Final evaluation report

Convergent Learning from Divergent Perspectives

NSF - DRL – AISL # 1811119

Prepared by:
Justin Reeves Meyer
Donnelley Hayde
Laura Weiss

With past contributions from:
Joe E Heimlich
Rebecca Nall
Rebecca Kemper
Madison Venables

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Introduction

Description of the project

Convergent Learning from Divergent Perspectives is a project developed through a partnership between The Ohio State University (OSU) STEAM Factory and the Center of Science and Industry (COSI), both located in Columbus, OH. The project brought together researchers from different disciplines to communicate their research in a variety of informal learning settings. The primary goal of the project was to develop a program through which researchers would create collaborative, multidisciplinary learning content around convergent themes for public audiences of all ages in unstructured and semi-structured learning environments. Through this program, the project intended to increase the likelihood that researchers from different disciplines, and representing potentially divergent perspectives on a topic, would work together more often, learn from one another, and better communicate science to the public.

Researchers participated in the project as part of three to five person cohorts. Each cohort was tasked with presenting on a different science related topic. We refer to each cohort by their topic. They include Energy, Movement, Space, and Elements. The project involved several components for each cohort, including: science communication training, research presentations in several informal learning settings, facilitated and unfacilitated brainstorming sessions, research on cohort identities, and evaluation of audience outcomes as a result of the cohort presentations in informal settings.

Researcher cohorts produced two different types of presentations during the program. The first product was an individual presentation for each researcher in each cohort for each informal setting, where the researcher would provide their (singular) disciplinary perspective of the cohort topic. The second presentation product was a collaborative (convergent) presentation for each informal setting where at least two researchers in each cohort (and often all) would provide multiple disciplinary perspectives of the cohort topic. These presentation types made up the different 'treatment' types experienced by public audiences in these informal settings.

Informal settings in the project included pop-up demonstrations in a museum setting (COSI After Dark), intimate micro-lectures (Franklinton Friday: STEAM Factory), and day-long, group project competitions for high school students (hackathons). While these informal events started in person, the COVID-19 pandemic forced the team to transition these into virtual events (i.e., held over teleconferencing software like Zoom) starting in Year 3 of the project.

Role of evaluation on the project

COSI's Center for Research and Evaluation (CRE) – at the start of the project, named Lifelong Learning Group – led the evaluation of the project as a subaward. The evaluation team's primary roles on the project were twofold: 1) formative evaluation of training and other project processes that supported each cohort in their presentations, and 2) audience outcome evaluation that assessed how the cohort presentations affected learning attitudes and interest in STEM among public audiences. See Appendix C for the original logic model for the project. In particular, the evaluation team sought to test the hypothesis that the convergent presentations (those that were a collaborative effort among the cohort members representing different disciplines) would induce greater increase in learning attitudes and interest in STEM because they provided different researcher perspectives on a STEM-related topic. Outcomes are described in more detail in the Outcomes section of this report.

Initially, the evaluation team planned to evaluate audience learning outcomes immediately after listening to a researcher presentation, and then two to three months after. After having collected audience data from the first several events, the evaluation team found weak, if any, effects of the presentation treatments on public audience learning outcomes immediately after the events. Because of the difficulty in measuring/estimating these effects immediately after the presentation treatments, the evaluation team decided to forgo measuring any medium-term effects, and focus only on measuring and estimating the immediate, short-term effects. More about these methods and difficulties can be found in the Activity descriptions and methods section of this report.

The evaluation team looked to improve measurement and estimation of the immediate, short-term effects by calibrating outcome evaluation methods (i.e. the post-event questionnaire) to better match the idiosyncrasies of each event type. Additionally, we added more case-based process and content analyses during the presentations to better understand the experience of public audiences. These calibrations and changes to the evaluation methods are described in more detail in Activity descriptions and methods and Findings from public events sections of this report.

The COVID-19 Pandemic and subsequent transition to virtual events drastically impacted the way the project team worked with each other, the participating researchers, and public audiences. One example of this impact was the difficulty of gathering data to assess audience learning outcomes. Many of the in-person events had to be canceled or postponed, and the evaluation design had to change as a result of events transitioning to virtual settings. In response, the evaluation team used a Qualtrics Panel survey to assess the different learning outcomes as a result of different types of researcher presentations.

Timeline of evaluation activities

Project Year 1 (September 2018 - August 2019)

In the first year of the project, the evaluation team helped with the recruitment of the first cohort (named Energy) of researchers from at The Ohio State University. Once this cohort was selected, the evaluation team, with COSI's Master Educator Leonard Sparks, planned and evaluated a series of training sessions. These sessions were designed to equip researchers with skills to communicate their research to a wide range of audiences in informal settings. The Energy cohort then completed individual presentations at COSI After Dark and the Franklinton Friday: STEAM Gallery (referred to as Franklinton Friday for short), for which the evaluation team collected exit questionnaire responses to gauge audience outcomes. After the individual presentations, the project tasked the Energy cohort to prepare a convergent challenge for the HSI/O Hackathon. The Energy cohort initially struggled to come up with a convergent challenge, so the evaluation team and others from the project team convened a group brainstorming session to support the creation of the convergent challenge. The brainstorming session successfully facilitated the development of a convergent challenge, which was presented at the hackathon. Building on this experience, the Energy cohort then developed a convergent presentation for a COSI After Dark event toward the end of the project year. As with the individual presentation events, the evaluation team collected exit questionnaires to assess audience outcomes at COSI After Dark.

Project Year 2 (September 2019 - August 2020)

The second year of the project started with a convergent presentation by the Energy cohort at the Franklinton Friday: STEAM Gallery event. Additionally, two new cohorts – Movement and Space – were recruited. The evaluation team collected data from exit questionnaires at the Franklinton Friday event to assess audience outcomes. We also started to adapt our audience outcome evaluation method for Franklinton Friday to better suit the unique context of the event. Next, the evaluation team and Leonard Sparks planned and facilitated a series of four training sessions for the two new cohorts, using similar science communication content as in the first year's training sessions. Then, both the Movement and Space cohorts gave their individual presentations at a series of COSI After Dark and Franklinton Friday events, and the evaluation team continued to evaluate audience outcomes for each, with adapted methods. Given the need for brainstorming sessions for the first cohort, the evaluation team and some others on the project team facilitated another series of brainstorming for the Movement and Space cohorts. The Space cohort was able to have their first brainstorming session in-person in February 2020.

Before the completion of any more project activities, the COVID-19 pandemic caused most public (and all project activity) events to be canceled or postponed. Up until this point, almost all project activities (including most project team meetings) occurred in person. Despite not knowing how the rest of the project would be completed, the project team decided to continue the brainstorming sessions with the

Movement and Space cohorts over Zoom teleconferencing software. For the Movement cohort, these sessions occurred nearly once a week through to the end of project year 2.

Project Year 3 (September 2020 - August 2021)

Once the project team learned that the pandemic would continue to make in-person public events difficult for at least another year, we decided to switch presentation events and the Hackathon to virtual settings (such as Zoom and a Discord server). The Movement and Energy cohorts each presented a convergent challenge at the virtual hackathon, and the Movement cohort gave their convergent presentations over Zoom for a new event type: a Virtual Science Pub. The evaluation team continued to assess audience outcomes with questionnaires, but also adapted new techniques to better suit the online environments.

A new cohort was recruited for working primarily in virtual settings, named the Elements cohort. Working with COSI's Director (now Senior Director) of Scientific Content and Research, Marci Howdyshell, the evaluation team helped to plan another series of training sessions for the Elements cohort, but this time specializing in science communication strategies in virtual settings. The evaluation team continued to assess this training, and helped facilitate virtual brainstorming sessions for the Elements cohort. Subsequently, the Elements cohort was tasked to give individual and then convergent presentations to a series of virtual events, including Virtual Franklinton Friday: STEAM Gallery, Virtual Science Pub, and a Virtual Hackathon. For purposes of gaining consistent data, the project team invited the first cohort, Energy, to give their convergent presentation during a Virtual Science Pub, as well. The evaluation team assessed audience outcomes using newly honed methods for the virtual events.

Project Year 4 (September 2021 - August 2022)

The evaluation team also decided to augment our evaluation and evaluative research by using a Qualtrics panel of respondents. Respondents answered questions about their learning attitudes after being randomly assigned a video (or videos) of individual or convergent presentations by the Movement and Elements cohorts that were recorded during the virtual events. We used these data to make more precise and causal claims about the effects of the presentations on learning outcomes. The first phase of these panels started at the end of project year 3, and the second occurred in project year 4.

Formative evaluation

Training

Description

The training (similar to Portal to the Public training) brought the project's first cohort of researchers (Energy) together at COSI for two half-days in Year 1 of the project. It similarly brought the project's second and third cohorts of researchers (Movement and Space) together to COSI for two half-day sessions over three days in Year 2. Leonard Sparks, COSI's Master Educator, facilitated the training, introducing the cohort to different ways of thinking about science in the context of informal learning environments. Sparks used a variety of activities used in Portal to the Public, with the goal of helping the cohort get to know one another, think about their research from different perspectives, and communicate their research in informal environments.

As in Year 1 and Year 2, the project's fourth cohort of researchers (Elements) attended a Portal to the Public-like training facilitated by COSI before developing their presentations. Due to COVID-19 restrictions, the training was conducted virtually. Each individual experienced three, two-hour training sessions at times that suited their schedule. Shorter and more frequent sessions (compared to previous years) were scheduled to prevent Zoom fatigue. COSI partners Marci Howdyshell and Leonard Sparks facilitated the training experiences, introducing the cohort to different ways of thinking about science in the context of informal learning environments. The sessions also had a particular focus on communicating via synchronous, virtual means, to match the delivery method of the programs during COVID (i.e. virtual events).

Evaluation methods

During the trainings in Years 1 through 3, CRE observed the researcher cohorts to find out the following:

- Is each individual researcher engaged with the training?
- Are researchers working collectively in the training?
- Are researchers building rapport throughout the training?

Through the observation, CRE noted how individual researchers reacted to instructions given in the training sessions and how they participated in each training exercise. CRE also noted how often the researchers talked with one another between the exercises.

Additionally, during training in Years 1 and 2 (before COVID), CRE conducted pulse interviews, or interviews that very quickly (~30 seconds) captured the mood of each researcher, during breaks and immediately after the training. In doing so, CRE was able to gauge whether the researchers were getting what they needed out of the training and if they were encountering any obstacles that were keeping them from progressing in the training.

The questions for these pulse interviews included:

- Are you feeling good about the training?
- Are you getting what you need?
- If not, what do you need to feel better about the training?

In Year 3 during the virtual training session, trainers asked reflection questions at the end of each session, eliminating the need for pulse interviews.

Energy cohort's training experience

Observation and pulse interviews showed that the researcher cohort initially (day 1) struggled with understanding the purpose of the training and the potential value from this experience. By the end of the second training, the cohort started to understand that the training was trying to get them to think how they might communicate their research to lay-audiences in an informal learning environment. However, they still seemed to struggle with *how* they were going to communicate their research with others in an informal environment.

As might be expected when bringing together three people who do not know one another, the cohort did not interact much with each other during the first training session, though this changed during the second training session. Exercises facilitated by the training instructor got the cohort to start talking to one another and asking questions about each other's research. This resulted in some shared experience of how difficult it is to "dumb down" their research and present it in a "hands on" way.

While the training did not result in the cohort having clarified, finished plans on how they would present their research in an informal setting, it did successfully get them to consider these issues. Ostensibly, the training also helped the cohort bond with one another, which would prove vital when they were tasked with creating a convergent presentation together.

Based on the experience with the first cohort's training, we supplemented the training with a brainstorming session with the cohort to help them think through their individual presentations and how they might adapt their research communication strategy for environments like Franklinton Friday and COSI After Dark.

Movement and Space cohorts' training experience

Data from observations and pulse interviews suggested that researchers from the second and third cohorts largely had positive, productive experiences in the training experiences. In general, the participating researchers showed strong enthusiasm for the purpose and goals of the training. As they began training, they were most concerned about the challenge of translating their work for specific informal contexts (e.g. COSI After Dark, which they perceived as being the most novel project setting) and ways of getting audiences' attention.

While the researchers did not initially engage much with each other, they did so more and more as the training experiences progressed. This was in part due to the structure of the training exercises, such as an activity that involved describing an image to someone who could not see it, so that the other person could effectively reproduce the image. At the same time, some of the group engagement was initiated by the researchers themselves: several participants identified clear connections between their professional work and each other's stories about their own experiences of informal learning (e.g., an astronomer talking about his love of music with someone whose research focuses on music). In other moments, participants empathized with each other's struggle to find a "hook" for talking about their research with lay audiences, especially for topics that lay audiences might not have heard of before. When the evaluation team asked what they felt they might still need, most participants simply said they needed to try out different techniques and practice their approach in a real-world setting.

