th grade students conducted through a joint program by **University of Nevada College of Education** and University of Nevada Cooperative Extension shows that **PBS Reno's Ready To Learn** workshops lead to stronger learning outcomes in the classroom.

Three schools participated in the study which consisted of one experimental group who attended **PBS Reno's Ready To Learn** workshops and one control group of 4th grade students who did not attend the workshops. Six STEM-based lessons were presented to each class in the experimental group.



The results showed that the PBS Reno workshops, along with teacher presentations, led to stronger learning outcomes than those attained by classrooms that did not have the workshops.

CONCLUSION: In this study **PBS Reno's Ready To Learn** workshops improved learning outcomes with generally equal conditions and when used in conjunction with classroom instruction.

"We are thrilled to have the University's College of Education and Cooperative Extension partner with KNPB in the Ready To Learn workshops. By researching effective approaches to STEM delivery, we continue to make an impact on shaping the future and transforming lives through quality education."

-- Kevin Carman, Executive Vice President and Provost, UNR.

** Full details on the study are available from PBS Reno's Education Department or the UNR College of Education.*

Participant Evaluation: Engagement and Re-Engagement

When evaluating participation, programs typically opt to survey participants upon enrollment and then maintain that data. Surveys may include name, demographic information, as well as information about how they heard about the program. Programs may also opt to record participants who complete or don't complete the program. All of this data can be evaluated in different ways. A program may just want to know the number of participants enrolled in a program, percentage of completers, demographics of the participants to see if they have hit their target audience, or how they heard about the program to inform marketing decisions.

The software a program uses will depend on the program manager's needs, abilities, and available funding. Software examples include MS Excel, Google Forms, Salesforce, SurveyMonkey, Slate, Eventbrite, rsvpify, and on and on.

To evaluate re-engagement, you might cross-reference enrollment survey information, or you might rely on participant self-reporting to tell you if they have participated in your program before.

Additionally, some programs have found it beneficial to conduct exit-surveys (completed while program is ending) or follow-up surveys (completed in the months after the program has ended). Such surveys might ask participants to describe their take-aways from the program as well as how likely they are to re-enroll or recommend the program to a friend.

Evaluating re-engagement is particularly beneficial for informal STEM programs because research tells us informal STEM experiences are most impactful when they are ongoing; each experience adds to the previous experiences to help participants develop their STEM interests, identities, and understanding.

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Participant Evaluation: STEM Identity

Developing a STEM identity

"Having a STEM identity means recognizing yourself as a science (and technology, engineering, or math) kind of person. This process of developing an identity is part of learning (Lave and Wenger 1991). As we interact with people and ideas, we assimilate the ideas and words that impress us. We try on different identities (writer, mathematician, athlete, scientist) and we keep those that seem to fit. We have multiple identities that change throughout our lives and depend on our interactions in social situations (Gee 2000). Some identities last only a short time, while others become stable and persist into adulthood.

Four constructs found to be important to the development of a STEM identity are:

- demonstrating competence in science knowledge and practices (Carlone 2012),
- belonging to a community of practice (Wenger 1998),
- meaningful recognition by others and self (Carlone and Johnson 2007), and
- a discovery orientation that includes ways of thinking, feeling, and acting when immersed in a field of science that motivates one to persevere in sense-making activities (Hill et al. 2017; Jaber and Hammer 2016)."

Rodriguez, L. *From Interest to Identity: Creating and nurturing STEM kids in middle school.* (2018)

Strategies for helping participants develop STEM identities include:

- Use science notebooks which require students to record their observations, thoughts, and explain their thinking.
- Engage in the science and engineering practices (SEP) so that participants are doing the work and engaging in sense-making.
- Foster a community of practice wherein everyone is working together to make sense of the phenomena or problem. Ensure each participant contributes by first building a safe environment to do so, and equipping participants with tools, such as sentence frames, to successfully engage.

Surveys such as Is Science Me? developed at Caltech, the Student Motivation Toward Science Learning Questionnaire (SMTSL) or Science Motivation Questionnaire II (SMQ-II) developed at the University of Georgia ask about student interests, activities, and beliefs. The surveys can be used to measure participant identity changes before and after your program.

The table below describes the ways a program might evaluate participants.

Outcome of Interest	Types of Evaluation	Sample Items
STEM Knowledge and Skills	Content questions related to information covered (multiple choice or open ended)	Draw and label a model of energy transfer. Describe how and why Nevada's landscape has changed over time.
Participation and Re-Engagement	Attendance and demographic data Exit or follow-up surveys	Have you participated in this program before? Are you likely to participate in this program again? Why/ why not?
STEM Identity	Is Science Me? Survey Exit interviews or focus groups	I think science is fun. (Agree/Disagree) I could be a good scientist one day. (Agree/Disagree) Are you a science person? How do you know? Do you think others see you as a science person? How do you know?

