2021

STEMCAP Evaluation Report
June 2021

Prepared by the Utah Education Policy Center
on behalf of
The STEMCAP Program

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Introduction

Purpose

The STEM Community Alliance Program (STEMCAP) administrative team contracted with the Utah Education Policy Center (UEPC) to evaluate the implementation and outcomes of the STEMCAP program. The UEPC conducted the evaluation in Spring 2021. The STEMCAP program is a collaborative partnership among the University of Utah, Utah Juvenile Justice Services (JJS), the Utah State Board of Education, and local school districts along the Wasatch Front. This program creates intentional connections between scientists, artists, educators, and students in youth-in-custody (YIC)[1] facilities. These YIC facilities are located within the Provo, Granite and Davis School Districts. Teachers within the facilities are employed by their respective local school districts.

For this evaluation, the UEPC focused on evaluation tools aligned with the USBE program and student objectives. We address both implementation and outcome evaluation questions through the analysis and interpretation of a variety of qualitative data sources, such as interviews and presenter documents. Evaluation questions and data sources are described in more detail in the Methods section of this report. Additionally, we provide a discussion at the conclusion of the report that offers opportunities for STEMCAP scalability, incorporating Coburn's (2003) four dimensions of scale: depth, spread, sustainability, and ownership. [2]

STEMCAP Program Overview

The STEM Community Alliance Program was designed to foster interest in science among YIC by helping them to self-identify as science-capable learners and encouraging them to contribute to science, nature protection, and the STEM workforce by cultivating relationships between YIC, their teachers, and local scientists and artists.[3] STEMCAP is funded by a grant through the Utah State Board of Education (USBE). The program is designed to connect local scientists and artists with educators at five YIC facilities around the Salt Lake Valley. Table 1 identifies the STEMCAP program and student objectives. These objectives also aligned with those objectives stipulated by the USBE as part of the grant program. The program provides workshops for the students on a wide variety of STEM topics. See Table 2 for an overview of the types of workshops provided by the STEMCAP program, provided by STEMCAP program staff.

[1] The use of terms such as "Youth-in-Custody" reflect the language used by the Utah State Board of Education when referring to "individuals under the age of 21 who are in custody of or receiving services from the Utah Department of Human Services or an equivalent Native American tribe, or who are being held in a juvenile detention facility." (Retrieved from: https://www.schools.utah.gov/yic)

[2] Coburn, C. E. (2003). Rethinking scale: Moving beyond numbers to deep and lasting change. *Educational Researcher, 32*(6), 3-12.

[3] Retrieved from https://www.stemcap.org/about-us/.

Table 1. STEMCAP Program and Student Objectives

STEMCAP Program Objectives
• Spark student curiosity in STEM fields. • Prepare students to communicate effectively using scientific language and reasoning. • Build student confidence in pursuing the study of science and scientific careers. • Prepare students to support and engage in their communities in positive ways. • Forge meaningful relationships between students, scientists, and community leaders that will facilitate successful transition in home and school settings. • Create a model for program implementation and evaluation for YIC- University partnerships that may be transferred to other institutions. • Support professional development of USBE YIC teachers. • Empower students by proving opportunities to contribute to real-world conservation efforts.
STEMCAP Student Objectives
• Spark student curiosity, awareness, and interest in STEM related fields and research topics. • Develop mastery of content, academic skills, positive attitudes and confidence related to STEM educational and professional pursuits. • Build a deeper understanding of the nature of science. • Communicate effectively using science language and reasoning. • Recognize science pathways as personally accessible and achievable as a degree or career. • Establish relationships with community members that will facilitate successful transition in home and school settings.

When the STEMCAP program began, all workshops were designed for in-person facilitation in order to maximize interactive and hands-on learning experiences for students. However, due to the COVID-19 pandemic, all planning and facilitation of workshops became virtual in March 2020. Despite the challenges that virtual lessons offered, the STEMCAP team continued its efforts to recruit and support presenters in their work with YIC students and teachers.

Table 2. STEMCAP Workshops

STEMCAP Workshops	
Science Right Now!	Cutting-edge scientists teach students about on-going research while providing them with the lens that science is current and dynamic. These workshops are designed to dive deeply into the current research being done within a certain field.
Art-Science	Presenters use creative outlets to help students see that there are multiple ways of understanding the world, and that different disciplines and approaches can deepen this understanding. The workshops connect science to other ways of knowing and communicating in the arts and humanities, and include hands-on experiences aimed at inspiring excitement about learning science content.
Objects from Nature	Museum professionals and /or naturalists share natural history objects that can be handled by students. Students practice a variety of observation techniques and

		have the chance to directly handle natural objects while learning about the role of natural history in on-going discovery, the role of nature in human life, and the role of observation in science.
	Portal to Science	Research scientists introduce students to the scholarly, physical, and collaborative environment of academic labs in order to demystify lab work. Presenters demonstrate the range of skill levels and educational backgrounds within a lab group, help students understand the nature of science investigation, and reveal the range of career/life paths that training in a lab might lead to.
	Conservation Workshop	Students work closely with a conservationist to learn about an ecological issue and participate in a project that contributes to on-going conservation efforts in Utah. They also learn how science contributes to hands-on conservation efforts.
	Mission STEMCAP	Presenters focus students' attention on multiple facets of a single topic in order to more deeply explore aspects of science that are integral to societal and environmental well-being. Utilizing a series programming model rather than stand-alone presentations allows for deeper connections between presenters and students.
	Long-Term Conservation Projects	Students experience the sense of fulfillment that comes with giving back to their community and to the Earth while learning hands-on skills. These workshops are typically long-term projects such as raising milkweed plants to support Monarch butterfly populations and learning seed-saving practices. Throughout these workshops, students learn how science contributes to conservation efforts and the ecological well-being of communities.

Report Organization

The remainder of this report first provides a description of our methods, including evaluation questions, data sources, and our analytic approach. Next, we provide a summary of our evaluation findings organized into three sections: (1) Program Design and Implementation; (2) Outcomes; and (3) Program Scalability and Sustainability. Within each section, we present the themes from our findings in the form of subheadings within this section of the report. Finally, we conclude with a discussion of program considerations and implications, organized within three main themes: *Develop Systems for Collaboration and Continuity*, *Implement with Intentionality*, and *Strengthen Coherence*.

Participant Definitions and Terms

Scientists and artists are collectively referred to as "presenters," "participants," and "interviewees." The terms "presentation" and "lesson" are used interchangeably to refer to the presenters' presentation for students in the centers. Lastly, all YIC are also referred to as "students" throughout this report.

Methods

Evaluation Questions

This evaluation of the STEMCAP program utilizes a variety of data sources to address both implementation and outcome evaluation questions. In particular, we interviewed STEMCAP program staff, scientists and artists who presented lessons as part of STEMCAP workshops, and teachers of YIC who partner with STEMCAP by hosting presenters in their classrooms. We also collected and reviewed program-related documents, including sections from the STEMCAP program handbook as well as a sample of presenters' lesson materials. Table 3 provides a summary of evaluation questions and the data sources used to answer each. As outlined in the table, we organize our findings into three major sections pertaining to program design and implementation, outcomes, and sustainability and scalability.

Table 3. STEMCAP Evaluation Questions and Data Sources

	Evaluation Questions	Data Sources				
		Presenter Interviews	Teacher Interviews	District & USBE Interviews	STEMCAP Staff Interviews	Document Analysis
Implementation Questions	**Part One: Program Design and Implementation**					
	In what ways did presenter and educator lessons address STEMCAP program and student objectives? What were the characteristics of the lessons?	✓	✓	✓	✓	✓
	How did STEMCAP serve as a catalyst for STEM learning, collaboration, capacity building, and access to resources, including preparation guidance for presenters and educators for their role?	✓	✓	✓	✓	✓
Outcome Questions	**Part Two: Outcomes**					
	What evidence is there of how the program design (e.g., use of art…) and implementation increased student knowledge of science content, interest, confidence, engagement and pathways in STEAM (e.g., science-engaged careers, volunteer opportunities)?	✓	✓	✓	✓	✓
	How effective and valuable was STEMCAP design and implementation at building the nature and quality of engagement and relationships between presenters and educators and students through STEM learning?	✓	✓		✓	
	How effective and valuable was STEMCAP design and implementation at strengthening engagement and developing relationships between presenters, educators, and students through STEM learning?	✓	✓	✓	✓	✓

	Evaluation Questions		Data Sources			
		Presenter Interviews	Teacher Interviews	District & USBE Interviews	STEMCAP Staff Interviews	Document Analysis
Sustainability & Scalability	**Part Three: Sustainability and Scalability**					
	What contributes to STEMCAP program scalability and sustainability?	✓	✓	✓	✓	
	In what ways could the partnership and work between program, presenters, and educators be improved to meet program and student objectives?	✓	✓	✓	✓	✓

Human Subjects Protections and Institutional Review Board Approvals

The UEPC maintains an approved Institutional Review Board (IRB) approval, including an Exemption Umbrella Protocol Approval. This IRB approval ensures that evaluation and research activities of the UEPC and UEPC personnel are conducted and maintained consistent with Human Subject research requirements, as defined by the Office of Human Research Protections (OHRP) in 45 CFR 46.102 and non-human research and as defined by the University. All UEPC staff receive FERPA and IRB Human Research Protections Program (HRPP) CITI (Collaborative Institutional Training Initiative) trainings and certification, which covers issues of data privacy, security, and protections, formal data, privacy and security training, and ethics of data management and use. As such, the University's IRB ensures that all research and evaluation conducted by the UEPC and its personnel are aligned with ethical research practices. Our IRB approval is subject to an annual reporting and review, which includes oversight by the University of Utah IRB. Prior to participating in any research data collection (e.g., interviews, focus groups, surveys), participants are provided a consent. The consent form indicates that participation is voluntary and participation can be stopped or withdrawn at any time. Information reported in the evaluation is de-identified to protect the identity of the participant. Finally, the UEPC limits and restricts data access to leaders in charge of the day-to-day operations of the research, and professionally and technically qualified staff who conduct research and evaluation. UEPC employees who have access to data are required to also sign a Non-Disclosure Agreement, which pertains to all data collected for research and evaluation purposes.