While the depth of relationship-building varied between cohorts and individuals over the course of the year, the training experience did appear to provide some inroads toward the emergence of team-based thinking. In response to the experiences of the first project cohort (who went through this process in year 1), Convergent Learning project personnel also helped the second and third cohorts identify strategies for staying in closer communication and benefitting from group brainstorming throughout the year. These sessions varied in format and tone from the outset, and this variation increased in the context of OSU's closure due to the COVID-19 pandemic (along with other attendant challenges and stressors in the researchers' lives). Regardless, the experience of regular-but-flexible opportunities to discuss their work informally with one another seemed to deepen the researchers' awareness of each other's expertise and help them think with increasing attention toward collaborative possibilities.

Elements cohort's training experience

The Elements cohort started off generally interested in collaboration with people from different fields, and in particular, the arts. A stronger interest in identifying connections with the arts is likely because one of the researchers in the cohort represented Theatre/Dramatic Arts. Throughout the training, a common challenge for most of the researchers was using more accessible, non-technical language when communicating with one another. One exception of this was the researcher from Theatre, who was able to use non-technical language during the communication exercises. Over the sessions, the cohort became more comfortable with one another and displayed more familiarity with each other, as evidenced by some in the group being able to interpret and communicate another person's disciplinary perspective, as well as the demonstrated ability to find areas of common interest.

Brainstorming sessions

After reflecting on feedback from the first project cohort (Energy), the Convergent Learning project team felt the initial brainstorming session held in Year 1 was successful. At the same time, the team identified the need for even more facilitation support and structure for researchers attempting to collaborate across different disciplines and topics. The Energy cohort's experience with the HSI/O hackathon also highlighted the value of providing cohort members with a concrete, bounded task (i.e., developing a structured deliverable in the form of a hackathon challenge statement). The task of developing a hackathon challenge provided a straightforward scenario in which researchers were asked to consider a very specific audience (high school students interested in developing software programs intended to solve real-word problems). In contrast to planning for events where the audience was expected to be more broad (i.e. COSI After Dark and Franklinton Fridays), creating a hackathon challenge with this audience in mind seemed to provide a clearer sense of the task's purpose and accountability to real people with whom the researchers would interact.

As the project progressed and new cohorts began their participation in training and presentations, the project team used these lessons from the first cohort's experience to identify ways to support the new cohorts more effectively. A key element of this work involved going in with a plan to host scheduled brainstorming sessions (with the frequency and format determined by each cohort's collective preference). The project team was directly involved in these brainstorming sessions in a variety of ways. First, to mitigate the burden of planning and correspondence, project leadership (see Appendix X) took on the administrative work of scheduling, finding physical space and/or setting up remote meeting options, and documenting the work of each cohort's sessions. To support productive conversation in general, members of the CRE evaluation team often served in a facilitation role that consisted of asking each cohort questions to get them talking about their individual research and the goal of "converging" across their disciplines. To provide specific framing and context for the ISL events where the cohorts would present their research, members of the project team with specific expertise related to the events attended key sessions.

The format and frequency of the brainstorming sessions varied meaningfully across cohorts due to a combination of necessity and preference. For example, the Space cohort was the first to gather for a brainstorming session, and because of the timing, the researchers were able to meet in person; however, after this initial gathering, all of the remaining cohorts, including Space, only had the option of meeting by videoconference due to pandemic restrictions. For the Space cohort, finding times that were workable for the whole group was particularly challenging in light of the researchers' teaching schedules and other obligations, which included both significant care responsibilities during the early days of the pandemic and preparation for tenure review. Given the relatively limited time that they had together, the researchers in the Space cohort generally sought to use their brainstorming sessions with maximum operational efficiency in mind. Accordingly, their conversations tended to be much more deliverables-focused than those of other cohorts.

Meanwhile, the Movement cohort found value in having a substantial amount of unstructured time to get to know one another, and they tended to find the structure and accountability of a regular video conference session appealing. Both because of this general shared feeling and because of the timing of their engagement, the cohort members built significant personal bonds during an especially challenging period of involvement, which encompassed several difficult personal experiences that were compounded by the early days of pandemic lockdown. Beyond this style of individual engagement and more contact time overall, the Movement cohort also generally approached the brainstorming sessions as an inherently valuable process of understanding one another's perspectives better. In practical terms, this meant that they used many more of their brainstorming sessions to have broad discussions about epistemology and the meaning of convergence and pivoted to practical planning only as events became imminent. As the only cohort to collaborate exclusively online, the Elements cohort also found it helpful to have regularly scheduled calls. However, they tended to approach the brainstorming sessions as operational in focus, and the task of creating shared deliverables seemed to be what stimulated the most conversation within their team.

In reflecting on the experiences of the Space, Movement, and Elements cohorts, the project team widely considered the brainstorming sessions to be important to successful convergent presentations. More specifically, project team members identified the apparent importance of opportunities for researchers to build relationships with others in their cohort. (Incidentally, some of these relationships resulted in sustained collaborations between cohort members, as well as between cohort members and members of the project team. These collaborations include writing and outreach, as well as three new NSF-funded projects. These projects are not identified to preserve anonymity of the researcher participants). In describing this, team members cited the importance of designated times for cohorts to gather without the expectation of managing logistics or reaching specific outcomes in each meeting. The project team also observed value in providing cohorts with resources and support while also stepping back enough to ensure that each cohort held ownership over its own process. Tactically, this meant helping cohorts understand ISL events through resources and examples, and through sharing the successes, challenges, and learning from previous cohorts. At the same time, it also meant holding space for cohort members to work through the hard process of coming together to identify their unique strategies for convergent communication.

Activity outcomes evaluation

Outcomes

We focus on eleven self-reported learning outcome indicators: interest in science, knowledge of science, interest in technology, knowledge of technology, interest in engineering, knowledge of engineering, interest in math, knowledge of math, perceived relatedness of the disciplines represented, likelihood to share something about their experience, and likelihood to learn more about something in the presentation(s). We used affect response measures to indicate changes in learning attitudes and bigger picture cognitive measures to indicate changes in knowledge as a result of the presentations. Because the presentations represented several different topics and, at most, a 20-minute learning experience in an informal context, we decided later not to directly measure content-specific learning outcomes. Also, because we underestimated the difficulties in assessing short-term learning outcomes, we decided to forego trying to measure medium-term outcomes and focus on improving our methods for measuring short-term outcomes. The original logic model can be found in Appendix C.

Presentation/treatment types

Participating researchers in each cohort planned two presentations: individual presentations and convergent presentations. For the individual presentations, researchers presented on their discipline alone, with no collaboration from the larger cohort. For the convergent presentations, the researcher cohorts collaborated to create a presentation that wove together their divergent disciplines. At public events, the researchers either all delivered their individual presentations or delivered their convergent presentation as a group. See Figure 1.

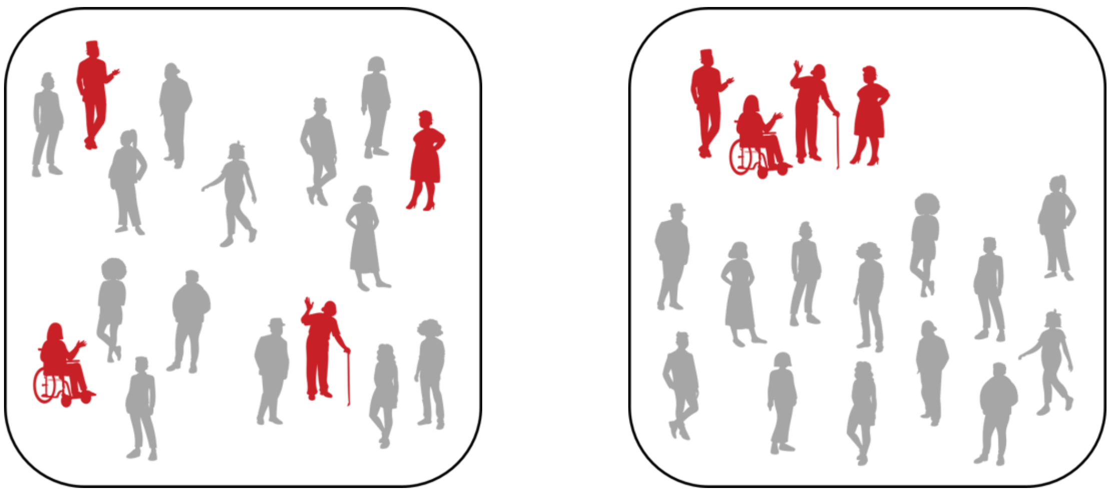
Figure 1: Presentation types

Individual Presentations

One or more presenters
Divergent disciplines
No collaboration

Convergent Presentations

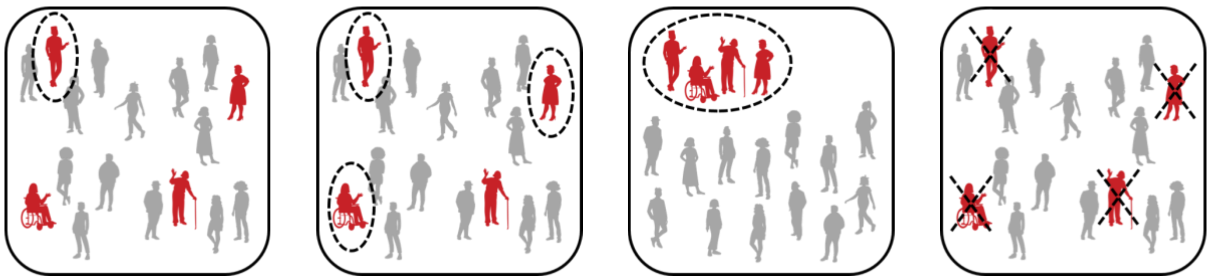
Multiple presenters
Divergent disciplines
Collaborative



The presentations that respondents reported seeing at the event they were attending determined their treatment type. At the events where researchers were delivering their individual presentations, respondents could experience an individual treatment, a multiple treatment, or a none treatment. If a respondent reported seeing only one of the individual presentations, that was considered an individual treatment. If they reported seeing more than one of the individual presentations, that was considered a multiple treatment. And if they attended the event but did not see any of the presentations by the cohort members, that was considered a none treatment. At events where the researchers were delivering their convergent presentation, respondents could experience a convergent treatment or a none treatment. If the respondent reported seeing the convergent presentation, that was considered a convergent treatment. If they did not, it was considered a none treatment. See Figure 2.

Figure 2: Treatment types

Individual Treatment	Multiple Treatment	Convergent Treatment	None Treatment
Respondent saw one individual presentation	Respondent saw more than one individual presentation	Respondent saw one convergent presentation	Respondent saw none of the researcher presentations



Events descriptions

Table 1: Number of events by project year

	COSI After Darks	Franklinton Fridays	Hackathons	Virtual events
Year 1	3	2	1	0
Year 2	3	4	0	0
Year 3	0	0	2 (both virtual)	6

COSI After Dark Events

COSI After Dark is a monthly event at the Center of Science and Industry (COSI) open to adults over the age of 21. Members of the community come to COSI and participate in various exhibits between the hours of approximately 6pm to 10pm. In addition to the exhibits, outside collaborators facilitate demonstrations and hands-on activities at a series of tables organized in the corridors outside of the main COSI exhibits. COSI After Dark events are almost always themed events, i.e., they encourage collaborators and guests to dress in costumes, and the museum incorporates decorations and additional experiences that fit the theme. One example: the October After Dark events usually incorporate a Halloween theme, and COSI encourages guests to wear costumes, decorates the museum with 'spooky' items, and encourages presenters to do the same. COSI After Dark events tend to attract several hundred, mostly 20-40- something adults over the course of the night. There is usually a constant flow of people in and out of the main doors of the museum throughout the evening. The evaluation team primarily used tablet-based exit questionnaires to measure learning outcomes of those leaving the event, though we added other kinds of data collection methods (such as observations and quick intercept interviews) to better understand the experience that visitors had with our cohorts of researchers.

Researchers from the Energy, Movement, and Space cohorts each presented their research at one of the collaborator tables during COSI After Dark in years 1 and 2 of the project. Only the Energy cohort was able to give their convergent presentation at COSI After Dark; the COVID-19 pandemic forced COSI to cancel COSI After Dark events for much of years 2 and 3. The project's researcher cohorts participated in a total of six COSI After Dark events in years 1 and 2.