Impact on Local STEM Ecosystem

Participant Pursuit of STEM Pathways Stakeholder Engagement

In this STEM Ecosystem section, you'll find information about evaluating the program's impact on the STEM ecosystem.

Programs may evaluate their impact on the community, region, or state's STEM ecosystem by identifying **participants' pursuit of STEM pathways** (do participants pursue STEM opportunities in the area?) as well as stakeholder engagement in STEM initiatives.

Impact on STEM Ecosystem: Participant Pursuit of STEM Pathways

Programs and organizations may evaluate their impact on the STEM ecosystem by answering questions such as, “Do my program participants go on to pursue careers in STEM?” “How does my program change the STEM ecosystem?” and “Are more STEM stakeholders, such as families, educators, and industry leaders, involved in STEM after my program implementation?”

Evaluating long-term impact on informal STEM learning experiences has challenges due to the unique qualities of informal STEM learning. For example, informal experiences tend to involve isolated experiences, rather than ongoing experiences during which the program can track impact.

Here, we turn to long-term impact studies, such as the one completed by *FIRST*, that have been able to successfully track their program participants’ pursuit of STEM pathways.

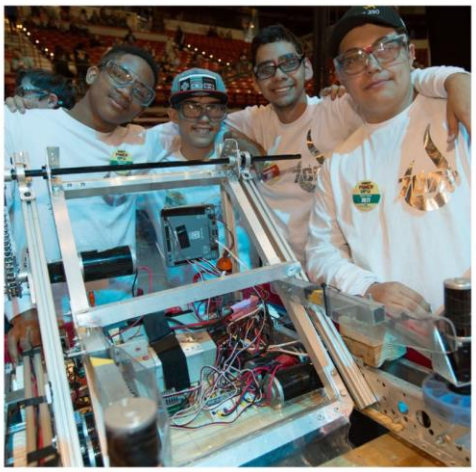
Case Study: FIRST Nevada Shares Longitudinal Study Highlights Regarding Participant Retention in STEM Pathways

FIRST Nevada is a 501(c)(3) non-profit organization promoting *FIRST*® robotics programs and STEAM education initiatives in Nevada.

FIRST Nevada Mission: To inspire young people to become science and technology leaders, by engaging them in exciting mentor-based programs that build science, engineering, and technology skills, that inspire innovation, and that foster well-rounded life capabilities including self-confidence, communication, and leadership.

Overview: *FIRST* is an acronym: For Inspiration and Recognition of Science and Technology. It's a non-profit workforce development program that challenges Pre-K to 12th grade students to work as a team to design, build, and program a robot. This friendly coopertition gets students excited about careers in science, technology, engineering, arts, and math by providing them with hands-on applications of what is being taught in the classroom. *FIRST* inspires innovation excellence, teaching 21st century skills, and immersing participants in project-based learning and robotics competitions. It's the only sport where anyone can turn pro!

On the following pages, you'll see the *FIRST* 2021 Longitudinal Study Highlights. *FIRST* has succeeded in studying the impact *FIRST* has had on retaining students in STEM studies.



Research shows *FIRST*® drives STEM engagement and outcomes

FIRST® is a mission-driven global robotics community that prepares young people for the future and inspires today's kids to build tomorrow's leaders.

Research from a multi-year longitudinal study shows *FIRST* is advancing its mission to increase the number of students interested in STEM — and that interest is influencing their educational and career choices.

FIRST students are prepared for greater success in the classroom and workforce.

At *FIRST*, we understand that interest, rather than academic proficiency, is a greater predictor of children pursuing studies and careers in STEM fields. Our evidence-based programs use strategies known to increase student interest and engagement in science, technology, engineering, and math (STEM), including:

- HANDS-ON LEARNING
- WORKING AS A TEAM ON REAL-LIFE PROBLEMS
- EXPOSURE TO CAREERS AND ADULT MENTORS
- EMPHASIS ON *FIRST* CORE VALUES
- CULMINATING CELEBRATION WHERE STUDENTS CAN SHOWCASE WHAT THEY CREATED AND LEARNED