Data Sources & Analysis

Participants

To facilitate the UEPC recruitment process for interviews and focus groups, STEMCAP program staff provided contact information for 33 presenters, four YIC teachers, and five district

administrators and state-level specialists.[4] The staff then sent initial emails to presenters and teachers explaining the purpose and process of the evaluation, as well as preparing them for future email correspondence from the UEPC to schedule focus groups. Most presenters were affiliated with the University of Utah, with some from nearby academic institutions, agencies, or non-profit organizations.

Presenter participants had presented between one and ten lessons since the inception of the program in 2017. All but one participant had presented within the past year, 2020-2021. Four participants had presented as part of an artist-scientist team as part of the Art-Science workshop, while the remaining participants had presented independently. Two of the four YIC teachers (50%) participated in this evaluation. Both taught science to YIC at different facilities. One teacher had worked with the STEMCAP program for several years, while the other was relatively new to the program. The number of interviewees affiliated with each type of STEMCAP workshop is listed, but no individual respondents are identified throughout this report (Table 4). All four district administrators and USBE specialists agreed to participate in interviews.

Due to the voluntary nature of the STEMCAP evaluation, not all STEMCAP workshops were represented equally in our data. The majority of participants had presented lessons as part of the "Science Right Now!" workshop. "Art-Science" and "Mission STEMCAP" workshops were also represented by at least five participants. It is important to note that none of the 18 participants were involved with the "Conservation" or "Long-Term Conservation Projects" workshops.

Table 4. Number of Presenter Participants by Workshop

STEMCAP Workshop Title	# of Affiliated Interviewees
Science Right Now!	10
Art-Science	6
Objects from Nature	2
Portal to Science	1
Conservation	0
Mission STEMCAP	5
Long-Term Conservation Projects	0

Note: Some presenters participated in more than one workshop, which is reflected in the counts above.

Focus Groups and Interviews

UEPC used both focus groups and interviews. We conducted a total of six focus groups and 14 interviews. We facilitated one focus group with STEMCAP staff, and two interviews with the two teacher participants. For presenters, we used a two-step process that included both focus

[4] STEMCAP staff shared information about their preexisting IRB requirements, which were followed throughout this evaluation.

groups and individual interviews, which we describe in greater detail below. Lastly, we conducted two interviews with two district administrators and one interview with two specialists from the Utah State Board of Education (USBE) who are involved in STEMCAP programming. See Table 5 for a summary of the data collection methods we used for each participant group.

Table 5. Data Collection Methods by Participant Type

STEMCAP Participant Type	Focus Group	Interview
Presenter	✓	✓
Teacher		✓
Program staff	✓	
District administrator		✓
USBE specialist		✓

The purpose of the focus groups was to develop an understanding of specific roles, responsibilities, and expectations of the participants regarding the STEMCAP program, as well as perceptions of intended student and program outcomes. The focus group format provided an opportunity for participants to respond to and build off of each other's experiences, opinions, and beliefs. The purpose of interviews was to gain a deeper and more nuanced understanding of individual participants' experiences and perceptions about the program.

We began by inviting presenters to sign up for pre-determined focus group time slots. Each presenter focus group included between three and six participants. We then purposefully sampled a total of nine presenters from the focus groups to participate in a follow-up one-on-one interview. This sample included presenters from a wide variety of workshops who demonstrated a willingness to share rich information about their STEMCAP experiences during the focus group.

A total of 26 participants were interviewed for this evaluation, including 18 presenters, two science teachers of YIC, two STEMCAP staff members, and four district administrators and USBE specialists. Of the 18 presenters, 17 held positions in science-related fields, and one held an art-related position. All presenters had presented at least one lesson to students as part of a STEMCAP workshop. Eighteen (55%) presenters also participated in a focus group. All findings related to student outcomes and impacts on students were participants' perceptions; no students participated in this study.

Focus groups ranged from 45-60 minutes, and individual interviews ranged from 17-45 minutes. Due to the COVID-19 pandemic, the focus groups and interviews were conducted virtually via Zoom, and each was recorded and transcribed.

Focus Group and Interview Data Analysis

Interview and focus group transcripts were coded deductively and inductively using initial and focused methods.[5] We first created a codebook based on concepts within both the evaluation questions and STEMCAP program objectives. Data that did not fit these initial parameters were coded inductively, using participants' language and experiences. Codes were then organized into categories and themes (See Findings Section). Data reported in the findings represents all interview participants.

Document Analysis

We asked presenters who participated in a one-on-one interview to submit relevant lesson materials (e.g., slide decks, handouts, lesson plans) for document analysis. Three of 18 total participants submitted lesson slide decks. Without accompanying lesson plans and handouts, the provided slide decks did not yield information about the nature and quality of lesson activities. We did, however, use these materials to triangulate interview data as appropriate and possible, which we include in some sections within the findings. We also reviewed a chapter from the STEMCAP program handbook which listed the STEMCAP workshops with accompanying descriptions, which provided essential context to better understand participants' experiences. Future evaluations of STEMCAP will include requests for a sampling of documents from each presenter, including lessons plans, intended outcomes and objectives, and supplementary handouts and slide decks.

In the following section, we organize and report our findings by evaluation question. Within each evaluation question, we identify the salient themes that emerged from our data analysis, as communicated within the sub-headings of the report. We then provide a brief summary of each theme, followed by representative evidence (i.e., quotes) from presenters, teachers, STEMCAP staff, district administrators, and USBE specialists.

[5] Saldaña, J. (2016). The coding manual for qualitative researchers (3rd ed.). Los Angeles, CA: Sage.

Part 1: Program Design and Implementation

In what ways did presenter and educator lessons address STEMCAP program and student objectives? What were the characteristics of the lessons?

Lessons prioritized students' curiosity and engagement through flexible, interactive, hands-on design

STEMCAP lessons prioritized students' curiosity and creating instructional opportunities, both formal and informal, for students to explore content and self. To enhance engagement, presenters designed lessons that were interactive and hands-on, and positioned students to ask questions. During the focus groups and interviews, presenters emphasized the importance of being flexible and willing to pivot away from the lesson design in order to follow students' interest and answer students' questions. As noted, this provided an opportunity to address the sparks of interest among students. In this way, presenters prioritized student curiosity and engagement more so than delivering detailed content.

> "You're really there to spark their interest, not to get them to remember a certain concept."
>
> -Presenter

- "The main [objectives] we were really trying to focus on were really sparking that curiosity and building that confidence." (Presenter)
- "But, I think that the kind of trying to import scientific knowledge, per se, or science content I think is very difficult in that format, and I don't think it's the most important thing versus thinking of science as a career or scientific thinking, or sparking curiosity, or having the students feel that the sciences are accessible. I think that those have become much more important in the kind of workshops and presentations I do for STEMCAP, and I think that that's been a shift." (Teacher)
- "The teachers might say, 'Oh so they might be a little behind for the regular age.' And for me that's not important. I'm not discussing exams or grades. I'm talking about something that could bring out the curiosity that is innate to all human beings, and they have so many questions…" (Presenter)
- "There was a lot of shifting as far as how to get [the students] engaged and interacting with the material and stuff. It's [research topic], it's hard to make it exciting. So that became a much higher priority as we were developing [the presentation]. We knew it was going to be hard from this part but that and being a higher priority was kind of the engagement." (Presenter)
- "Faculty have brought down things like electronics kits, where we make electronic circuits. They've brought down where we've candled elements and like they actually like light the liquefied elements on fire and we're seeing like the smoke and fumes wafting up towards

the fire suppression unit and I'm going, 'This is the coolest thing I've ever seen. That is like totally purple fire.' [The presenters] are remarkable. So sparking curiosity? Yeah, check and double-check." (Teacher)

- "There's definitely a point where I think the questions start being asked and [the students] kind of start asking each other questions, often before they ask me a question. The interaction is what I look for. It becomes a dialogue and not just me spewing science at them. That's where I see that I've made an impact, or at least that there's some interest and it's not just me telling them things." (Presenter)