Franklinton Fridays

Franklinton Fridays are a neighborhood-wide art, music, food and gallery hop for the public, held on the second Friday of every month. During Franklinton Fridays, the OSU STEAM Factory hosts STEAM Galleries, an opportunity for researchers and members of the general public to meet in an "interactive, informal, and pop-up science environment." Invited researchers, including those from the cohorts, bring interactive table presentations to the STEAM Factory. Our Energy, Movement, and Space cohorts prepared micro-lectures, abbreviated academic talks intended for lay audiences. The Franklinton Friday STEAM Gallery events (for brevity, referred throughout the report as 'Franklinton Fridays') tend to attract mostly adults, including college/grad-school aged people, as well as older adults. Some youth/children are present with their parents. For the most part, these events have a 'cocktail party' type of atmosphere, where 20-30 people arrive at the beginning of the event and stay around two hours until the end, and then leave. Like most in-person events, Franklinton Fridays were canceled for much of Years 2 and 3 of the project due to the COVID-19 pandemic.

In the first year of the project, data collection at Franklinton Friday events used the same tablet-based exit questionnaire that was used at COSI After Dark. However, the team observed that the events' social atmosphere and micro-lecture format meant that this method consistently oversampled drop-in visitors, and undersampled visitors who stayed longer (and were therefore more likely to listen to one of our research cohort's presentations). Further, the survey dampened an otherwise engaging event. In response, we adapted the questionnaire to 1) suit the event's tone, 2) better sample those who experienced the micro-lectures, and 3) make evaluation a value-added experience for people participating in Franklinton Fridays. This new method became the “Franklinton Friday Metagame.” We started developing and using the Metagame method at the start of Year 2 of the project, but were not able to implement it fully because of the emergence of the COVID-19 Pandemic. The project’s researcher cohorts participated in a total of six Franklinton Fridays in years 1 and 2.

Hackathons

The OHI/O hackathons (referred to as hackathons in this report) invite high school age learners to create teams and solve coding-based challenges over the course of a day. Participating teams can select one (or more) of several challenges posed to them at the beginning of the day. Teams are given several hours to come up with solutions to these challenges, while local technology professionals and researchers are available to the teams to provide technical, conceptual, and moral support. At the end of the day, teams submit their solutions to a panel of judges for feedback and prizes.

As part of the project, our cohorts of researchers developed convergent challenges for teams at the hackathon event to tackle. These challenges needed to incorporate both the theme of the cohort and involve some sense of convergence (i.e., combining multiple different disciplinary perspectives) to solve the problem. The Energy cohort was the only cohort to participate in an in-person Hackathon event; the other cohorts (Movement, Space, and Elements) participated virtually when the event was moved to an online format. While we initially intended to use post-event, emailed surveys to measure participant learning outcomes, the evaluation team decided that observations of how the teams and the researcher cohorts interacted/worked together would provide more substantive information on the high school teams’ learning experience. The project’s researcher cohorts participated in a total of three hackathons (including two virtual events) in years 1 and 3. The Movement and Space cohorts each presented a challenge at the same virtual hackathon in year 3.

Virtual Events

Due to the COVID-19 pandemic, we replaced the in-person events with virtual, synchronous informal learning events held over Zoom. The project mainly leveraged the existing virtual platform hosted by Columbus Science Pub, a monthly speaker series that before the pandemic, took place in The Shadow Box Live Theater in Columbus. Researchers in each of the four cohorts gave their convergent presentations at a Virtual Columbus Science Pub event. The Elements cohort (which began their work together in 2021) shared their individual presentations virtually as a hybrid component of the March 2021 Franklinton Friday event. The project’s researcher cohorts participated in a total of six Virtual Events in Year 3 of the project.

Table 2: Cohort presentation types by event

	COSI After Dark	Franklinton Fridays	Hackathon	Virtual events
Energy	Individual & Convergent	Individual & Convergent	Convergent	Convergent
Movement	Individual	Individual	Convergent	Convergent
Space	Individual	Individual	Convergent	Convergent
Elements			Convergent	Individual & Convergent

Methods description

Outcomes measurement

The learning outcomes of interest to the evaluation (see Outcomes Description section and Table 3 below) were mainly measured using the tablet questionnaires and the Meta-game. We measured interest in science, technology, engineering, and math using retrospective-pre/post, 7-point Likert-like scale items. This means that after any event, we asked respondents to first think retrospectively about their interest in science, technology, engineering, and math before they attended the event and rate their interest on a scale of 1 = very little interest to 7 = a great deal of interest. Next, we asked them to think about after the event and rate their interest in science/technology/engineering/math on the same scale. This retrospective-pre/post technique has been shown to more accurately reflect change in learning attitudes as a result of an experience than a traditional pre/post, because it asks respondents to reflect on their learning attitudes with the experience in mind.

We also measured knowledge of science, technology, engineering, and math using retrospective-pre/post, 7-point Likert-like scale items. This means that after any event, we asked respondents to first think retrospectively about their knowledge of science, technology, engineering, and math before they attended the event and rate their knowledge of science, technology, engineering, and math, on a scale of 1 = very little knowledge to 7 = a great deal of knowledge. Next, we asked them to think about after the event and rate their knowledge in science/technology/engineering/math on the same scale.

We measured likelihood to share something about their experience and likelihood to learn more about something in the presentation(s) using a post-only, 7-point Likert-like scale of 1 = extremely unlikely to 7 = extremely likely. Higher scores in these measures (i.e. scores greater than 4) indicate positive learning attitudes, which would make people more open to more learning experiences.

Table 3: Core constructs and item types in the tablet questionnaires and the metagame

Construct	Item type(s)
STEM interest	Post+Retro pre, Likert-like 7 point scale
STEM knowledge	Post+Retro pre, Likert-like 7 point scale
Likelihood to share	Post only; Likert-like 7 point scale
Treatment (which presentation did respondent see, if any)	Remember hearing about [presentation theme]?; yes/no OR Remember seeing any of the following [headshots of researchers presenting]?; yes/no
Socioeconomic background	Education, single select Household Income, single select
Individual background	Gender, single select Race/ethnicity, multiple select
Geographic background	Zip code, open field

Table 4: Methods used by event and project year

Darkened years indicate when planned methods were used for each event type.

Grayed out years indicate when methods were planned but not used.

Red years indicate when unplanned methods were added

	COSI After Dark	Franklinton Friday	Hackathon	Virtual events
Questionnaires	Y1, Y2, Y3	Y1, Y2, Y3	Y1, Y2, Y3	Y3
Metagame		Y2, Y3		
Virtual polls				Y3
Observations	Y2, Y3,		Y2, Y3	Y3
Quick interviews	Y2, Y3			

Questionnaires

We intended for questionnaires to be the main method for measuring audience outcomes throughout the project, allowing us to collect quantifiable data that could be compared across events. A tablet-based questionnaire worked reasonably well as an exit intercept survey for COSI After Dark, due to the large number of visitors leaving the building throughout the event. We learned that questionnaires did not work well for Franklinton Fridays, which had a smaller number of visitors with little turnover during the event. During the COVID-19 pandemic, we repurposed the questionnaire for use as an emailed, post-event follow-up survey to virtual events.

All questionnaires included the same core items, measuring the same main constructs (see Table 3). To measure learning outcomes, the questionnaires used the following items: change in interest in science, technology, engineering, and math (STEM), change in knowledge of STEM, and likelihood to share something about their experience with a friend or family member (see Outcomes section of this report for more information). Secondly, we asked respondents about their backgrounds, such as their level of completed formal education, their household income, their gender identity, their racial/ethnic identity, and in which ZIP code they live (See Appendix D for the instruments). Importantly, we also asked whether they saw any particular presentations or researchers, in order to determine the 'treatment they received', i.e. whether they saw one of our researcher's presentations, multiple researcher presentations, or the convergent researcher presentation (see Presentation/treatment section for more information).

The questionnaires did sometimes include additional, experimental items that we wanted to pilot, or alternative versions of the core items, though many did not perform well or give us any added information.

Metagame

The Franklinton Friday Metagame was presented as a colorful workbook (see Appendix D, Figure D1), and it reframed core questionnaire items as a challenge experience to be completed during the event. In addition to the questionnaire items, the workbook invited respondents to calculate their own change scores, thereby encouraging metacognition about the experience. Initially, we placed the workbooks throughout the main seating area and invited visitors to participate between micro-lectures, as opposed to when they left the event. This self-complete, real-time approach indeed yielded a more representative sample of respondents. Still, testing suggested that we could better integrate the method through facilitation. Prior to the COVID-19 pandemic, we created a plan to integrate the workbooks with our own evaluation micro-lecture (to be given as part of the event). The micro-lecture experience we planned could be adapted to each event's theme and in general would explore the logic of our questions and how we analyze data (see Figure 3 example, below). However, because the pandemic forced all of the in-person events (including Franklinton Fridays) to be canceled, we were not able to implement the facilitated Metagame experience.

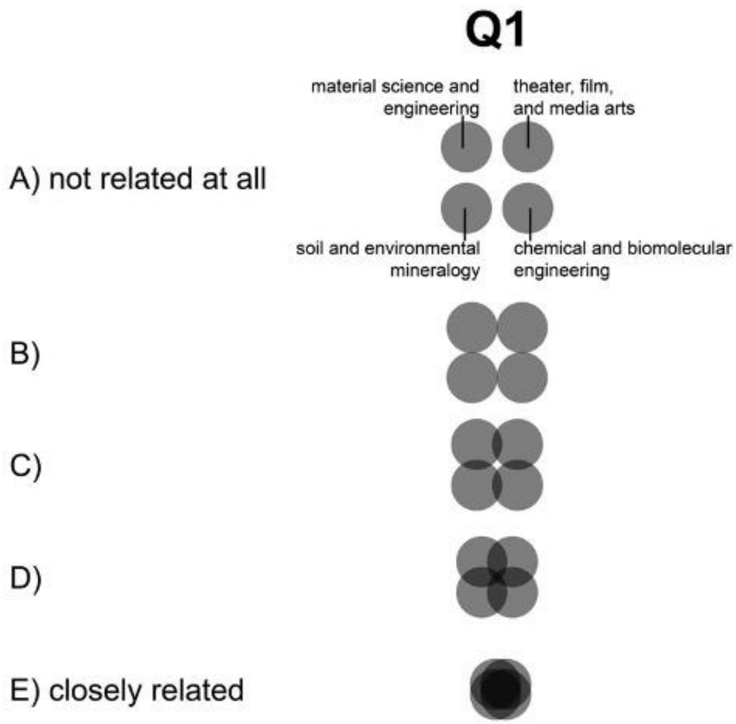
Figure 3: Valentine's Day-themed Metagame question

NB: This evaluation question was included as part of a slide-show component of the Metagame, tailored specifically to the Valentine's day theme of the event.

Virtual polls

We used virtual polls during the virtual events to measure the perceived relatedness of the disciplines in order to detect the presence of higher-level, conceptual connections that audiences might pick up from the presentations. To do this, we used a 5-point scale with graphic representations of relatedness of disciplines that would be represented by researchers in the event presentations (see Figure 4). We used a traditional pre/post technique, asking them about perceived relatedness at the beginning of the event and at the end of the event. Perceiving disciplines as more related would indicate that audiences probably found similarities between them, potentially making a relatively less known discipline more familiar through its similarities with a more well-known discipline.

Figure 4: Virtual poll measuring perceived relatedness of disciplines



Observations of participants

In year 2 of the project, the project team and CRE incorporated two additional evaluation data collection methods for the COSI After Dark events. We added these methods to better help us understand the quality of an audience member's experience at one of the presentation tables.

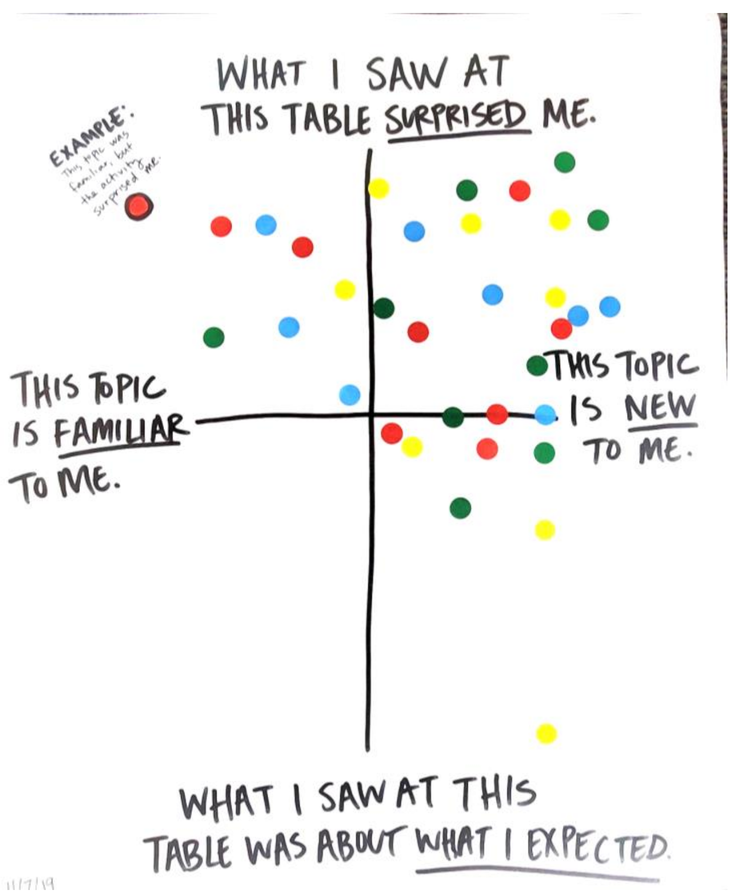
For the first added method, observations of participants, the CRE evaluation team members observed COSI visitors as they interacted with each of our cohort members' presentation tables. Each observer noted how many visitors interacted with the researcher at the table, how long the visitors interacted, and what kind of interaction took place (e.g., the visitor watched, listened to the researcher talk, the visitor talked with the researcher, the visitor did an activity at the researcher's table). Evaluators were assigned to observe a single researcher table for approximately 30 minute increments, and switched between all of the researcher presentation tables.