OUR PARTNERSHIP WITH BRANDEIS UNIVERSITY

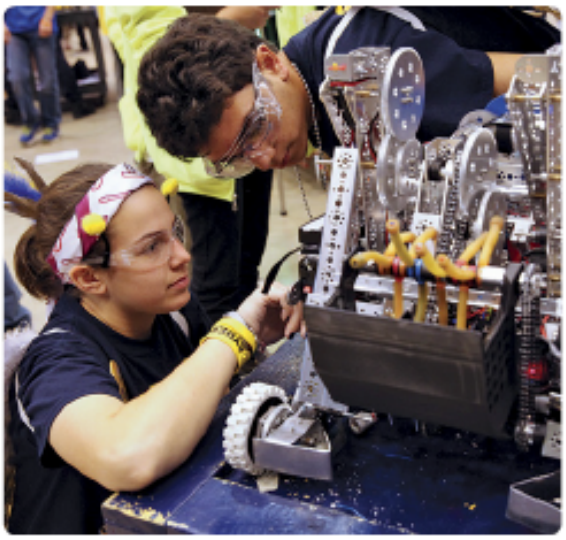
FIRST is partnering with Brandeis University to conduct a multi-year longitudinal study measuring STEM-related impacts.

The study included **822 *FIRST* students** and **451 comparison group students**. The comparison group included students who did not participate in *FIRST* programs, but were enrolled in science and math classes at the same schools. All students received a baseline survey and follow-up surveys each year.

OVERALL, 79% OF STUDENTS REMAINED IN THE STUDY AT YEAR SEVEN.

Research Highlights

FIRST prepares students for a STEM future



Gains in Workforce Skills

FIRST participants show significant gains in workforce skills such as teamwork, communication, and problem-solving.

"*FIRST* has given me life skills and tools to work well with others and be a team player and always do my personal best with *Gracious Professionalism*.® These are skills I will use in my daily life and beyond!"

FIRST Alumni

By their fourth year of college, *FIRST* alumni are more likely to be majoring in STEM fields than comparison group peers.

DECLARE A MAJOR IN STEM (SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH)

FIRST ALUMNI: 89%

COMPARISON GROUP: 58%

DECLARE A MAJOR IN ENGINEERING OR COMPUTER SCIENCE

FIRST ALUMNI: 68%

COMPARISON GROUP: 29%

Women in *FIRST*

Young women in *FIRST* have significant gains in all STEM areas including STEM interest, career interest, activity, knowledge, and identity compared to young women in the comparison group.

DECLARE A MAJOR IN ENGINEERING OR COMPUTER SCIENCE

FEMALE *FIRST* ALUMNI: 51%

FEMALE COMPARISON GROUP: 16%

MORE LIKELY TO TAKE COURSES IN ENGINEERING OR COMPUTER SCIENCE

3.4x Computer Science

2.6x Engineering

"x" = times as likely

Benefits of *FIRST*

FIRST students are two times more likely to show an increase in STEM-related attitudes and interests than comparison group students.

Positive impacts are evident for all *FIRST* students regardless of race, gender, income, or community type.

***FIRST* STUDENTS ARE SIGNIFICANTLY MORE LIKELY TO SHOW GAINS IN STEM OUTCOMES THAN COMPARISON STUDENTS**

2x

STEM Interest
STEM Career Interest
STEM Knowledge
STEM Activity
STEM Identity

Detailed information about the study can be found at www.firstinspires.org/impact

All differences statistically significant, $p \leq .05$

Impact on STEM Ecosystem: Stakeholder Engagement

Stakeholders include families, industry partners, schools, funders, and other interested parties who engage with your informal STEM program. Stakeholders can help support your program in many ways, including promoting awareness of your program, funding your program, making connections to other relevant stakeholders, and contributing to the content of your program; this might include curriculum development or volunteering to work with participants.

Your organization or program may decide to evaluate stakeholder engagement using the Leading by Convening (LbC): Stakeholder Engagement in Evaluation rubrics published by WestEd. These rubrics help programs investigate interactions with stakeholders and can inform users how to deepen such interactions to make meaningful impact on program participants. The document also shares tips, such as the ones below.

Tips from implementers and stakeholders

- Use your networks to find as many stakeholders as possible and involve them in the evaluation from this point forward.
- Generate an infographic to visualize the goal and the process that is intended to lead to that goal.
- Create a short description to distribute to stakeholders about the evaluation in understandable and concise language. Avoid jargon.
- Prioritize outreach efforts and promote dialogue to develop an engagement strategy.
- Stakeholders can develop a fact sheets that provide background information, explaining the ways different groups express the same issue.
- Review and consider ideas presented in the IDEA Partnership Dialogue Guide.
- Plan your evaluation and work with the stakeholders to create the best possible evaluation communication plan.
- Articulate the value of stakeholder participation in the invitation to stakeholders who are not present at the initial meeting.
- Continue to reach out to groups that are important to the success of your evaluation efforts, even if they do not respond to the initial invitation (e.g., ask who else cares about this issue and why?).