- "So, as long as they can be flexible and pivot – and read the room. I mean, really, this isn't like you're disseminating information to your peers and you just – this is your presentation. It is supposed to be interesting to them. So, if everyone looks really, really bored, maybe try to engage with them a little more." (Presenter)

> "I'm hoping it's giving [the students] a richness of exposure to things. Some of the barriers to curiosity are not even knowing what's out there…"
>
> -Presenter

- "A lot of the presenters are great about following along with the student interest, if they show an interest in a specific part of a presentation, they will kind of expand on that." (Teacher)

- "I would say…spark[ing] student curiosity in STEM fields is [an objective] that we address in all of our programming. And evidence for that I would say is kind of engagement of the students and the questions that they ask." (Staff member)

- "So one thing that's pretty big in our mentoring of the presenters that come to us is reminding them that the goal of the program is not to kind of teach a typical science class and say 'this is what genetics is' and that it's more about kind of diving deeply into specific topics and then interacting with the students in a way that allows the students to ask questions about that subject and apply it to interests that they have kind of beyond STEM fields. We really try to emphasize that interactive component as a way to help with that sparking curiosity as well as incorporating hands on activities and then incorporating art which we only do in some of our programs." (Staff member)

- "I think posing a question about extinction got the kids thinking. And I consider that seeds, that we're planting seeds and we may not see them at full fruition. But that's what they could possibly be taking with them as they move to new areas in their lives." (District administrator)

Lessons highlighted various pathways to science by emphasizing that scientists come from a variety of backgrounds

To encourage students' beliefs in their abilities to become scientists, presenters reported demystifying and debunking common stereotypes of science and scientists ("an older White gentleman with glasses, always wearing a lab coat"). Presenters took time to introduce

themselves to students, which not only created an engaging environment, but also highlighted their own nontraditional entry points into science. Others explicitly addressed stereotypes of scientists in their lessons by showcasing a diverse representation of scientists and their respective contributions (e.g., presenting a lesson focused on the contribution of women scientists). Our review of submitted materials showed that the presenters shared information about their journey into science.

- "So, I tried to include a bit of my background and how I got into science myself. And I think by having that example, it shows a scientist can come from anywhere and have any kind of background." (Presenter)
- "Spending those times on those introductions began at least some sort of dialog with the students that could like let them maybe let their guard down a little bit and maybe perhaps let them realize that you weren't just here to teach them about science." (Presenter)
- "We talked a lot about how I got involved in science and ways that students could also continue on and become scientists that they'd like to, or to be involved in science from a number of different directions, not just being a scientist." (Presenter)
- "We did a project…about important contributions of women, both in science and in art and history and social studies, all connected to Utah, and worked with an artist to help students develop portraits about women that had made positive change, either in their community or in their life or whatever. And so – and then we worked with female scientists, female-identifying scientists in the community to talk about their work as well. So, I felt like them being able to get to know these people on personal levels and kind of develop a rapport with them helps students see themselves in some ways as being able to be change makers and leaders in their community in that way as well." (Presenter)
- "But I'm a big proponent of mentoring and I have mentoring throughout my program and seeing scientists and seeing highly successful people, especially for a young lady to see people like [female STEMCAP staff member] as successful are good for our kids to see versus all the bad examples on TV." (District administrator)

The STEMCAP program used teachers' expertise in managing classrooms, connecting to prior learning, and providing other support for the presenters as they participated in the lessons

Teachers supported presenters' workshops by taking on the role of facilitator and participating alongside the students. Specific facilitation actions included managing/distributing materials, employing classroom management strategies, making connections with prior learning, and providing students with general support, as needed. Teachers believed their role during presentations was to create conditions in the classroom that would set the presenter up for success. Presenters expressed gratitude for the opportunity to collaborate in this way with teachers, particularly during virtual workshops during the pandemic.

- "I feel like my role is to facilitate – make sure there's a willing audience, make sure they have the things that they need to succeed and the things to thrive, kind of connect with the presenter. I think it's important for me to sort of jump in there and kind of advocate for thinking in a directed direction, 'cause sometimes they get a little off topic…I see my role as to encourage, to make sure that there's a connection with the information that they're trying to get out. I always I try to bring some background so I can remind them, 'Oh, this is like when we looked at this or when we looked at that or when we looked at shapes in nature,' however, right?" (Teacher)

- "…The rapport [the teachers] have with the students is fantastic. And having them there to support is definitely what makes the program function because they know the students, they know their particulars, they know them by name, and they know how to prompt questions." (Presenter)

- "I just am here to facilitate and participate as much as I can. Oftentimes for me I don't know a whole lot going in, but I become like the – after it's over we can reflect and kind of give them a little bit more guidance if there's something they're interested in or if they still have questions. So I step back and kind of let the presenters teach the kids and I become one of the students often, because they know a lot more than I do about some of the subjects." (Teacher)

How did STEMCAP serve as a catalyst for STEM learning, collaboration, capacity building, and access to resources?

STEMCAP staff provided helpful, actionable guidance to presenters to support effective lessons in STEMCAP program and beyond

One element of the STEMCAP process included the guidance and feedback that the STEMCAP staff provided to the presenters as they prepared their lessons. This guidance fell into three areas: curricular, pedagogical, and experiential. Curricular guidance included determining topics, the depth and breadth of the content, and materials that would be allowed in the centers. STEMCAP staff also provided pedagogical feedback, including suggestions for effective questioning, engagement strategies, checking for understanding, and using student-friendly language. Lastly, the staff prepared presenters about what to expect during the experience, including information and background context about the facilities and students.

> "They had really great suggestions…those terms that are second nature to us may not have ever been heard before by the students…."
>
> -Presenter

- "I think a lot of the hesitancy, or kind of anxiety was definitely in my own head and caused by the environment, and [STEMCAP staff member] did a great job of kind of just addressing that up front and saying, 'This can be uncomfortable,' so we were able to have a conversation about kind of any concerns, or not even conversations, but the fact that she

brought them up like, 'This can feel intimidating,' it helped me feel a little less out of place." (Presenter)

- "I think for teaching, it's definitely made me a little more compassionate and relaxed. I'm not as strict sometimes with, 'We have so much material to cover, and we need to cover it.' I let some of those conversations go on that I wouldn't have. I interact with students a little more. In [my scientific area], kind of we're taught we just want the material. We don't do any icebreakers. We don't need to know who you are. So, that's changed a little bit - how I interact with the students. I'm not, maybe, as robotic as I was." (Presenter)

- "[The STEMCAP staff did a really good job of having me go over [my lesson] beforehand and just being like, 'okay, when you focus on this topic, maybe just brush over this, you don't have to go super in-depth into here', or 'is there another term you could use to define this' or something like that? And just making sure that if I'm going to be using a certain term throughout that may be commonplace to me, that I define it beforehand. And so, [the STEMCAP staff] did a really good job at focusing on that and making sure that basically the entire presentation was streamlined and yeah, that we were just hashing and hitting all of the main goals we had." (Presenter)

- "And then definitely I practiced ahead of time with [STEMCAP staff] and we went through the talk and they had really great suggestions…those terms that are second nature to us, but may not have ever been heard before by the students. They were really helpful in identifying those and also helping to come up with ways of like, 'this might be a good place to introduce that term or define it here and like the organization that way'. So, that was really helpful." (Presenter)

- "I think a lot of the hesitancy, or kind of anxiety was definitely in my own head and kind of caused by the environment, and [STEMCAP staff member] did a great job of kind of just addressing that up front and saying, 'This can be uncomfortable,' so we were able to have a conversation about kind of any concerns, or not even conversations, but the fact that she brought them up like, 'This can feel intimidating,' it helped me feel a little less out of place." (Presenter)

- "A lot of the conversation was had with [STEMCAP staff member], who is super confident, who is really able to lay out, 'Here is what you're up against, here are the challenges.'" (Presenter)

- "[The] STEMCAP staff are great. [They're] preparing [the presenters] well to go into the environment because sometimes they can be intimidating. I don't imagine the thought processes that they go through, but they seem to show their passion and that's what kids need to see more from adults is what's made them passionate in the field they've chosen to go into." (District administrator)

- "[The presenters] know what they can bring. They know what art projects they can do. They know what topics that they're going to kind of shy away from that might be triggers,

especially in a psychiatric setting. But they're also going to bring really relevant, current practice to these students. So, that's a win. Right?" (District administrator)

STEMCAP staff helped presenters to reconceptualize and share their work in different ways

The STEMCAP team helped the presenters to understand the need to adopt a "different lens" and think about their work differently. Artist-scientist presenter teams gained new perspectives and adopted new ways of thinking about their work due to the influence of their co-presenters and their fields. Some participants described new insights about similarities between the Art and Science disciplines that they would not have expected. Others noted lasting impressions on how the two disciplines connect in new ways. The STEMCAP staff assisted presenters in shifting away from sharing the nuanced, highly academic details of their areas of expertise and toward a more generalized topical presentation that was more appropriate for a younger audience. Lastly, some participants described feeling challenged by the students' questions, as the students offered a reaction, perspective, and insight different from the students they typically encounter at their respective universities.