These observations helped the evaluation team better understand both the cohort members' approaches to research communication in ISL settings and what kind of experiences visitors had at the researcher tables. This method was also intended to help contextualize and better explain the short-term learning outcomes reported by visitors in the exit questionnaires. With a similar goal, CRE team members also observed cohort members' interactions with participants in hackathons and their presentations at subsequent virtual events (i.e. Franklinton Friday and Virtual Science Pub).

Quick intercept interviews

The second method added to the COSI After Dark events was a quick intercept interview, conducted with visitors whom the evaluation team saw interacting with one of the researchers' individual presentation tables. Evaluators asked the respondent to place a sticker on a X-Y graph to describe their experience at the researcher's table (Figure 5). The X-axis described how new or familiar the topic was to the respondent, and the Y-axis described how surprising or expected the presentation of the topic was to the respondent. Lastly, the evaluator asked the respondent a few follow-up questions in order to capture the respondent's reasoning for where they placed their sticker and additional context for their experience.

Figure 5: X-Y graph and sticker answers



Findings from public events

Questionnaires

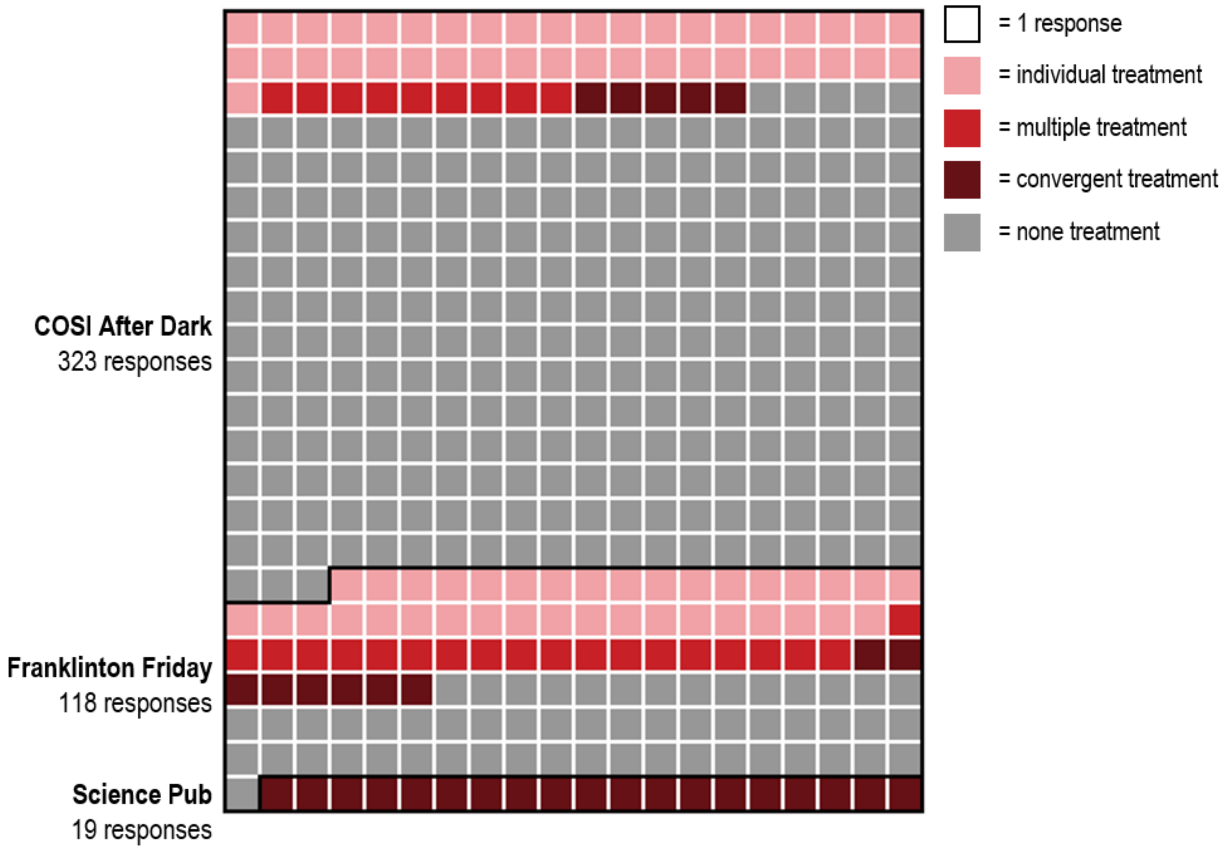
Before the COVID-19 pandemic stopped in-person data collection, the evaluation team conducted tablet questionnaires at six COSI After Dark events and four Franklinton Fridays. We collected 323 questionnaires from COSI After Dark participants. Most of these respondents (n=268, 83%) reported that they did not see the research presentations (i.e., had none treatments). One in eight respondents at COSI After Dark (n=41, 12.7%) reported seeing one individual presentation (i.e, individual treatment). Few (n=9, 2.8%) reported seeing multiple individual presentations. We collected 118 questionnaires at Franklinton Fridays. Just under half of these respondents experienced a none treatment (n=55, 46.6%). Three in ten respondents (n=36, 30.5%) reported an individual treatment, and one in six (n=19, 16.1%) reported a multiple treatment. Very few respondents at either of these events experienced convergent treatments, which is expected as most of the presentations at these events were individual presentations.

After the switch to virtual presentations, the evaluation team sent email questionnaires to participants after four virtual Columbus Science Pub events and one virtual Franklinton Friday. We only received responses from Science Pub participants, with a total of 19 completed questionnaires. All of these questionnaire respondents experienced a convergent treatment as the presentations at the Science Pubs were all convergent presentations.

In total, we collected 460 questionnaires across the different public events (in-person and virtually). The majority of these respondents experienced a none treatment (n=323, 70.2%). One in six (n=77, 16.7%) experienced an individual treatment. About the same number of respondents experienced a multiple treatment (n=28, 6.1%) as experienced a convergent treatment (n=32, 7%). In regard to the cohorts, most of the questionnaires were collected at events where the Energy cohort (n=233, 50.6%) or Space cohort (n=168, 36.5%) was presenting. These cohorts did most of their presentations in-person before the COVID-19 pause. We have fewer questionnaire responses from events where the Movement (n=55, 12%) or Elements (n=4, 0.9%) cohorts were presenting. These were the cohorts most affected by the COVID-19 shift to virtual events.

Due to the small sample size of respondents that experienced individual, multiple, and convergent treatments, we report below on the data from all of the questionnaires in aggregate rather than by event type.

Figure 6: Questionnaire samples by treatment and event type

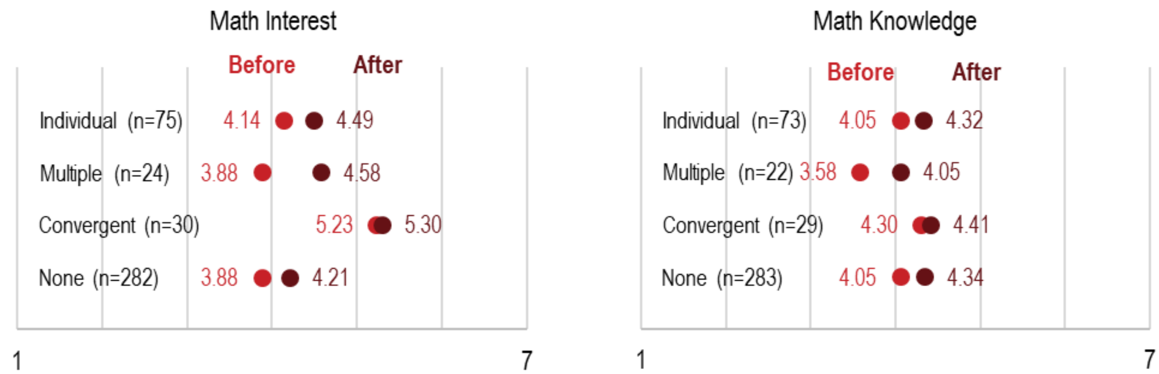


To explore learning outcomes, our analysis focused on the topics of science, technology, engineering, and math (STEM). Kruskal-Wallis tests showed no statistically significant differences in before and after ratings for these topics between the four treatment types (individual, multiple, convergent, none). Due to the small sample sizes, we also explored if seeing any type of presentation (individual, multiple, or convergent treatment) made a difference versus not seeing one (none treatment). Wilcoxon Rank Sum Tests showed no statistically significant differences in before and after ratings for any of the topics by whether or not a respondent saw a presentation.

It is important to remember that respondents were people who had chosen to attend a STEM event. Even for those that did not see a researcher's presentation, they likely still experienced other STEM activities at the events. On average, respondents shared before ratings for these topics that were toward the higher end of the scale; after ratings were also high on average. Very few respondents shared after scores that were lower than their before scores. This means that, overall, most respondents either had experiences that reinforced their existing interest or knowledge in STEM topics (i.e., no change in ratings) or increased them (i.e., increased ratings from before to after).

The charts below show the average before and after ratings for the STEM topics by treatment type. Again, while there were no significant differences between the treatment types, the charts do illustrate the high average ratings from respondents.

Figure 7: STEM interest and knowledge Retrospective-Pre/Post results



Respondents also rated their interest in the presenting cohort's theme before and after the event they attended. For respondents who experience a treatment type other than none, a Kruskal-Wallis test showed no statistically significant difference in before and after ratings for interest in theme between the four cohort themes (energy, space, movement, and elements). Across respondents, a Kruskal-Wallis test also showed no statistically significant difference in before and after ratings for interest in theme between the four treatment types (individual, multiple, convergent, none). As with the STEAM topics, on average, before and after ratings for interest in the theme were high.

Respondents also rated their likelihood to share something they learned with others. A Kruskal-Wallis test showed no statistically significant differences in likelihood to share ratings between the four treatment types (individual, multiple, convergent, none). On average, ratings for likelihood to share with others were high across treatment types (5.5 or above on a 7-point scale). Again, it is worth noting that even respondents that experience a none treatment likely interacted with other STEAM activities during the event they attended, which could also prompt them to want to share something with others.

Metagame findings

For the last two in-person Franklinton Friday events (before COVID19), we switched from intercept tablet questionnaire data collection to the more event appropriate Metagame workbooks. In the first year of data collection, we found that the tablet exit questionnaires (the same used for COSI After Dark) captured a high proportion of visitors to the STEAM Galleries that very briefly entered the gallery space and left without engaging with any of our research cohort's presentations. Of the 99 completed tablet questionnaires, only 50 (50.5%) reported hearing the research cohort presentations.

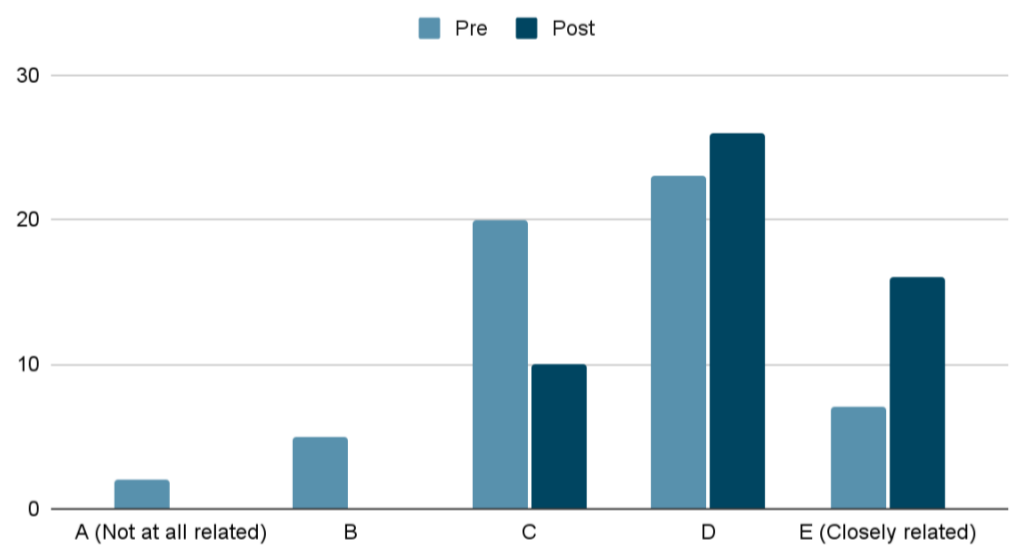
In our first two uses of the workbooks, we collected 19 completes, of which 13 (68%) reported hearing at least one of our researcher cohort presentations (i.e. received the treatment). Further, the change in workbook method increased the refusal rate from 15% using the tablet questionnaires to 62%. We counted refusals as the number of workbooks that we handed out that were left blank or not returned.