Informal STEM programs develop STEM individuals, but also are key contributors to an area's STEM ecosystem. Ecosystems are strengthened, become more impactful, and are more sustainable when programs engage stakeholders in meaningful ways (such as in program design and by working alongside participants to enrich experiences).

References

"Appendix I – Engineering Design in the NGSS." *Next Generation Science Standards.* https://www.nextgenscience.org/sites/default/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf. Accessed 27 October 2021.

"Assessment Practices in Informal Science." *Informal Science*. https://www.informalscience.org/news-views/assessment-practices-informal-science. Accessed 27 October 2021.

"Assessment Tools in Informal STEM (ATIS)." *Pear.* http://www.pearweb.org/atis/tools/28. Accessed 27 October 2021.

Ayers, K. A., Wade-Jaimes, K., Wang, L., Pennella, R. A., and Pounds, S. B. "The St. Jude STEM Clubs: An Afterschool STEM Club for Upper Elementary School Students in Memphis, TN." *Journal of STEM Outreach*, vol. 3, no. 1, Nov. 2020. https://doi.org/10.15695/jstem/v3i1.13.

Burnham, K. "5 Culturally Responsive Teaching Strategies." *Northeastern University.* https://www.northeastern.edu/graduate/blog/culturally-responsive-teaching-strategies/. Accessed 27 October 2021.

"Championing Equity and Inclusion." Sierra Nevada Journeys. https://www.sierranevadajourneys.org/equity-and-inclusion. Accessed 27 October 2021.

"Connecting science instruction to neighborhood life through collaborative design with community." *STEM teaching tools.* http://stemteachingtools.org/brief/73. Accessed 27 October 2021.

"Dialogue Guides: Models for Stakeholder Interaction Around Issues." *idea Partnership.* http://www.ideapartnership.org/documents/NovUploads/Blueprint%20USB/Meetings%20to%20Co-Create/Dialogue%20Guides.pdf. Accessed 27 October 2021.

"EQuIP Rubric for Lessons & Units: Mathematics." *Achieve.* https://www.achieve.org/files/EQuIPmathrubric-06-17-13_1.pdf. Accessed 27 October 2021.

"EQuIP Rubric for Science." *Achieve.* https://www.nextgenscience.org/resources/equip-rubric-science. Accessed 27 October 2021.

"Evaluation Tools and Instruments." *Informal Science.* https://www.informalscience.org/evaluation/evaluation-tools-instruments/evaluation-tools-and-instruments. Accessed 27 October 2021.

"Evidence Statements." *Next Generation Science Standards*. https://www.nextgenscience.org/evidence-statements. Accessed 27 October 2021.

"Fires in the Bathroom: Advice for Teachers from High School Students." *The New Press*. https://thenewpress.com/books/fires-bathroom. Accessed 27 October 2021.

"Getting their hands dirty: Engaging learners in authentic science practices outside the classroom." *STEM teaching tools.* http://stemteachingtools.org/brief/20. Accessed 27 October 2021.

Hammond, Z. “Distinctions of Equity.” Culturally Responsive Teaching and the Brain. https://crtandthebrain.com/wp-content/uploads/Hammond_Full-Distinctions-of-Equity-Chart.pdf. Accessed 27 October 2021.

Hill, S., Barnes, S., and Wagner, A. *Sierra Nevada Journeys Classrooms Unleashed Community Needs Assessment*. Sierra Nevada Journeys, 2021. https://static1.squarespace.com/static/55774404e4b07f2c7dc881a0/t/617b20e8b626aa479ef186be/1635459345070/SNJ_Community_Needs_Assessment_20211025.pdf.

Identity in Science and STEM: Reflections on Interviews with the Field. Center for Advancement of Informal Science Education, 2018.

“Impact.” *First.* https://www.firstinspires.org/about/impact. Accessed 27 October 2021.

“Informal STEM Learning Environments (ISLE) Subcommittee.” *OSIT*, https://osit.nv.gov/STEM/ISLE_Subcommittee. Accessed 27 October 2021.

Informal STEM Learning: Professional Competency Framework. http://www.islframework.org/. Accessed 27 October 2021.

“ISL Framework.” *Informal STEM Learning: Professional Competency Framework.* http://www.islframework.org/wp-content/uploads/2019/11/ISL_Framework_grid_1page_8.5x11v2.pdf. Accessed 27 October 2021.