> "You realize, 'Well, what about my project is important to the actual community, or important to society?'"
>
> -Presenter

- "I really appreciate always the wonderful group of people we get to work with at STEMCAP because oftentimes it's them kind of coming to me with an idea. Like 'Hey. We're exploring this theme. What do you think about it? How can we kind of make it work?' And then I usually have some time to kind of go process it. Some of them are really challenging…And every time it's been like just such a fun challenge because I have been able to make it work. And it's made me as a facilitator and an educator look at [art] just through a completely different lens which I think is so wonderful for my own growth but also just to kind of think about things in new ways is fun." (Presenter)

- "I loved being able to get perspectives of the scientists and seeing things through the lens of biodiversity and different aspects of the scientific world that I never would have really thought about in art. Which now that's all I can think about, to be frank. Whenever I'm not working, and my brain goes to places that it didn't go before. So it's really expanded my own kind of world view of possibilities for using art to talk about lots of different things which I think is just super exciting…I think that's helped kind of expand my ideas of what's possible both for like curriculum development and projects and programs and collaborations and all of those things." (Presenter)

- "I think that it's awesome to interact with this group because of the unique perspectives and opinions that you get from doing this type of work, the biggest thing being, if I'm having to prepare for a scientific talk or whatever, that I'm going to get some type of question on the analysis or some type of pushback in a certain, really specific format. But, what is really amazing about the Mission STEMCAP stuff is that the questions that you get and the perspectives that you're exposed to are more at the fundamental, 'So what?' of your work, like you then take a step back from the actual science that you're doing, because that's what's so important. You realize, 'Well, what about my project is important to the actual

community, or important to society? Why does this type of stuff actually matter beyond just advancing science?' which, when we really get down to the nitty-gritty, doesn't affect as many people as we would like. It was really cool to look at it and be able to use the process as a way to kind of expand your thinking a little bit, take a step back from your project and see it in the eyes of someone that is not necessarily completely in tuned to just the analytics or why you're doing exactly what you're doing, this very small niche that you're trying to fill out of that, then extrapolate to the larger community. I think that was one of the coolest things that came from it." (Presenter)

- "[My STEMCAP experience] helped me definitely evolve and kind of think outside what a traditional engagement or outreach experience is…But thinking outside the box and kind of presenting myself as much as the content I think definitely helped me shift how I think about what science engagement and outreach is and how important it is to be present and make yourself part of that engagement versus just 'Here's how you build a [object]: Stick this here, stick this here, plug this in. Ooh, it lights.' Which is cool, but it definitely helped me shift how I thought about doing engagement projects." (Presenter)

- "What is really amazing about the [STEMCAP] stuff is that the questions that you get and the perspectives that you're exposed to are more at the fundamental, 'So what?' of your work, like you then take a step back from the actual science that you're doing, because that's what's so important. You realize, 'Well, what about my project is important to the actual community, or important to society? Why does this type of stuff actually matter beyond just advancing science?' which, when we really get down to the nitty-gritty, doesn't affect as many people as we would like." (Presenter)

- "I had that unique opportunity of interacting with the artist…It was really fun to see like kind of the similarities between how [the artist] and I start a new project. And then also we had a chance to kind of learn from each other. And I think that was probably really nice for the students to see that like there can be effective communication between fields that are typically thought of as very opposite, science and arts. So, I think that was really nice and it would be great if that could be included in others STEMCAP things." (Presenter)

- "But it was still new territory for both [the artist and me], and I think we definitely learned how to cross-pollinate and mix our disciplines…It helped me try to think about artwork from a scientific perspective. I'd never done that before." (Presenter)

- "It's one of the few places I've gotten to kind of do an art and science workshop…I got to develop new content in a way that I don't often get the chance to. I think it's the only place I've done a cyanotype workshop, for instance, and being able to kind of talk a little bit about the chemistry, a little bit about modern artists, and then just let them have at it." (Presenter)

Teachers valued and learned from the expertise of the presenters

In addition to the variety of content that the presenters offered, the teachers valued the unique opportunity for the students to hear from other adults in the community who offered a different perspective about science. Teachers also appreciated the level of expertise and the amount of engagement that the presenters were able to create during their lessons.

> "As long as I'm teaching science to an underserved population, I really, really, really need this resource."
>
> -Teacher

- "Honestly, it's nice to have a different point of view every once in a while for the students and to see different faces and go, "Hey, there's another person out there that's as strange as you are." So that's helpful. The fact that they're bringing in things that – like expertise that I don't have. I don't know how to make a 3-D art book, and that's one of the things they did. And I don't know a ton about ants, and they learned about ants. So it gives me just a wider repertoire of information and people that are specialized in that information, along with just kind of a break from them listening to me all the time and getting to like see more outside the world of our little community." (Teacher)

- "My IQ goes up when they walk through the threshold. No kidding. *[Laughs]* It is absolutely so – the caliber of the people that we're able to talk with, the projects that they're putting up, the amount of community scientist engagement that they're achieving, I mean seriously, it's nothing short of miraculous." (Teacher)

- "…the professional development in my eyes is just expanding your knowledge and like continuing to learn all the time. So in that sense very much, yes, like I've learned lots of things that I did not know about various topics and tried new activities that I probably wouldn't have. So it stretched me and I've kind of gone beyond my comfort zone a bit, which I think is part of professional development just as much as like the classes that you get points for." (Teacher)

Part Two: Outcomes

What evidence is there of how the program design and implementation increased student knowledge of science content, interest, confidence, engagement, and pathways in STEAM?

Students posed questions to demonstrate high levels of interest and curiosity during lessons

The participants described the students as interested and curious during the presentations. They recognized student interest by the questions they asked during the lessons, which in many cases were more than the presenters had time to address. One member of a scientist-artist team felt like student engagement was highest during her collaborative presentations as opposed to solo presentations in the past. Many presenters described feeling surprised by the degree of student engagement, which we explore further in the following sections.

> "There was almost more questions than we could handle at times… we had to cut out big parts of what we were planning on doing because we didn't get to it because of the questions."
>
> -Presenter

- "I'm always very impressed by how curious [the students] can be and how deep the questions can go…. It's not like, "Oh, I cannot bring that sort of level of content because I don't think they" – it's always like the opposite. I'm like, "Oh wow, I need to revisit some stuff that I didn't think too much about. Now they're asking me questions that I don't know exactly the answer. And that makes me think, too." (Presenter)

- "Well, usually [the students] just get really excited and start asking lots of questions. Or they want to talk about it the next day or the next week." (Teacher)

- "And then what was fun too is I worked with one group and then I saw them again like a couple of weeks later doing something else and they totally remembered me and what we had talked about before to the point where it was like can we go back and talk about spiral jetty again? 'Cause I actually have a couple more questions. Even though we had like moved on weeks ago and were on like a totally different subject. I did not expect them to like one remember me or two like remember like details that we had talked about and then like we had thought about it and wanted to come back with more questions a couple weeks later. That warmed my heart. That was wonderful." (Presenter)

- "And I realize [the students] have this innate curiosity, that they just need a little spark and then they're going to get involved, especially having hands-on opportunities. I think they love that. They love to participate and interact among themselves." (Presenter)

- "And I felt like actually the most engagement of the different kinds of work I've done with STEMCAP was probably with me and a scientist just because it's like there's so much going on. There's a lot of different perspectives running around. And there were almost more

questions than we could handle at times where we had to cut out big parts of what we were planning on doing because we didn't get to it because of the questions." (Presenter)

- "Last time I went [to the Youth-in-Custody facility], kids were just asking great questions. I think it was the activities were built in a way that the lessons went well. And I think it engendered a lot of discussion with the kids especially the girls…so I think it does help with student curiosity." (District administrator)

Students shared work samples to demonstrate high levels of engagement during lessons

Students shared their artwork and other STEMCAP work samples with the presenters and their peers during lessons. The presenters discussed the creativity that the students demonstrated through their work, in addition to their willingness to engage with others as they explained their work. As they shared their projects, students also shared their individual thought processes in creating their work, which further offers evidence of student engagement in the lessons.

- "But my goodness. [The students] were really open and willing to show us their artwork. Because they'd have to actually come up and like hold things up to the screen which putting myself in that place I don't know if I would do that. I'm not sure I would feel comfortable talking up and showing two complete strangers on a screen like the artwork that I had made or my notes that I had taken. But I think every single one of them came up and like talked to us and showed us what they were doing and described their artwork or what they were thinking about. So to me that shows real engagement." (Presenter)

- "[The presentation] was virtual, so [the students] were passing around the web camera in the class and showing us their [artwork]. They would make a mess and they were laughing or there was a lot of positive talk." (Presenter)

- "It was just really fun to be able to see at the end the things [the students] came up with. I really enjoy giving students some tools and then seeing how they can be creative with that and what they can do…[The students] were willing to and would come up to the camera and show me the books they had made and that was just really super fun, so I really enjoyed that." (Presenter)

How effective and valuable was STEMCAP design and implementation at strengthening engagement and developing relationships between presenters, educators, and students through STEM learning?