There was an additional slideshow component to the workbook method protocol that we were unable to test because of COVID19 related cancellations. The evaluation and STEAM Factory teams had planned to facilitate the completion of the workbooks with a micro-lecture slideshow that matched the theme of the event, and expected that this addition would improve the response rate of the workbooks.

Virtual activity polls

For each of the five virtual events in year 3, we collected pre and post data using the 'relatedness of disciplines' poll (see Figure 4). While we encouraged everyone participating in the virtual event over Zoom to answer the poll questions both before and after the presentations, not everyone did. Some people answered the pre poll and not the post poll; some answered just the post poll; and some answered neither. Because the answers were completely anonymous, we had no way of tracking who answered what poll. To analyze the unbalanced and unmatched data for these polls, we first combined all pre data (n=57) and all post data (n=52) from only the virtual events that featured convergent presentations. See Figure 8 for a visualization of the pre and post data. We recoded the poll answers from an A-E scale to a 1-5 scale and conducted a Wilcoxon independent samples test ($W = 937$; p-value < 0.001). The results suggest a positive audience shift toward seeing the represented disciplines as more related after seeing the convergent presentations.

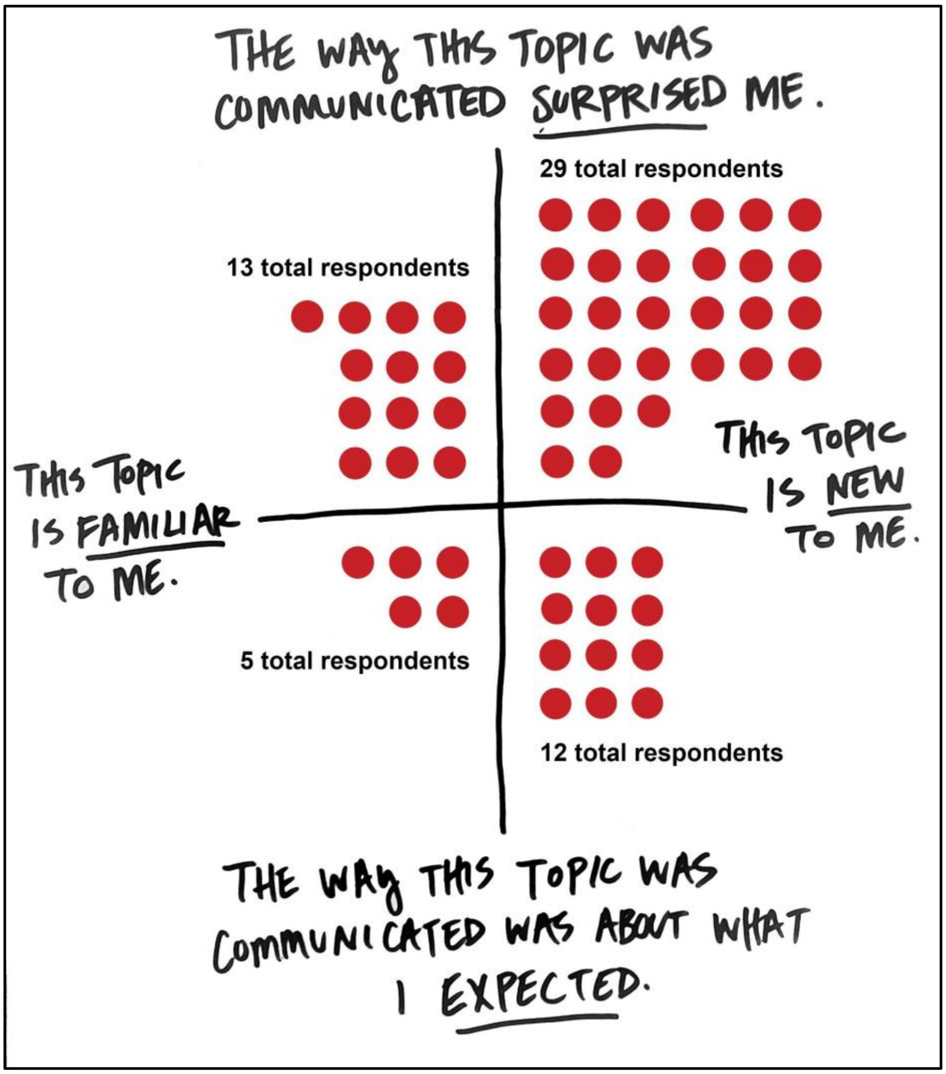
Figure 8: Pre and Post virtual poll scores: perceived relatedness of disciplines



Audience observations and quick intercept interviews

Intercept data from two COSI After Dark events held in November 2019 and early February 2020 reflect audience responses (n=65) to individual table presentations from researchers. Because intercepts were conducted directly next to individual researchers' presentation areas, each response reflects a reaction to only one of six participating researchers; in addition, the number of responses associated with each individual presentation varies, so the sample does not reflect an equal number of responses to each of the six presentations. At the group level, intercept data suggest that a majority of respondents found a researcher's style of presentation to be surprising (42 individuals, or 64%) and, separately, a majority of respondents (41 individuals, or 63%) encountered new content. Aggregated responses by quadrant are shown in Figure 9.

Figure 9: Aggregated sticker responses from intercepts by quadrant



Respondents' answers to follow-up questions and live observations of the same individual presentations also provide additional context. These data suggest that although public audiences had varying levels of entry awareness of researchers' topics of discussion, they were generally interested in finding out what was at each presentation area, tended to participate in activities as intended, and tended to find the presenters engaging.

Together, observation data (from a combination of in-person COSI After Dark events, in-person Franklinton Friday events, virtual Franklinton Friday and Columbus Science Pub events, chat logs from virtual hackathon events, and cohorts' brainstorming sessions) also provide some insight into the range of communication strategies used in researchers' individual and convergent presentations. Across event formats, researchers' individual presentations tended to be fairly didactic, but these efforts, which happened early in any given researcher's participation, served as an opportunity to try new-to-them presentation strategies (i.e., the use of models/visual aids, demonstrations, "hands-on" or interactive activities, and/or props/theming) and identify possible hooks for talking with lay people about their work. In addition, the evaluation team observed consistent application of lessons from the communication training cohort members received, ranging from adjusting their content for different audiences and contexts to actively trying to elicit information and feedback from others.

For each of the cohorts, the task of developing a hackathon challenge served as an opportunity to identify connections between their work and the work of others, with enough structure and constraint to give them a tangible goal. While the hackathon events did not provide much opportunity for the researchers to communicate their research directly to participants, the deliverables the cohorts produced reflected an initial attempt at convergence, which typically included references to each researcher's discipline, a problem statement that each of the disciplines could speak to meaningfully, and ways to leverage information or data from one or more of their disciplines. In their eventual convergent presentations, researchers seemed to leverage the content-specific hooks they developed in their individual presentations *and* the connections and collaborative storylines they developed in the hackathon challenges.

In addition to synchronous observation of the cohorts throughout their involvement, the use of recorded videos in the panel study also enabled the evaluation team to conduct additional analysis. Through inductive coding of transcripts of the convergent presentation videos used in the panel study, we have identified some potential rhetorical strategies that seem to be promising indicators of convergent presentation: references to teammates or one's cohort, references to other topics or disciplines (beyond the researcher's own), the use of collective, first-person language, and the inclusion of personal narratives. Although further analysis is needed to describe these strategies as desirable or necessary elements of convergence in relation to audience outcomes, we put these characteristics forward as potential areas to explore in future research on what constitutes convergent research communication; we expect that further operationalizing the presentation strategies that make communication more, less, or differently convergent will be of particular interest to ISL practitioners and researchers interested in outreach and applied contexts.

Qualtrics panels and findings

Recorded virtual events helped the evaluation team switch gears in response to the pandemic and expand the scope of audience that the program reached. We replicated individual and convergent presentations using a large virtual audience panel recruited through Qualtrics. The panel of nearly 3,000 respondents allowed us to further evaluate audience learning outcomes with greater statistical power, and to generalize outcomes to more diverse audience groups. Rather than attend a live event, panel respondents were shown videos of presentations from the Movement and Elements cohorts. Panel respondents watched one of three different video treatments: 1) individual, which consisted of one video with a single researcher presenting; 2) multiple, which consisted of two or three of the individual videos; and 3) convergent, which consisted of one video with multiple researchers presenting together. Treatments were randomly assigned.

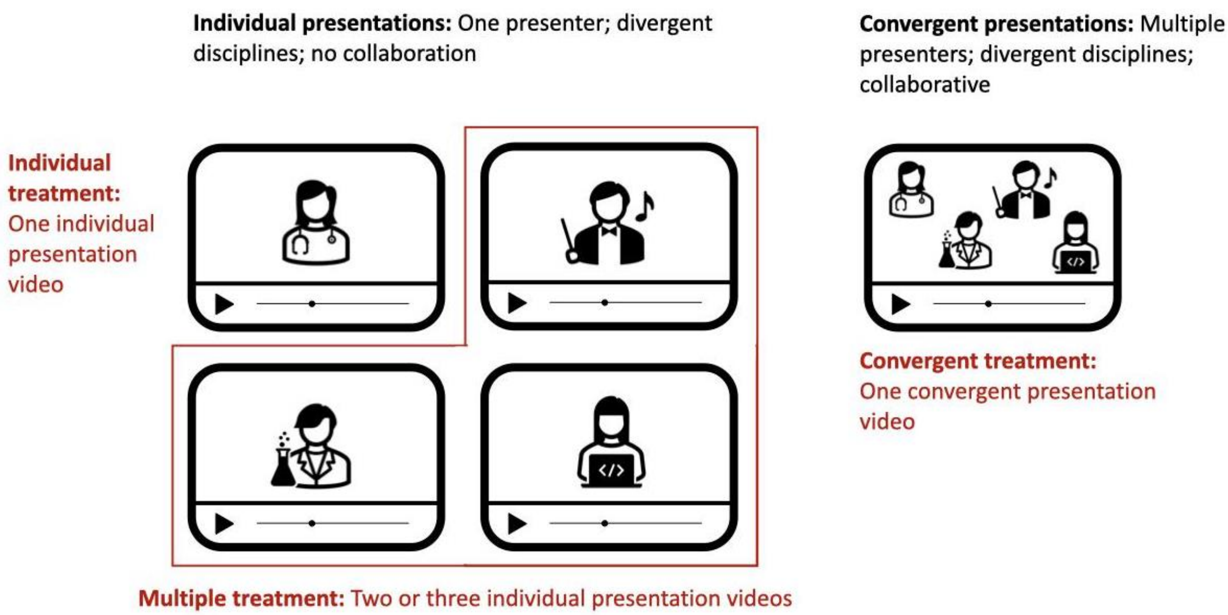
Statistical analysis and modeling

The descriptive statistics of our Qualtrics panel respondents can be found in Appendix X. We modeled respondent learning outcomes using both linear (Ordinary Least Squares) and nonlinear (logit) functions. We used linear models that approximate the learning outcomes as continuous, numeric variables. Doing so allowed us to estimate the incremental effect of different presentation treatments on outcomes, compared to a single, individual presentation treatment. Since the outcome scales are subjective and not, strictly speaking, continuous variables, we also used a logit, nonlinear model to estimate the likelihood of a large change (>1 on the 5- and 7-point scales) in the interest and knowledge of science, technology, engineering, and math, and relatedness of disciplines outcome variables, and the likelihood of a high score (>4 on a 7-point scale) occurring for the likelihood to share and likelihood to learn more outcome variables. For all of these models, we included demographic and STEM identity variables to account for diversity of respondents that influence learning outcomes (see Appendix X for a general specification of the models).