“Leading by Convening (LbC): Rubrics to Assess and Shape Practice.” *WestEd*. https://ncsi.wested.org/wp-content/uploads/2017/02/LbC-Rubric-Stakeholder-Engagement-in-Evaluation.pdf. Accessed 27 October 2021.

National Research Council 2015. *Identifying and Supporting Productive STEM Programs in Out-of-School Settings*. Washington, DC: The National Academies. Press. https://doi.org/10.17226/21740. Accessed 27 October 2021.

National Research Council 2009. *Learning Science in Informal Environments: People, Places, and Pursuits.* Washington, DC: The National Academies Press. https://doi.org/10.17226/12190. Accessed 27 October 2021.

National Research Council 2010. *Surrounded by Science: Learning Science in Informal Environments.* Washington, DC: The National Academies Press. https://doi.org/10.17226/12614. Accessed 27 October 2021.

“Nevada STEM Framework.” *OSIT.* https://osit.nv.gov/STEM/NV_STEM_Framework/. Accessed 27 October 2021.

“Nevada STEM Networks: Asset Map Survey.” *Google Forms*. https://forms.gle/271RonYV1FYnq3KB6. Accessed 27 October 2021.

“Nevada STEMList.” *OSIT.* https://osit.nv.gov/STEM/STEMlist/. Accessed 27 October 2021.

NextGen TIME. https://nextgentime.org/. Accessed 27 October 2021.

“NGSS Lesson Screener.” *Next Generation Science Standards.* https://www.nextgenscience.org/sites/default/files/NGSSScreeningTool-2.pdf. Accessed 27 October 2021.

“NV Regional STEM Networks.” *OSIT.* https://osit.nv.gov/STEM/Regional_STEM_Networks/. Accessed 27 October 2021.

"PD: Professional Development Session Resources." *STEM teaching tools*. http://stemteachingtools.org/pd. Accessed 27 October 2021.

Project Implicit. https://implicit.harvard.edu/implicit/takeatest.html. Accessed 27 October 2021.

"Read the Standards." *Next Generation Science Standards.* https://www.nextgenscience.org/search-standards. Accessed 27 October 2021.

"Research Brief: The Informal Formative Assessment Cycle as a Model for Teacher Practice." *STEM teaching tools*. http://stemteachingtools.org/brief/16. Accessed 27 October 2021.

"Resource Brief: Goals and Metrics – Gathering Evidence for Success."

"Review Tools." *edreports.* https://www.edreports.org/reports/review-tools. Accessed 27 October 2021.

Rodriguez, L. *From interest to identity: Creating and nurturing STEM kids in middle school.* National Science Teachers Association, 2018.

"Science and Engineering Practices." *NGSS@NSTA.* https://ngss.nsta.org/PracticesFull.aspx. Accessed 27 October 2021.

"Science Motivation Questionnaire II (SMQ-II)." *University of Georgia.* https://coe.uga.edu/assets/downloads/mse/smqii-glynn.pdf. Accessed 27 October 2021.

"Science Task Prescreen." *Next Generation Science Standards*. https://www.nextgenscience.org/sites/default/files/resource/files/Achieve%20Task%20PreScreener_Final_9.21.18.pdf. Accessed 27 October 2021.

"STEM Reports." *OSIT*. https://osit.nv.gov/Reports/STEM_Reports/. Accessed 27 October 2021.

STEM teaching tools. http://stemteachingtools.org/tools. Accessed 27 October 2021.

STEMworks at WestEd. https://stemworks.wested.org/. Accessed 27 October 2021.

"STEMworks Design Principles." *STEMworks at WestEd*. https://stemworks.wested.org/sites/default/files/STEMworks_Design_Principles.pdf. Accessed 27 October 2021.

"Systemic Equity Review Framework: A Practical Approach to Achieving High Educational Outcomes for All Students." *Education Development Center.* https://www.edc.org/sites/default/files/uploads/Systemic%20Equity%20Review%20Framework.pdf. Accessed 27 October 2021.

The Caltech Precollege Science Initiative (CAPSI) Research Group. *Is Science Me? A Study of Identify and Influences.* Caltech.

"The Education Justice Research and Organizing Collaborative (EJ-ROC)." *The Metropolitan Center for Research on Equity and the Transformation of Schools.* https://steinhardt.nyu.edu/metrocenter/ejroc/culturally-responsive-curriculum-scorecards. Accessed 27 October 2021.

"What is the role of informal science education in supporting the vision for K-12 science education?" *STEM teaching tools.* http://stemteachingtools.org/brief/38. Accessed 27 October 2021.