Virtual lessons and single presentations made it difficult to establish meaningful relationships with the students

Although presenters were able to recount small moments of connection with students during their workshops, they found it difficult to get to know the students in a meaningful way. This was particularly true for those who provided workshops virtually during the pandemic, who described limited visibility and the inability to physically interact with students as significant barriers. Presenters who were in person prior to the pandemic described positive moments of connection but explained that it was challenging to try to build a meaningful relationship during a single presentation. One participant who had presented multiple times at the same facility as part of a series noted that the relationships strengthened with repeated exposure.

- "I only presented one time to a group of three classes so there really wasn't a lot of opportunity to develop relationships with the students." (Presenter)
- "I felt like [building meaningful relationships] was missing, but I don't think it was STEMCAP's fault or STEMAP's fault, I just think it was the fact I had to be remote because of COVID. So I felt really sad about that. It's harder to engage over a screen with students but I felt like we did have – I did feel grateful we did have three sessions, so they did see me three times; I got to see them three times. I did notice that they were a little more willing to open up and share and speak up when I asked a question, as we went along and they got used to this weird head on the screen." (Presenter)
- "[My presentation] was [in] three different classrooms, so three different screens. And some of them I was looking at the back of their head; some of them I was looking at the side of them but they were looking at me at the front of the room. So one of the classes – I kept trying not to look at that screen because it surprised me because I was looking at the back of their head and then I could see me talking in front." (Presenter)

The STEMCAP team's guidance on introductions and initial personal connections to students was beneficial

As the presenters prepared their lessons, they received support from the STEMCAP team on how to best introduce themselves to the students. These introductions often included the presenters sharing a bit of personal information with the students, such as their backgrounds, hobbies, and early interests in science. The presenters appreciated this guidance, and some noted that these intentional introductions and connections helped to build engagement among the students during the lessons.

- "I really like how the program is structured, that the coordinators want us to share a little personal background, or at least that's how my presentation's been, about 'Share a little bit of your personal struggles.' I was a hyperactive kid and I was lucky enough to have parents to say, 'Go explore. Go outside. Flip a rock. Come back and tell us what you found.' And so, I understand that perhaps some of those students also were hyperactive kids and unfortunately didn't have the opportunities I had to either explore or to have parents sparking that curiosity. And so, when I'm there I'm not trying to occupy that gap, but the idea of bringing similar opportunities…" (Presenter)

- "With our activity it felt like STEMCAP provided input to give the background on yourself and spend ten or fifteen minutes introducing ourselves and that really helped I think start some engagement and some discussion like I would talk about like, 'Oh, I like to go hiking,' and then sometimes that would like really spark a lot of interest in students like, 'Oh, where do you want to go?' and all of these different things. And then so that maybe warmed things up and the science like we would do the science of art and that really seemed to be quite the lull with the PowerPoint slides. And then once we were back into the activity I felt like the students really engaged." (Presenter)

Students shifted presenters' assumptions through their high levels of engagement and interaction

Presenters described the students positively, naming the students' willingness to participate, share about themselves, ask questions, and engage in activities as significant. Some described the students as more engaged than their counterparts in traditional school settings, both at the high school and college level. Many explained that this level of engagement, questioning, and willingness to participate was an unanticipated, yet positive surprise.

- "We come with a little bias like 'I don't know what exactly they did or what brought them to the facility.' And I think that might be the first thought we might have. And once you just ask questions, they're excited. I feel that if you treat them as people with curiosity and presence, they're going to open themselves and ask questions and engage. If you just go and drop a bunch of terms and leave and feel like I am a great citizen, I think the transformative power of your interaction would be very limited…" (Presenter)

> "I think we tend to make assumptions that [the students] completely shattered."
>
> -Presenter

- "I think it's actually right away your perception starts to shift when you realize despite the very imposing surroundings, like these are people, and not that I ever thought they weren't people, but it's really hard to know how to feel comfortable in that environment, or what you should be doing differently, or what should be done the same. I think as soon as you're able to have a conversation and say, "Hello," and you get responses, it's pretty much, working with teenagers, just a totally different environment. That kind of changed very quickly." (Presenter)

- "But I think for the most part they're like with it and they're willing to go along with you more than I even think like kids in more traditional school climates are. Going into high schools it's like come on. Nobody – you can tell there's maybe something going on in their mind, but they are just not willing to show it. But I find with the STEMCAP kids, these groups, they're much more willing to show some of their feelings and their interests out loud and express them which that did surprise me. I expected there to be more kind of introvertedness and like not willing to share, having more kind of walls built up and they're just very like willing to talk to you and go along with you." (Presenter)

- "I realized I was a little bit biased in terms of some groups of people not being interested in science, but [the students] were actually way better than most college kids in terms of asking questions and how interested they were." (Presenter)

- "…the feedback I've heard from some of the scientists that participated and how this was a population they didn't even know existed or were unaware of how many kids were actually involved in this population. And some of the feedback that it was a positive experience and it helped them like not only want to be involved with the STEMCAP program but other community actions to support this population." (USBE specialist)

How substantively did the program expand student self-identity and importance of civic engagement through STEM?

Lessons and projects expanded student self-identity and introduced civic engagement through activities and discussions

STEMCAP programs provided students with opportunities to participate in citizen science projects. They also included resources for students to engage in citizen science outside of the STEMCAP presentations. Teachers reported that the lessons opened students' eyes to new experiences and opportunities to personally engage in science and increased students' ability to envision themselves as future scientists. USBE specialists and district administrators also emphasized the impact of hands-on projects on students to provide opportunities for continuity and success and to spark their interest in related future endeavors. While data from students were not available, our analysis of interview data suggested that some STEMCAP workshops (e.g., conservation and Mission STEMCAP) may more intentionally address civic engagement than other workshops.

- And so, having [the students] actively involved in a project, hoping that they can see that they can actively contribute to science, and they can be a citizen scientist or a scientist themselves. That was a really important thing for us." (Presenter)

- “We tried to provide [the students] a couple examples of things they could even do now. So, just pointing them at resources that a lot of universities have because of big biodiversity datasets where citizen scientists or just anyone can observe some animal in some habitat and report that, and that goes into these huge datasets that ecologists use to study conservation or evolution. So, kind of pointing at that stuff that they could do kind of right away with that access. And one of the activities that we did was just looking at these actual cameras that we have out on reefs where we're tracking what animals are doing. And then, in the activities they had to identify key features that they thought helped differentiate the species from each other.” (Presenter)

> “It's opened their eyes to possibilities of what they could do in the future and careers that might actually interest them that they have never even thought about…”
>
> -Presenter

- “[The students] were getting on a citizen science platform called Zooniverse and then actively contributing to scientific projects across the world.” (Presenter)

- “I guess this is more of a hope that for the general student that it inspires [the students] a little bit, especially like to actually engage in a citizen science project, whether we were using our naturalist or they were helping me look through camera photos or something like that to show them that science is an available option to anybody and at any time, and that it's a great career path, no matter where you're at.” (Presenter)

- "Empower students by providing opportunities to contribute to real-world conservation," yes, we do this. Because we are citizen scientists, and so we can look at any global project and then we can do things like count meerkats, or look at whale shape shark spots, or, you know, check off the number of elk we see in a trail cam just up behind the university. So yes, we are absolutely developing citizen scientists.” (Teacher)

- “We had a kid here, we were talking about ice and the problems with glacial ice. And we watched a really beautiful documentary and they were just talking about what this guy was willing to do to get these pictures, these beautiful, beautiful images of this ice. And the kid just sitting right here off my left elbow said, "Man, I could do that. I'd love to do that."…So I think it's quite clear, you know? It's quite clear, they don't all have to work at Big O. They can go learn to scuba dive and go to work for NASA, you know? *[Laughs]* Get in the big pool. Just talk them into it. They can do anything.” (Teacher)

- “So far what I've noticed or seen is that [the students] are more interested in a variety of things. Like they never considered that taking care of pet birds is science, or that certain universities – 'cause we worked with the University of Utah a lot, that they had such a robust program in veterinary stuff. I think it's opened their eyes to possibilities of what they could do in the future and careers that might actually interest them that they have never even thought about, and have those be actual science college-related careers.” (Teacher)

- "You see the students build confidence in their ability to actually, 'I could be this. I could do this with my life.'" (Teacher)

- "…Students will ask what it's like to study science in college, how much different college is from high school. They'll ask questions about what a specific thing that they're interested in even if it's not necessarily directed related to the presentation. They might say oh I'm really interested in biomedical engineering. How would I get into that field? And so they are kind of asking these questions that indicate that they do have that curiosity for STEM education and STEM pursuits." (Staff member)

- "I think that our mission STEMCAP collective work, our two-week sessions has a unit that we design specifically to help students understand that they can contribute. They do have a voice. We're asking for them response rather than just shoving stuff at them. So I think the way we've tried to design that has given the students a sense that they can contribute, that they are empowered to at least for one little instance that we provide they have confidence that they have a say. And I think that's pretty significant." (Staff member)