In estimating the effect of a specific presentation treatment on learning outcomes, we control for a range of demographic characteristics and unobservable factors that are common to each treatment experience. Because of a tendency for some respondents to overestimate the change in their learning attitudes as a result of their experience, we also had respondents answer retrospective-pre/post items about their interest in and knowledge of sports. Since none of the presentation treatments included anything about sports, we would not expect any change in knowledge of sports. If a respondent did indicate a change, controlling for this effect will reduce potential bias in how the respondent reported change in the outcomes of interest (e.g. interest and knowledge of engineering).

We also set up the analyses to model measures of learning outcomes after the presentation treatments, because not all had a pre- or retro-pre-measurement component. We included retrospective-pre / post scores for outcomes with these components, as a way of controlling for the amount of change seen before and after. We also control for correlation between idiosyncratic error and control variables in the model, and report heteroskedasticity robust standard errors. See Appendix H, and Tables H3 - H8 for more details.

Figure 10: Video treatments for Qualtrics panels

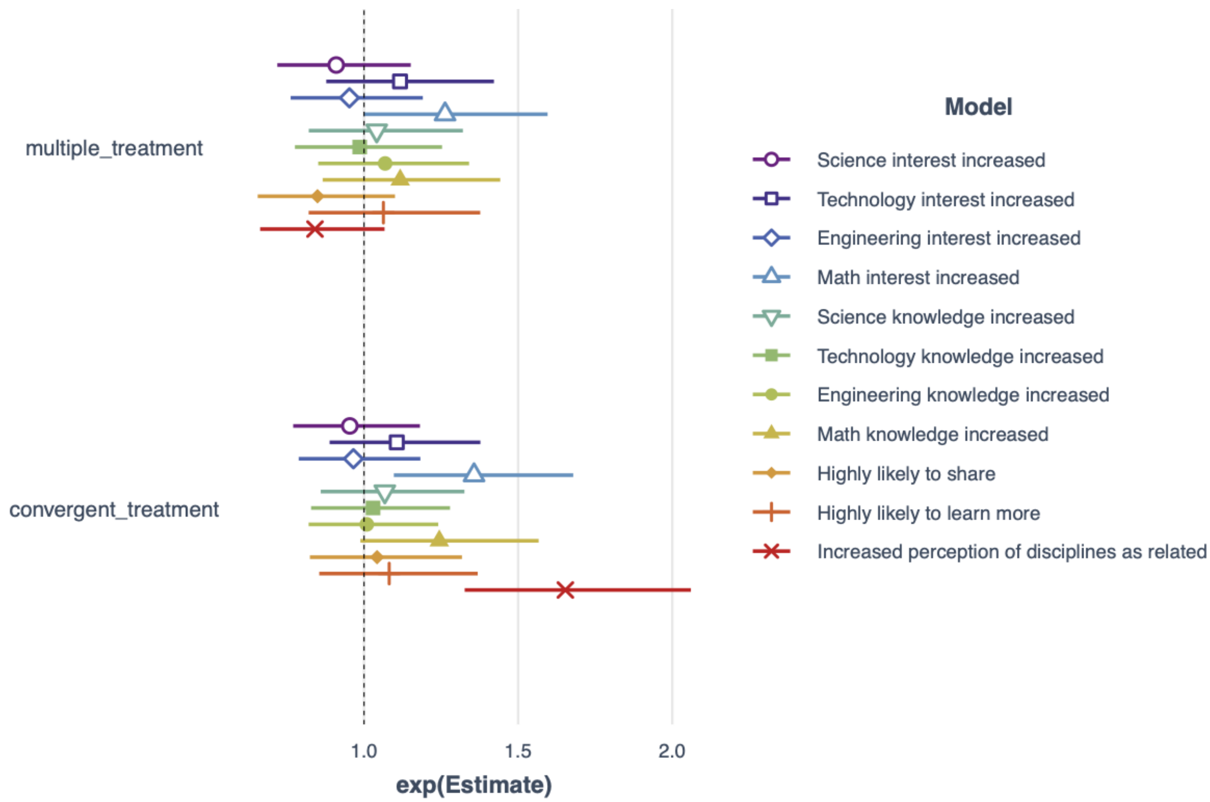


Findings

Convergent treatment effects on interest and knowledge do not seem to be much different compared to individual treatments, in terms of both increased odds of improving interest/knowledge and the treatment's incremental effect on the interest/knowledge scale (see Figures 11 and 12, respectively). The convergent treatment effects on increased odds and incremental effects on interest and knowledge also do not appear much larger than those of the multiple treatment (Table 12). Where the convergent treatment appears to have the largest effect is on the perceived relatedness of the disciplines, likelihood to share, and likelihood to learn more. The convergent treatment seems to contribute to increased odds of perceived relatedness (Table 11) and an incremental, positive effect on the perceived relatedness scale (Table 12). Both effects are statistically significant and larger than the individual and multiple treatment effects. To a lesser degree, the convergent treatment effects for the likelihood to share and learn more indicators are larger and positive compared to the individual and multiple treatment effects, particularly when assessing the incremental effects in the linear models (Table 12).

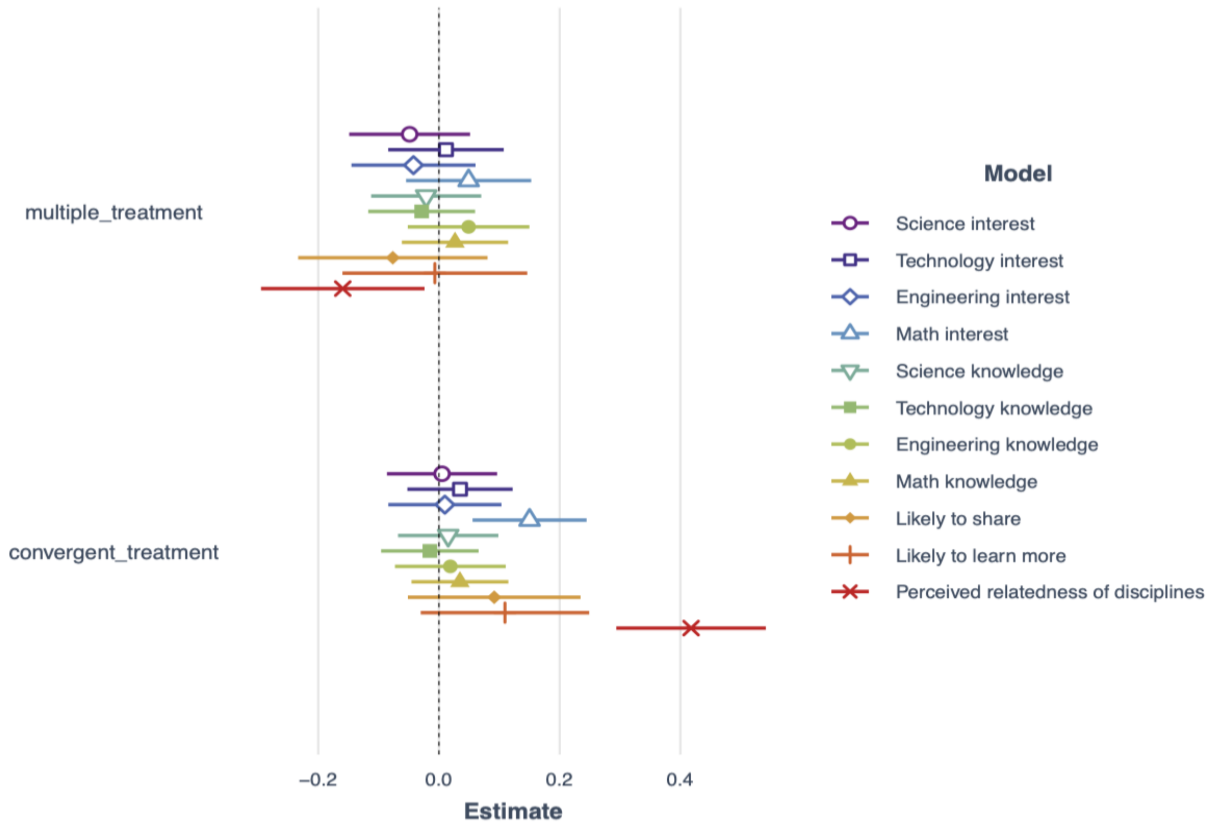
The results of these models suggest that the convergent treatment, while not necessarily contributing much to learning indicators for science, technology, engineering, and math, do appear to have a large and positive effect on learning attitudes and especially the perceived relatedness of the disciplines presented, even when compared to the multiple presentation treatment.

Figure 11: Estimated treatment effects on learning outcome indicators: Logit models



Notes: Odds ratio scale; treatments effects are in reference to one individual presentation

Figure 12: Estimated treatment effects on learning outcome indicators: OLS models



Notes: Ordinary Least Squares models; 1-7 point Likert-like scales; treatment effects are in reference to one individual presentation

Conclusion and future directions

We have evidence that a convergent approach (i.e., collaborative and interdisciplinary) to presenting research to public audiences has a stronger positive effect on audience learning affect outcomes relative to when researchers present individually. In particular, audiences are significantly more likely to increase their perception of how much divergent disciplines relate to one another. This is particularly important as the process of identifying connections between different kinds of information and content can lead to more impactful learning experiences, a desire to share what they have learned with others, or desire to learn more about the topic. Drawing connections between disparate fields also can help learners practice finding relationships between other potentially disparate experiences and lead to more satisfying ways to make meaning of the world around them. When we set out to evaluate these convergent presentations, we hypothesized that they would have an effect on audiences over and above traditional ways of sharing research individually. While we have evidence to support that hypothesis, the evaluation of the *Convergent Learning* project has revealed more paths for exploration and more hypotheses.

One path is articulating exactly *what* makes for an effective convergent presentation. For the purpose of our analyses, we defined convergence as when researchers from different disciplines collaborate on a presentation. However, the project's four cohorts (Energy, Movement, Space, and Elements) all had different *kinds* of collaborative presentations and ways of collaborating. For example, the Movement cohort used a mutual interview format for their presentation, while the Elements cohort used a show and tell format, in which each member of the cohort chose an object that represented their point of view on their theme. When looking at the effect of different *kinds* of convergent presentations, we need more examples, including those by the same people in each cohort, to assess the kinds of communication methods that produce the intended outcomes among audiences. In the last year of the *Convergent Learning* project, we started to characterize different aspects of convergence, in large part with the help of our research assistant and data analyst Mimi Cai in coding the content and methods present in each of the presentations. We hope to continue this analysis in the future, or provide data for others to carry forward.

Another exploratory path that emerged from the evaluation regarded *how* to best support convergence among researchers from different disciplines, so that convergence can be successfully replicated. Our findings from formative evaluation of cohort training and development experiences highlight the importance of both facilitation and informal, unstructured time to cohorts' collaborations. Facilitated time, or time when an outside party prompted cohort members to think together and/or synthesize their ideas, was likely important because it gave cohorts an outside perspective and someone to ensure they were on track with specific project milestones. We also observed, via our presence at meetings and cohort members' own accounts, that informal, unstructured time together helped cohort members build relationships and deepen their understanding of each other's work. Lastly, our evaluation also revealed that another hypothetically important aspect of *how* to converge involved giving and allowing cohort members time to be learners and not just experts on a particular topic. This likely occurs when researchers feel comfortable with their collaborators and not in a position to be judged.

The *Convergent Learning* project has provided some promising examples of science communication strategies and modes of support for researchers to develop effective transdisciplinary skills. Further research is needed to more concretely operationalize and test specific collaborative processes and rhetorical strategies that reflect the concept of convergence. Our evaluation does point to the necessity of dedicated and supported time for meaningful and effective collaboration with those working with very different contexts and topics. Notably, this kind of dedicated and supportive time (facilitated time, informal, unstructured time, and time to be a learner) is rare in higher learning settings. For institutions wishing to advance research communication via a convergent approach, implementation will require intentional investment in these resources, as well as close examination of and changes in norms and incentive structures.