- "The primary programming that we really focus on [civic engagement] are our Mission STEMCAP and our conservation projects. And for both of those we typically really try to have outcomes that the students create that are put out into the community. So we work with the Utah Museum of Fine Arts and then the students create artwork that is then sort of put at the, on the website for the Utah Museum of Fine Arts kind of showing them that they have a voice, that other people are seeing. Previously we've also done podcasts that people can listen to kind of hear what the students think about these conservation and environmental issues. And then with our hands on conservation project sort of the evidence for that is that these students really are raising these milkweed plants that are directly going into the community… A lot of our programming goals with the conservation and mission STEMCAP program is to bring in a bunch of different community members that are showing them that they do care about them, that they think of them as community members and kind of encouraging them to be a part of that community and reminding them that even though they're in these centers they are still active community members and they can still make those choices to engage with the community." (Staff member)

- "Anything that they would do that would be structured and project-based would be helpful. [Another program has] initiatives that just re-up every year. And so, they become somewhat institutionalized, which is really helpful. Students know that they're going to be writing in this month, they know they may be constructing something in this month, they know they're going to be doing a read-a-thon…So, that's a model that could be looked at for that kind of continuity. Outside of that, anything that would be project-based and structured over time would be a real win." (District administrator)

- "When we were at that graduation there was a graduate who had his grandpa and he was walking him around to the plants telling him which ones he had planted and cared for. It made me so happy. It was just adorable 'cause here is this tough kid walking around

showing grandpa which plants he planted– he talked about the tomato plant that wasn't successful or something so it was a really fun conversation to overhear." (USBE Specialist)

- "I love these guys being in the facilities with the kids and that interaction and kind of giving them hope. I feel like that gives them some hope for the next steps in their life in some ways too." (USBE Specialist)

Part Three: Program Scalability and Sustainability

What contributes to STEMCAP program scalability and sustainability?

There is alignment between presenters' and teachers' values, and the STEMCAP mission, including a desire to give back to the community

Participants in our study expressed similar beliefs, values, and passion about the opportunities that the STEMCAP program offers YIC. Presenters participated in STEMCAP in part due to the degree of alignment between their personal values, particularly those related to social justice, inequity, and access, and those of the STEMCAP program. They viewed their involvement with STEMCAP as an opportunity to act upon those values and give back to the community. The STEMCAP staff and teachers expressed similar views on the importance of the program in offering YIC unique and valuable experiences within the fields of Art and Science. All USBE specialists and district administrators attributed STEMCAP staff members' passion for the program to the program's success.

- "I feel that there's a value…that is more impactful for me than to get a paper published in a nice journal. It might not be for some of my peers, but for me it's important. And also considering my background and the opportunities I have, I feel like there's something inside me that says we should return. You should give it back to people that otherwise might not be in the same position. And I was lucky enough that right now I can do that." (Presenter)

- "I wanted to get involved a little bit more in my community and bridge that gap that I see between the scientists and some marginalized populations within our community." (Presenter)

- "I assume a lot of us are doing this because we take issues with some of the inequities in social justice today, and this is a nice – it's different to see it and be part of it in a way instead of reading about it. So, it's motivating in that regard to do more." (Presenter)

- "You know, everything changes, but everything stays the same. And really at the end of the day you just end up cheering [the students] into it… Just convince them they can do it; they can do anything." (Teacher)

- "I had graduated from the environmental humanities program, and in that program I was primarily focused on sort of environmental education and science education for underserved youth. And I was really passionate about kind of bringing new people into the realm of environmental education." (Staff member)

- "Most of these teachers are incredibly passionate specifically about working with this population…They stay in these centers for years. They have extremely good longevity. They don't want to leave. It's something that they seek out and they really want to make a difference for these kids and they're very passionate about that." (Staff member)

- "[STEMCAP staff] just are die hards and they make it work. And so I think that is what makes it work. And then I think having passionate volunteers that are willing to go into these settings. And not just willing to go into these settings but have background checks and have to give up all of their technical stuff as they walk in in building. Because it is an uncomfortable environment I think for a normal population. Right? And so the passion and then going in and being willing to go outside of a comfort zone to do this kind of work." (USBE specialist)

- "It's like a passion project. Right? Like they don't have to do this probably, but they do and it's just awesome. Good human beings." (USBE specialist)

Presenters found their STEMCAP experiences professionally and personally rewarding

Presenters had positive experiences with the STEMCAP program. They described the opportunity to support youth-in-custody as "rewarding," not only because they had the chance to "open doors" for an underserved population, it also afforded them the opportunity to present to a unique audience. They also reported being challenged by the experience in fulfilling ways and felt like they could take aspects of what they learned during their experiences and apply it to their own professional contexts.

- "It felt good to be able to kind of open a door for [the students] that they might not otherwise have opened, and that definitely felt very valuable to me, and I hope it's valuable for them…I really do like working with STEMCAP." (Presenter)

- "Just physically showing up for these students and explaining what it's like to be a scientist, how you got to be a scientist could open these doors that don't normally get opened. I find it very rewarding, and I've told other people, too, to go ahead and do it because it's super rewarding, and it's a chance to do something different." (Presenter)

- "I just feel so fulfilled. I had a chance to talk about what I love…but also to feel that you can be appreciated by a community that's not just – other things, peer review, some bland science or things that might not fit in the big scheme of the world. I think we kind of live in a very narrow – or at least the scientific bubble can be very narrow. So, to have the opportunity to share some of your – some of who you are as a human as well to other people is very, I don't know, is very important to me." (Presenter)

- "I would definitely encourage [other scientists to participate]. I would say it's a population that you don't normally get to interact with, a population that's very underserved, that will probably get more out of what you have to offer, and you really get a chance to challenge yourself and kind of expand your expectations, both of yourself and what you're trying to communicate." (Presenter)

- "I feel like it was definitely a great learning opportunity for just addressing a different audience." (Presenter)

- "It was fun. I didn't know it would be fun. I thought it might be kind of a drag writing about [presentation topic] online. But it was clear from the circumstances [the students] don't have a lot of access to things that I wished they'd have access to, but they were super engaged. They knew a lot more than I might have otherwise assumed and they were interested and interesting. You just get the sense that they're happy to do this, they'd like to do more. And I also think they deserve more than they're probably getting. So, this is a nice supplemental program, though I wish there was more of it." (Presenter)

The STEMCAP program provided accessible, manageable pathways for presenters to participate

The STEMCAP staff members worked closely with presenters to create the pathway for scientists and artists to present to YIC while also ensuring that their own involvement felt manageable along the way. Presenters appreciated the STEMCAP team's support in managing background communication, coordination, and logistics; providing clear actionable feedback of lessons; and attending and responding to presenter needs. One participant within an artist-scientist team explained that partnering with another presenter made both the preparation for and the presentation of their lessons easier as well.

- "It's not hard for teachers to come in and say, 'Sure, come on in and take over my class.' I'm okay with that. I think it would be harder to coordinate all of the behind-the-scenes stuff that has to happen, but I think it'd be very valuable in almost any classroom." (Teacher)

- "One thing I did want to mention I really appreciated about STEMCAP was just the facilitating the contact with the schools, the locations. I would not have known how to do that. I could have looked up online and found phone numbers and like worked through whatever the chain of contact to get to a teacher to actually schedule a thing. That really took a lot of scheduling burden off of me that they already had those contacts. Then I think putting myself in the teacher's or the school's shoes, it probably helps them to have a single point of contact so they're not being contacted by all these random scientists and not knowing who's who and where they're from and what they're going to show up with… that middle person being a facilitator both ways I think just makes the logistics of a connection a lot easier, so I really appreciated that a lot." (Presenter)

- "[STEMCAP staff member] is really easy to work with. Usually, I'll just give her a list of the supplies I need, and she'll tell me how much time I have. Sometimes I'll say like, "Would it be possible if we had a little bit more time?" She's usually pretty good about following up about that and checking in to see if it's possible to give us a little bit more time. So, she's been really great to work with. She organizes the supplies in a very easy to use manner. Yeah, she's been great to work with." (Presenter)

- "It's just really nice for me because it helps relieve some of the real labor of having to think about organizing all of that…They made really good suggestions and it just helped reduce that workload for me, and I appreciate that so much. With everything that we have going on having someone who is able to put that time and effort into it sort of match your effort is really great." (Presenter)

- "I would totally prefer to do a collaboration. I think, one, it's more valuable for the students. It's more valuable for us, and then it also makes the workload a lot easier like not having to come up with everything and think about an activity…if I wanted to come up with an activity like that, I would probably have to brainstorm materials and stuff and it would be a lot of work – worthwhile, but it's a lot easier if you have someone to collaborate with." (Presenter)

STEMCAP staff members strategically developed and maintained relationships with scientists in the community, resulting in a robust network of presenters

The STEMCAP team recruited many of their presenters through personal and professional network connections (same department at the university, a mutual colleague, academic advisor, etc.) Some presenters in our study had already been involved in the STEM Ambassador Program, a program funded by the National Science Foundation to train scientists to engage members of the public in innovative ways outside traditional venues (www.stemap.org). Multiple presenters expressed their belief that there is a growing interest among their peers and colleagues both in Utah and in other states to participate in a program like STEMCAP.

- "I first got involved with STEMCAP because I was working with [the director] quite a bit just on kind of the STEM ambassador program and stuff like that. And she had mentioned the STEMCAP program and yeah, so I just, I wanted to get involved." (Presenter)

- "I was involved in a lot of other programs to help out [the director]." (Presenter)

- "I actually started with STEMCAP as a graduate student in the Chemistry department." (Presenter)

- "I'm a first-year graduate student new to the STEMCAP program." (Presenter)

- "I'm assistant professor of materials science and engineering. And heard about [the STEMCAP program] from one of my colleagues who said, 'Oh, you would love this. You love outreach.'" (Presenter)

- "I'm in the environmental humanities program at the University of Utah…and I got involved just because I was bugging [STEMCAP program staff member] when I first started in environmental – she's an environmental humanities graduate and she did a thesis project that's similar to what I'm interested in doing in terms of environmental education, so I was bugging her about her thesis and then we got coffee and she was telling me about STEMCAP." (Presenter)

- "I did my undergrad in biology at the U, and the – one of the labs that I worked in primarily was just down the hall from [the director's] lab. I was friends with some of the graduate students that had worked with her and really had gotten a lot of positive feedback from them working INSPIRE." (Presenter)

- "Everyone I've talked to about [the STEMCAP program] all thought it was such a cool idea. And they were wondering how they could get involved, even locally in [large metropolitan city], which of course has its own huge incarceration problems. And I think, yeah, it was just really rewarding, and I think in the scientific community there's are a lot of people who are really, really interested in getting involved in this kind of thing. And it actually seems like there aren't enough – not nearly enough of this kind of program…. So, yeah, I think if the program was expanded into other regions even that would be awesome." (Presenter)

USBE specialists, district administrators, and presenters offered considerations to sustain and scale the STEMCAP program related to recruiting presenters, expanding student services, and marketing

Presenters expressed interest and a belief that the STEMCAP program could be expanded, though only one presenter offered possibilities for doing so. Specifically, this presenter suggested increasing and institutionalizing graduate students' participation in the program by linking it to coursework. District administrators and USBE specialists provided a greater variety of considerations and suggestions for sustaining and scaling the program related to expanding the student population served and marketing the program and its success more broadly throughout the community. One district administrator encouraged STEMCAP staff to consider providing programming to other students who meet YIC eligibility but are not in the facilities. District administrators and USBE specialists also noted the upcoming transition in STEMCAP leadership as an opportunity to align and expand services, as they reported that students between 21 and 25 years of age could now meet YIC eligibility requirements.

- "I definitely think that having chapters outside of Utah – that INSPIRE and STEMCAP has that capability. And you guys have such a great framework already that you could really help facilitate that for other states and other locations and still kind of be the core of it and make a bigger impact that way. I think inequalities is something that's more at the forefront of a lot of people's minds, and this program is so important in showing that and addressing some of these things that people don't always have access to or even have the time to think about because they're kind of in these other sections of Maslow's Hierarchy of Needs. And so, it's

really cool to have a space where people don't have to go out of their way and don't have to do something crazy to get these opportunities." (Presenter)

- "I learned [about STEMCAP] through my advisor, but maybe if they emailed the graduate school advisors, maybe that would help students get involved or I guess like a faculty if it was brought up at faculty meetings. If they were able to make it a course because I know they're filming it now or doing it online. So if they were to record it and then have students join and participate and—I don't know—if they got three 7,000-level course credits or something like that in engineering, there would probably be more participation." (Presenter)

- "I personally have some opinions on what priorities are for researchers and faculty, and I think perhaps maybe there's just not enough emphasis on the department side, so having that support from the departments to encourage post-docs, researchers, or other people at these universities or schools to do activities like this…I think that would make a huge difference because I think frankly everyone wants to participate but they don't want to put in the time to do it…it feels like, 'Oh, I got a pat on the back for participating and doing this extracurricular activity.' But I think that that's the wrong perspective. I think it should be part of your job…" (Presenter)

- "I felt really fortunate in being able to participate because my office supported us…I did feel very fortunate because I realized that like that's not always an opportunity, having your department encourage engagement activities…" (Presenter)

- "The only thing off the top of my head [to strengthen STEMCAP partnerships] is some type of marketing or advertising, reaching out to them through media. Everyone has media access. There's so much bad news on TV that the places that do good stories and just talk about these. I think people want to hear positive stories…And I think getting the word out. I think there's still a lot of stigma about our populations. They're kind of disregarded. They're just doing this time versus we're really trying to look at success with a different set of eyeballs than what we did in the past. And so I think bringing that messaging to the community." (District administrator)

- "Right now a really hot topic with USBE YIC is the legislation that extended the age of students from 21 to being 25. And so there's lots of conversation about that and it's great that…[the incoming STEMCAP director will be] able to continue those types of conversations and how we can see if STEMCAP can be available to those students post 21 [years old]? It's a big conversation. How does STEMCAP play a role in those older youth that might be graduated?" (USBE specialist)

- "Maybe some youth services students or some other students that could still meet that service code eligibility under the YIC umbrella could participate [in STEMCAP] right alongside their peers at no additional cost." (District administrator)

In what ways could the partnership and work between the program, presenters, and educators be improved to meet program and student objectives?

Opportunities exist for further collaboration and alignment among presenters and teachers to understand student and curricular contexts, particularly in virtual settings

Presenters expressed a preference for a greater understanding about how their presentation fit into the students' curriculum. They suggested that collaborative time with teachers before the presentations would provide them the opportunity to learn more about their curriculum, the teacher's expectations for the presentation, and the students themselves. This would also allow presenters and teachers to better tailor the lessons to the student audience and strengthen connections to the students' prior learning. One USBE specialist also expressed an interest in providing opportunities for collaboration between presenters and teachers to strengthen lesson preparation and follow up.

- "…it'd be great if we could more actively connect to the teachers because I don't want to be an extraneous member… I know [the teachers] by name when I get there or a little beforehand, but I don't know exactly what's their style of teaching. We mentioned briefly about that during the focus group, you know, what they think would be more effective and how long they've interacted with that group of students might also kind of direct what sort of interaction I might be designing because I got to know more by exactly the people that are directly interacting with the students what could be effective, what could not be effective. Is that content – do you think they can appreciate this? Are they going to hate it? So I think it'd be really cool if somehow STEMCAP could facilitate direct connection between the people that are presenting with the regular teachers and not seeing them just as facilitators but also as members of that interaction as well." (Presenter)

> "The hindrance is not really knowing how you fit into a program or even if there is a traditional educational program in that context, or it's just workshops or… It's really hard to know how we fit into the program."
>
> -Presenter

- "Usually we see teachers for the first time on Zoom and they're like, 'Nice to meet you.'" (Presenter)

- "I wish I had kind of had more in-depth conversation with the teachers about where I was integrated into the curriculum, or if I was. I think that's also a case of now I know the questions I wish I had asked versus this is how it should have been from the start." (Presenter)

- "The only thing that I wish I'd had a little bit more of was direct connection with the classroom teacher. I did get to meet her when I dropped off the kit and talk with here a bit but I just wanted the opportunity to make that connection especially because I was remote

and she would be the one helping in the classroom, if there was anything students had needed to be shown again or needed physical help, somebody that would have been good to connect with her maybe a little bit sooner and a little bit more formally but it all worked out." (Presenter)

- "I do remember even going in person, it was easier to have those conversations with the teachers in person, because usually the teachers had a few clarifying questions because they wanted to follow up with their students. I think Zoom has made that a little more difficult because you can't have that kind of casual conversation on the side." (Presenter)

- "Yeah, my experience was a little different I think just because it was the beginning of COVID and we had I think two Zoom meetings with the teacher and so we were able to interact with her and discuss those details and how that would work out. But I think even then it was like we were trying to figure out like Zoom, Skype, where our head's going to be in the room because they had never done virtual learning and things like that. So it was more like technology stuff." (Presenter)

- "It would be great to have workshops with just the teachers and the scientists. Right? Like conversations that they can have together, help teachers be prepared for them to come and then know how to follow up or just building those relationships." (USBE Specialist)

A clear system for follow-up after presentations could help extend students' learning and career opportunities

Teachers and presenters both expressed a desire for a more systematic process of follow-up after the presentations. Opportunities exist for STEMCAP staff to design a more formal process for students or teachers who have additional questions or desire intentional connections across content areas after presenters have concluded the lessons. One presenter expressed a need for a formal transition structure to support students who would benefit from a STEMCAP program at their home schools after leaving the YIC facilities. Similarly, district administrators and USBE specialists expressed interest in providing students pathways, both educational and vocational, to pursue any stem-related interests that emerge from their STEMCAP experience, especially for older students who are ready to enter the workforce.