Appendices

Appendix A:Project activity timeline

Table A1: Detailed project activity timeline

Project Year	Date(s)	Major evaluation related activities	Cohort(s)
Year 1 Sep 2018 - Aug 2019	Feb 11, 2019 Feb 14, 2019 Feb 16, 2019 Mar 08, 2019 Mar 20, 2019 Mar 23, 2019 Apr 11, 2019 Apr 12, 2019 Jul 11, 2019	Training session 1 of 2 COSI After Dark (individual presentations) Training session 2 of 2 Franklinton Friday (individual presentations) Brainstorming session Hackathon COSI After Dark (individual presentations) Franklinton Friday (individual presentations) COSI After Dark (convergent presentation)	Energy Energy Energy Energy Energy Energy Energy Energy Energy
Project Year 2 Sep 2019 - Aug 2020	Sep 13, 2019 Sep 26, 2019 Sep 30, 2019 Oct 01, 2019 Oct 11, 2019 Oct 24, 2019 Nov 07, 2019 Nov 08, 2019 Dec 13, 2019 Feb 06, 2020 Feb 24, 2020 Mar-Jun 2020 May 20, 2020	Franklinton Friday (convergent presentation) Training sessions 1 and 2 of 4 Training session 3 of 4 Training session 4 of 4 Franklinton Friday (individual presentations) COSI After Dark (individual presentations) COSI After Dark (individual presentations) Franklinton Friday (individual presentations) Franklinton Friday (individual presentations) COSI After Dark (individual presentations) Brainstorming session Virtual Brainstorming sessions (approx. weekly) Virtual Brainstorming session	Energy Movement & Space Movement & Space Movement & Space Movement & Space Movement & Space Movement & Space Movement & Space Movement & Space Movement & Space Space Movement Space
Project Year 3 Sep 2020 - Aug 2021	Sep - Nov 2020 Oct 03, 2020 Dec 03, 2020 Jan 22, 2021 Jan 29, 2021 Jan 30, 2021 Feb 18, 2021 Mar-May 2021 Mar 12, 2021 Mar 20, 2021 Apr 01, 2021 Jun 03, 2021	Virtual Brainstorming sessions (approx. weekly) Virtual Hackathon Virtual Science Pub (convergent presentation) Virtual training 1 of 3 Virtual training 2 of 3 Virtual training 3 of 3 Virtual Science Pub (convergent presentation) Virtual Brainstorming sessions (approx. weekly) Virtual Franklinton Fri (individual presentation) Virtual Hackathon Virtual Science Pub (convergent presentation) Virtual Science Pub (convergent presentation)	Movement & Space Movement & Space Movement Elements Elements Elements Energy Elements Elements Elements Space Elements

	Jul 2021	Qualtrics panel survey Phase 1	Movement
Project Year 4 Sep 2021 - Aug 2022	Oct 2021	Qualtrics panel survey Phase 2	Elements

Appendix B: Project organization

Figure B1: Project organization chart

Source: Project Report 2022; prepared for external advisory board meeting.

Appendix C: Project logic models

Figure C1: Original logic model

activities	audience	outputs	short term	medium term	long term
Coaching	Presenters (researchers)	STEAM Gallery events	1. Inc. interest in divergent collaboration	1. Retained interest in divergent collaboration	1. More research conducted across disciplines
Presentations	Public	Experimental program	2. Learned from another perspective	2. Thought about research from another perspective	2. View research topics more divergently
Experimental programming		Podcast series	3. Felt they improved communication	3. Continued to improve communication	3. Improve STEM research communication
Research		Digital archive	4. Inc. desire to share research w/ public	4. Retained desire to share research w/ public	4. Increase STEM research shared w/ public
Replication		Replication manual	1. Achieved learning outcome	1. Retained learning outcome	1. Integration of knowledge to life
Dissemination		Evaluative research	2. Inc. interest in STEM theme	2. Retained interest in STEM theme	2. Deepen critical thinking about STEM theme
		Publications	3. Inc. interest in learning more STEM	3. Evidence of learning more STEM	3. Ongoing interest in STEM
		Conference presentations			

Appendix D: Evaluation instruments by method

Questionnaire

Version 1 preview links:

COSI AD https://cosicolumbus.az1.qualtrics.com/jfe/preview/previewId/639456fa-74c2-4706-ae0c-f8e0a2292efb/SV_bCt890IiDHt8uGN?Q_CHL=preview&Q_SurveyVersionID=current

Franklinton Friday https://cosicolumbus.az1.qualtrics.com/jfe/preview/previewId/dc42e109-caab-4f82-80bb-d02b1d2edb8e/SV_bNKhUYfhwcChI9f?Q_CHL=preview&Q_SurveyVersionID=current

Version 2 preview links:

COSI AD https://cosicolumbus.az1.qualtrics.com/jfe/preview/previewId/2f99c119-6990-40b8-9750-f36e4a12f082/SV_4ZvxGUl2N8OkmIl?Q_CHL=preview&Q_SurveyVersionID=current

Franklinton Friday
https://cosicolumbus.az1.qualtrics.com/jfe/preview/previewId/019b9830-4be5-4c84-94fc-9e83cadf9225/SV_eWlIUtTnbbXPtm5?Q_CHL=preview&Q_SurveyVersionID=current

Version 3 preview links:

COSI AD
https://cosicolumbus.az1.qualtrics.com/jfe/preview/previewId/328cd701-cde8-4ff1-8c62-4b2b858ff9b1/SV_7Qc4FyBAl09n6M5?Q_CHL=preview&Q_SurveyVersionID=current

Version 4 preview links:

Virtual Events
https://cosicolumbus.az1.qualtrics.com/jfe/preview/previewId/af6fb1a3-9b89-4e4d-9231-ec632df439f3/SV_25JLD6U9OHyFKR0?Q_CHL=preview&Q_SurveyVersionID=

Metagame

Figure D1: Metagame instrument, unfolded

final questions; complete when you are ready to leave!

1 How long have you been at the STEAM Gallery tonight? (mark ONE)

- ◯ less than 30 minutes
- ◯ between 30 minutes and 1 hour
- ◯ between 1 and 2 hours
- ◯ longer than 2 hours

2 What is your age in years?

3 What is your ZIP code? (e.g. 43215)

4 How likely are you to share something about your experience tonight at the STEAM Gallery with a friend or family member? (mark ONE)

- ◯ 1 -- extremely unlikely
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7 -- extremely likely

5 Which best describes your MAIN reason for coming to the event tonight? (mark ONE)

- ◯ I wanted to share a meaningful experience with people I care about
- ◯ I was interested in a specific aspect of the event tonight (like its theme)
- ◯ I didn't have anything else to do
- ◯ It seemed like lots of people go to this event

6 Thinking about **BEFORE** you came to the STEAM Gallery tonight, how much **INTEREST** did you have in each of the following topics? (please circle ONE number for each topic)

	very little interest ←						a great deal of interest →
science	1	2	3	4	5	6	7
technology	1	2	3	4	5	6	7
engineering	1	2	3	4	5	6	7
math	1	2	3	4	5	6	7
art	1	2	3	4	5	6	7
space	1	2	3	4	5	6	7
movement	1	2	3	4	5	6	7
sports	1	2	3	4	5	6	7

Thinking about **AFTER** coming to the STEAM Gallery tonight, how much **INTEREST** do you **NOW** have in each of the following topics? (please circle ONE number for each topic)

	very little interest ←						a great deal of interest →
science	1	2	3	4	5	6	7
technology	1	2	3	4	5	6	7
engineering	1	2	3	4	5	6	7
math	1	2	3	4	5	6	7
art	1	2	3	4	5	6	7
space	1	2	3	4	5	6	7
movement	1	2	3	4	5	6	7
sports	1	2	3	4	5	6	7

7 Thinking about **BEFORE** you came to the STEAM Gallery tonight, how much **KNOWLEDGE** did you have in each of the following topics? (please circle ONE number for each topic)

	very little knowledge ←						a great deal of knowledge →
science	1	2	3	4	5	6	7
technology	1	2	3	4	5	6	7
engineering	1	2	3	4	5	6	7
math	1	2	3	4	5	6	7
art	1	2	3	4	5	6	7
space	1	2	3	4	5	6	7
movement	1	2	3	4	5	6	7
sports	1	2	3	4	5	6	7

Thinking about **AFTER** coming to the STEAM Gallery tonight, how much **KNOWLEDGE** do you **NOW** have in each of the following topics? (please circle ONE number for each topic)

	very little knowledge ←						a great deal of knowledge →
science	1	2	3	4	5	6	7
technology	1	2	3	4	5	6	7
engineering	1	2	3	4	5	6	7
math	1	2	3	4	5	6	7
art	1	2	3	4	5	6	7
space	1	2	3	4	5	6	7
movement	1	2	3	4	5	6	7
sports	1	2	3	4	5	6	7

8 What is your gender?

- ◯ female
- ◯ male
- ◯ nonbinary
- ◯ prefer not to answer

9 What is your highest level of formal education completed? (mark ONE)

- ◯ some highschool
- ◯ highschool or equivalent (GED)
- ◯ associate's degree, technical college, or 2 -year college
- ◯ bachelor's degree (4 - year college)
- ◯ graduate degree (e.g. Masters, Ph.D, MD, etc.)

10 What is your ethnic/racial identity? (mark ANY/ALL that apply)

- ◯ African American or Black
- ◯ American Indian or Alaskan Native
- ◯ Asian
- ◯ Latino/a/x or Hispanic
- ◯ Hawaiian or Pacific Islander
- ◯ White
- ◯ Another identity (please describe)

11 What was your household income last year? (mark ONE)

- ◯ less than $30,000
- ◯ between $30,000 and $49,999
- ◯ between $50,000 and $99,999
- ◯ between $100,000 and $149,999
- ◯ $150,000 or more

12 If you are willing to continue to help out with our research, please provide an email address, at which we can contact you in the next few months. (e.g. janesmith@gmail.com).

Thank you! Please give this booklet to a data collector.