> "How can we take what [the students] have learned there and continue that momentum?"
>
> -District administrator

- "The only thing that I would say [about strengthening the program] would be maybe some way to follow up after. Not necessarily with me – or not necessarily with the scientists or the STEMCAP people, but it would be interesting to have like – the one time that they did discussion questions or follow-up questions it was kind of nice to go back and say, 'Hey, do you guys remember? Let's revisit this thought' where we can have some closure and say, 'What did we all learn from all this and what did we' – I do that all anyway, but it would be kind of nice if they had, you know, what were their main objectives to get out of it…if there

was a different point that the presenter was trying to get across and we totally missed it, it would be nice to have that little bit of a follow-up wrap-up." (Teacher)

- "You just said the $64,000 dollar word, it's 'transition.' When we have a kid that leaves here, if this kid is leaving our program and has had all of this opportunity and then goes back to [their] home school and walks through the door on the first day and gets dumped on and they never want to go back to school again, then we've sort of shot ourselves in the foot, you know? So it has to be good everywhere. The opportunities have to be everywhere." (Teacher)

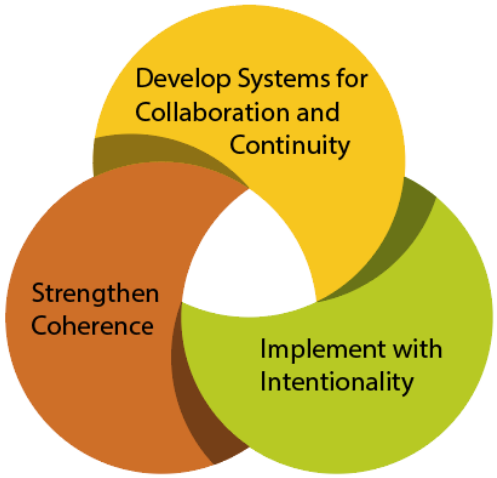
- So it does give [students] opportunities to think about what a career might look like. The challenge is we always have them in this carefully proctored world and then they go back to the other one…how we can continue to link them? Because the kids [are] not going to be with us forever...[we]want to make sure that we continue to build on momentum of interest if that makes sense. (District administrator)

- "We want to prepare them with a little more of a direction versus 'Ok, we're going to give you this experience and then you'll leave and then you'll go where you go' versus be a little bit more deliberate giving them some guidance." (District administrator)

- "I'm not an educator but I think something that just I thought of was if we could create post workshop curriculum or something along those lines. Like now this is how you can move it forward for the next nine months or something along those lines, tips, tricks, how to keep that ball rolling. And I think teachers would probably love the help to create that." (USBE specialist)

Discussion

This evaluation of the STEMCAP program answered both implementation and outcomes questions through a qualitative analysis of focus group and interview data and relevant documents. Program considerations from this evaluation are summarized below within three themes: *Develop Systems for Collaboration and Continuity*, *Implement with Intentionality*, and *Strengthen Coherence*. We acknowledge these primary considerations have much overlap among them. Designing the program and its implementation with the specific aim of achieving proactive redundancy supports a "confluence of influence[6]," in which all elements of the program work in tandem toward the same goal through ongoing communication, shared decision making, and the co-design of program activities to promote the sustainability and scalability of the STEMCAP program. We also acknowledge that some of our evaluation findings and considerations relate to program design shifts (e.g., virtual presentations) that were in response to the COVID-19 pandemic and may not reflect the original design and implementation of the program. Here we provide specific considerations aimed at enhancing STEMCAP's impact.



Develop Systems for Collaboration and Continuity

The findings from this evaluation suggest that STEMCAP experiences benefit students and presenters and that because of the program vision and infrastructure there are additional opportunities to increase and strengthen student outcomes related to STEM learning and building meaningful relationships with presenters. In part, STEMCAP could maximize student learning and its program features by seamlessly integrating presenters' and teachers' STEMCAP lessons into the curriculum. Though both teachers and presenters confirmed that students' curiosity was sparked through the STEMCAP lessons, they shared a deeper interest in igniting a flame that could sustain itself, including beyond program exposure, through collaborative discussions and follow-up engagement with the presenters.

[6] Rorrer, A. K., Park, V., Groth, C., Bradley, J. (2018). School Turnaround Reform: Optimizing Confluence of Influence and Dynamic Disequilibrium. In H. Shaked, C. Schechter, & A. Daly (Eds.), *Leading Holistically: How Schools, Districts, and States Improve Systemically*. New York: Routledge.

Considerations: Extend Collaboration

- Ensure that presenters and teachers meet prior to the STEMCAP lessons to discuss student learning needs, connections to prior curriculum and upcoming curriculum, and roles that each should play during the lessons.
- Provide the teachers and presenters with a meeting protocol and/or a list of guiding questions to make sure the meeting time is targeted, effective, and efficient. These questions could be provided to teachers and presenters in advance to aid with preparation.
- Build in timely reflection opportunities between presenters and teachers following the lessons to consider successes and opportunities for improvement in future lessons. Consider including summaries of student feedback, such as student "exit tickets", very brief, written questions asked of students at the conclusion of each lesson to assess their level of understanding, interest, etc.
- Assemble quarterly meetings among teachers, presenters, and STEMCAP staff to review data, assess progress toward student and program objectives, and reflect on opportunities for improvement.
- Engage further in opportunities to share the STEMCAP work with higher education faculty and discuss possibilities of building STEMCAP participation into graduate coursework.

Considerations: Create Continuity

- Prioritize scheduling presenters for a series of lessons rather than single presentations, when possible and appropriate. (Future STEMCAP evaluations may study the impact of this increased programming on students' development of STEM identities.)
- When pandemic restrictions are lifted, consider virtual presentations in classrooms/facilities with adequate technology to ensure student/presenter interactions are possible and relatively unimpeded.
- Provide presenters with a STEMCAP lesson planning template so that all lessons have similar formats and intentionally align to program and student objectives. Consider sharing completed templates with teachers in advance.
- Consider having the presenters provide extension activities after each lesson to help students/teachers make clear connections with their curriculum and with the next STEMCAP lesson.
- Provide activities through which students can continue their STEM-related learning experiences as they transition out of the facilities into other school settings. These activities could include STEMCAP activities with teachers and administrators in other schools, partnerships with local organizations for apprenticeships, and mentorship programs that connect "veteran" STEMCAP students with younger students.

Implement STEMCAP lesson content, data collection, and communication structures with intentionality

Implementing intentional structures and processes within the STEMCAP program will create opportunities for richer student engagement in discussions and activities, as well as promote

purposeful alignment with students' curriculum. In addition, these structures and processes will support more intentional data collection to track progress towards program and student objectives.

Consideration: Generate Intentional STEMCAP Lesson Content

- Recruit and mentor STEMCAP presenters who will facilitate discussions on topics that are intentionally aligned to program and student objectives.
- Encourage presenters and teachers to work together to ensure lesson content is integrated into course curriculum and materials.
- Ensure students have opportunities during lessons to engage in scientific thinking and reasoning and critical thinking skills.
- Design a lesson planning template that includes guidance to ensure lesson content meets program objectives.

Consideration: Develop Mechanisms for Data Collection

- Build opportunities for student feedback and reflection (e.g., exit tickets, STEMCAP journals, student portfolios) at the conclusion of each lesson. This aggregate data could be used to inform presenter effectiveness and program improvements.
- Provide teachers with a tool to collect student and/or teacher feedback (e.g., survey) about presenters' lessons and the degree to students demonstrate the expansion of their self-identity as citizen scientists. Teachers can share deidentified student response data.

Consideration: Promote Intentionality of Communication

- Share aggregate data collected from STEMCAP lessons with all partners to promote program transparency and solicit feedback for continuous program improvement.
- Generate a "what works" guide to be shared with presenters and teachers alike that provides strategies for engagement, addressing students interest, and finding ways to extend content to the curriculum.
- Promote STEMCAP success stories with all partners to increase shared language and understanding of the program's specific impacts on students.

Create coherence to promote sustainability and scalability of the STEMCAP program

Given the interrelated components of STEMCAP, coherence in program vision, goals, processes, and data collection is imperative when considering sustainability and scalability. In order to create this confluence of influence in which all parts are moving towards the same goal, all parties of the STEMCAP program must have shared understanding of the system components. As we consider opportunities for STEMCAP scalability, we are mindful of Coburn's four

dimensions of scale: depth, spread, sustainability, and ownership.[7] These four dimensions are considered within the recommendations below.

- Develop a program logic model in which resources, strategies, and short- and long-term outcomes are clearly outlined to develop coherence among all parties. This logic model will serve as the compass for the program and provide direction and a source of shared understanding and ownership for the STEMCAP team, presenters, teachers, and program partners.
- Provide professional learning opportunities for presenters to expand their depth of knowledge and skills related to teaching and building relationships with YIC, which may contribute to their longevity within the STEMCAP program. This focus on depth will offer presenters a chance to affirm their beliefs in the mission and vision of the program, as well as their understanding about the impacts of the program on students and the community as a whole.
- Develop common vision and goals, consistent and intentional presenter recruiting strategies, and methods of data collection carefully aligned to program and student objectives. Coherence across these elements will support program expansion, scalability, and spread.
- If not already in place, consider establishing an advisory board with representatives from partner agencies, local school districts, and participating colleges and universities to develop a shared ownership within the STEMCAP program. According to Coburn, this shared ownership is a critical component to the expansion of any system.
- Begin institutionalizing STEMCAP processes and structures discussed throughout this report so that the program can withstand any changes in leadership, personnel, and funding over time. This institutionalization will support Coburn's sustainability dimension as program leaders and partners consider possible changes within the system and start to make the STEMCAP processes and structures independent of personnel and resources.