Virtual Polls

Figure D2: Pre and Post poll for the Elements cohort

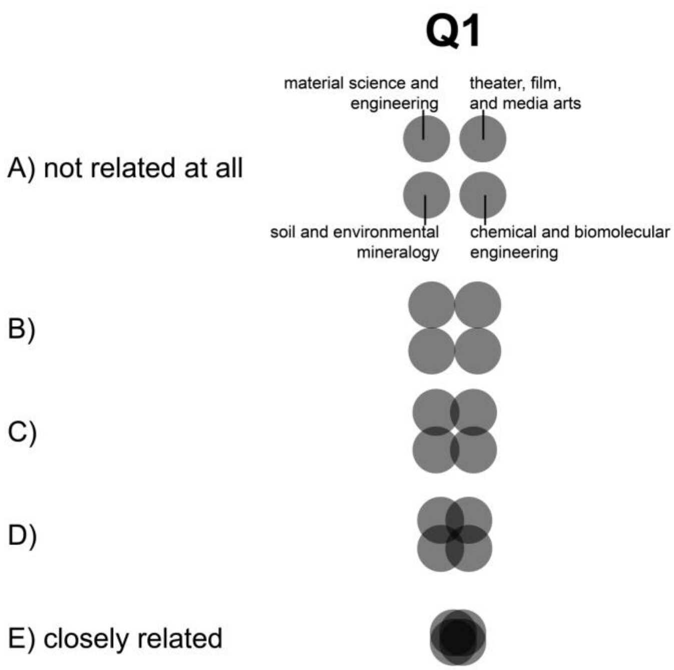


Figure D3: Pre and Post poll for the Energy cohort

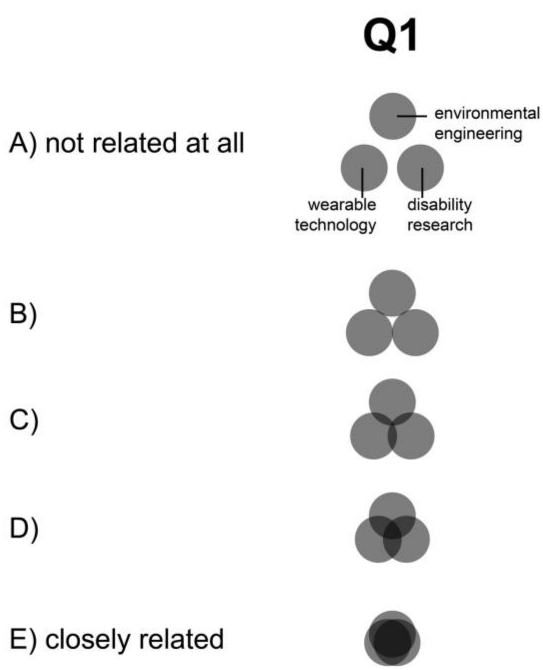
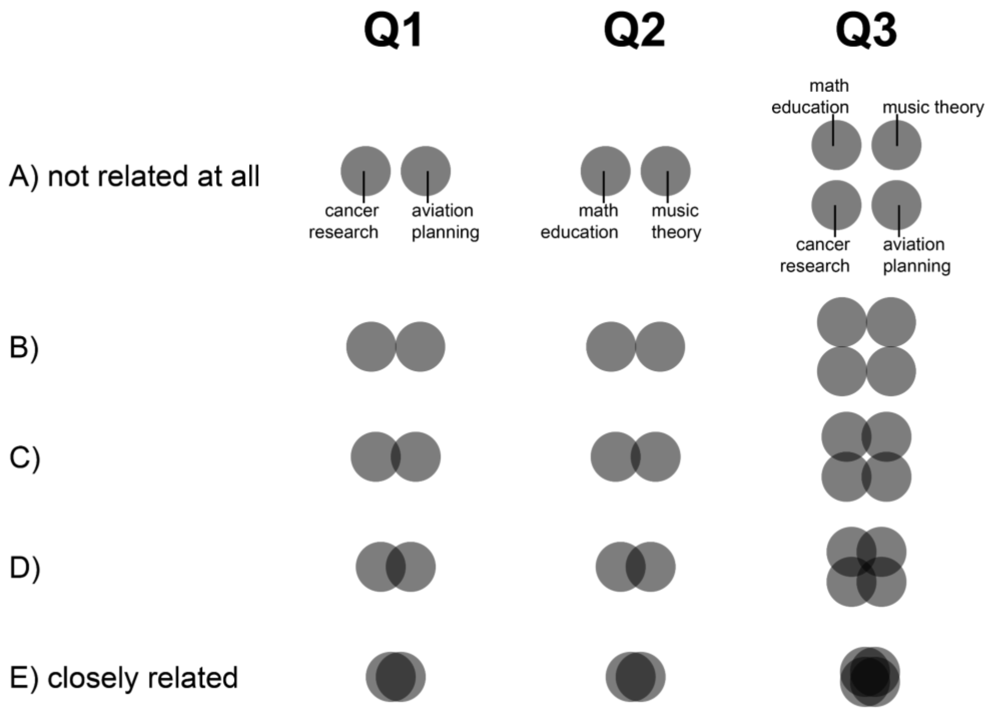
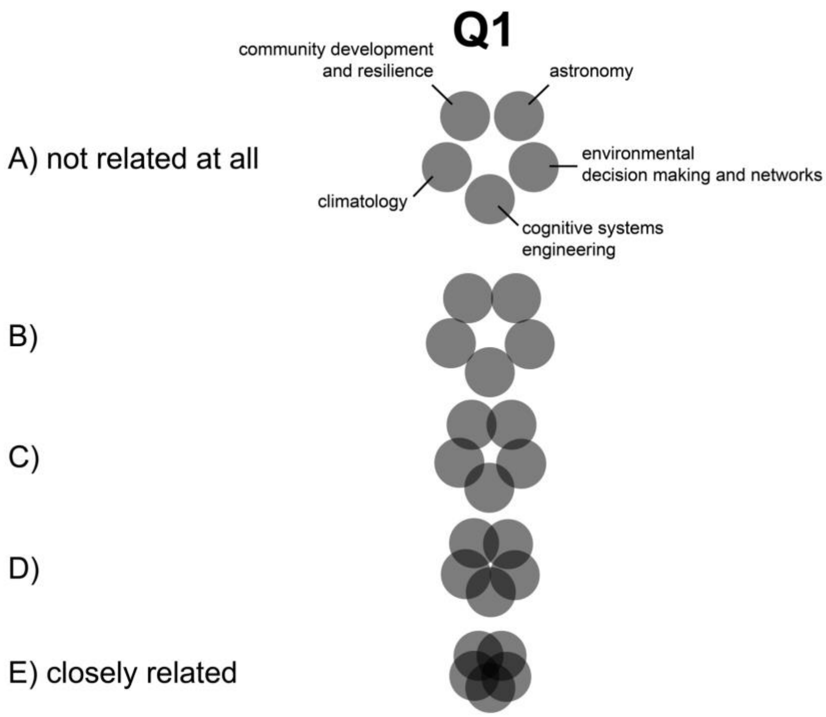


Figure D4: Pre and Post poll for the Movement cohort




Q1
community development and resilience
astronomy
environmental decision making and networks
climatology
cognitive systems engineering
A) not related at all
B)
C)
D)
E) closely related

Appendix E: Questionnaire results

Demographics of sample

The average age of respondents was 32 years old. Two in five respondents identified as female (61.5%), just over one-third identified as male (36.5%), 1% identified as non-binary, and 1% preferred not to answer. One-third of respondents reported annual household incomes under $50,000 per year, another one-third reported annual incomes between $50,000 and $99,999, and two in five (22.3%) reported incomes over $100,000. One in ten (9.7%) preferred not to answer. Almost three-quarters of respondents (72.4%) identified their race/ethnicity as white. Seven in ten respondents (70%) held a four year college degree or higher.

Table E1: Sample sizes by treatment and Event type

	Individual Treatment	Multiple Treatment	Convergent Treatment	None	*Total*
COSI After Dark	41	9	5	268	*323*
Franklinton Friday	36	19	8	55	*118*
Columbus Science Pub	0	0	19	0	*19*
Total	*77*	*28*	*32*	*323*	**460**

Mean ratings of post/retro-pre outcomes

Table E2: Mean ratings: Post/Retro-pre interest

	Individual Treatment	Multiple Treatment	Convergent Treatment	None

Science	Before Interest	5.55	5.96	6.10	5.54
	After Interest	6.00	5.92	6.43	5.91
	Difference	*0.45*	*0.00*	*0.33*	*0.37*
Technology	Before Interest	5.51	5.04	5.93	5.25
	After Interest	5.96	5.38	6.17	5.60
	Difference	*0.45*	*0.50*	*0.23*	*0.35*
Engineering	Before Interest	4.71	4.23	5.57	4.64
	After Interest	5.15	4.84	5.80	5.07
	Difference	*0.44*	*0.72*	*0.23*	*0.44*
Math	Before Interest	4.14	3.88	5.23	3.88
	After Interest	4.49	4.58	5.30	4.21
	Difference	*0.35*	*0.67*	*0.67*	*0.33*
Art	Before Interest	5.25	6.12	5.40	5.37
	After Interest	5.66	6.16	5.40	5.63
	Difference	*0.38*	*0.0*	*0.00*	*0.27*

Table E3: Mean ratings: Post/Retro-pre knowledge

	Individual Treatment	Multiple Treatment	Convergent Treatment	None

Science	Before Knowledge	4.81	5.29	5.03	4.99
	After Knowledge	5.27	5.82	5.33	5.41
	Difference	*0.47*	*0.43*	*0.30*	*0.42*
Technology	Before Knowledge	4.60	4.75	4.80	4.67
	After Knowledge	5.05	5.23	5.1	5.08
	Difference	*0.45*	*0.32*	*0.30*	*0.42*
Engineering	Before Knowledge	3.95	3.50	4.57	4.00
	After Knowledge	4.51	4.30	4.83	4.50
	Difference	*0.56*	*0.70*	*0.27*	*0.52*
Math	Before Knowledge	4.05	3.58	4.30	4.05
	After Knowledge	4.32	4.05	4.41	4.34
	Difference	*0.26*	*0.32*	*0.14*	*0.29*
Art	Before Knowledge	4.64	5.39	3.83	4.65
	After Knowledge	4.91	5.79	3.89	5.00
	Difference	*0.23*	*0.39*	*0.07*	*0.35*

Mean ratings of other outcomes

Table E4: Mean ratings: Retrospective-pre / post interest in cohort theme by cohort

		Energy Cohort	Space Cohort	Movement Cohort	Elements Cohort
Theme	Before Interest	5.16	5.97	5.18	4.00
	After Interest	5.66	6.07	5.63	4.75
	Difference	*0.49*	*0.10*	*0.56*	*0.75*

*Only for participants that saw a presentation

Table E5: Mean ratings: Retrospective-pre / post interest in cohort theme by treatment

		Individual Treatment	Multiple Treatment	Convergent Treatment	None
Theme	Before Interest	5.23	5.68	5.17	5.13
	After Interest	5.68	6.08	5.53	5.54
	Difference	*0.45*	*0.42*	*0.37*	*0.42*

Table E6: Mean ratings: Post likelihood to share with others

	Individual Treatment	Multiple Treatment	Convergent Treatment	None
Likelihood to share with others	5.75	6.38	5.71	5.49

Appendix F: Metagame results

Demographics of sample

We gave out a total of 50 Metagame workbooks and collected a total of 19 completed or partially completed Metagame workbooks over two Franklinton Friday events in year two of data collection. The average age of respondents was just over 45 years old and two thirds (10/16) were younger than 50. Of those who answered, 10 out of 15 respondents identified as female (66.7%), and 5 out of 15 identified as male (33.3%). No one identified as non-binary, and no one marked 'prefer not to answer', despite missing four responses on this question. Eight of out 14 (57%) respondents reported incomes over $100,000. Ten out of 19 respondents (57%) identified their race/ethnicity as white. Of the 13 people who identified their highest level of formal education, 11 (84.6%) reported that they held a four year college degree or higher.

Table F1: Sample sizes by treatment and Event

	Individual Treatment	Multiple Treatment	Convergent Treatment	None	*Total*
Franklinton Friday (11/08/19)	0	4	NA	4	*8*
Franklinton Friday (12/13/19)	3	6	NA	2	*11*
Total	*3*	*10*	*NA*	*6*	**19**

Table F2: Mean ratings: Post/Retro-pre interest

		Individual Treatment	Multiple Treatment	Convergent Treatment	None
Science	Before Interest	3.50	5.88	NA	5.17
	After Interest	5.00	5.86	NA	5.17

	Average Difference	*1.50*	*0.14*	*NA*	*0.00*
Technology	Before Interest	3.50	4.88	NA	5.17
	After Interest	5.00	5.14	NA	5.50
	Average Difference	*1.50*	*0.57*	*NA*	*0.33*
Engineering	Before Interest	4.00	4.50	NA	4.67
	After Interest	4.50	4.43	NA	4.50
	Average Difference	*0.50*	*0.29*	*NA*	*-0.17*
Math	Before Interest	4.00	4.75	NA	4.33
	After Interest	4.50	4.57	NA	4.50
	Average Difference	*0.50*	*0.00*	*NA*	*0.17*

Table F3: Mean ratings: Post/Retro-pre knowledge

		Individual Treatment	Multiple Treatment	Convergent Treatment	None
Science	Before Knowledge	4.50	4.50	NA	4.17
	After Knowledge	4.50	5.00	NA	4.50
	Average Difference	*0.00*	*0.50*	*NA*	*0.33*
Technology	Before Knowledge	3.50	3.17	NA	3.67

	After Knowledge	3.50	3.20	NA	3.83
	Average Difference	*0.00*	*0.00*	*NA*	*0.17*
Engineering	Before Knowledge	3.00	3.17	NA	3.17
	After Knowledge	3.50	3.67	NA	3.67
	Average Difference	*0.50*	*0.50*	*NA*	*0.50*
Math	Before Knowledge	3.50	3.50	NA	3.50
	After Knowledge	3.00	3.50	NA	3.67
	Average Difference	*-0.50*	*0.00*	*NA*	*0.17*

Mean ratings of other outcomes

Table F4: Mean ratings: Retrospective-pre / post interest in cohort theme by treatment

		Individual Treatment	Multiple Treatment	Convergent Treatment	None
Theme	Before Interest	3.50	4.57	NA	5.50
	After Interest	5.00	5.17	NA	5.67
	Difference	*1.50*	*0.83*	*NA*	*0.17*

Table F5: Mean ratings: Post likelihood to share with others

	Individual Treatment	Multiple Treatment	Convergent Treatment	None
Likelihood to share with others	5.00	6.00	NA	5.33

Appendix G: Virtual poll results

Table G1: Virtual poll, pre and post distributions

	Pre (# of votes)					Post (# of votes)				
Virtual event date	A Not related at all	B	C	D	E Closely related	A Not related at all	B	C	D	E Closely related
120320: Movement (Convergent)	0	1	4	3	1	0	0	3	3	3
021821: Energy (Convergent)	0	0	2	7	2	0	0	2	8	2
031221: Elements (Individual)	0	1	4	1	0	0	1	2	3	0
040121: Space (Convergent)	2	1	9	7	3	0	0	3	8	9
060321: Elements (Convergent)	0	3	5	6	1	0	0	2	7	2

Table G2: Virtual poll, pre and post descriptive statistics for convergent presentations

	Pre	Post

Total votes	57	52
Mean	3.49	4.12
Median	4	4
Min	1	3
Max	5	5

* NB: Wilcoxon independent samples test for pre-post scores: $W = 937$; p-value<0.001

Table G3: Mean pre and post scores, Elements cohort presentations

	Pre	Post
Individual presentation (pre n= 6; post n=6)*	3.00	3.33
Convergent presentation (pre n=15; post n=11)*	3.33	4

* NB: Wilcoxon independent samples test for both the individual and convergent presentation pre-post scores are inconclusive.

Appendix H: Qualtrics Panel Results

Descriptive statistics

In the final, total sample (n=2938), the average age of respondents was 55 years, and the median age was 59 years. Nearly eight in ten respondents (77.5%) identified as white-only, and two in three respondents (65.9%) identified as female. Nearly half of the respondents (45.8%) reported completing a 4-year college degree or higher. Half of respondents (48.1%) reported annual household incomes under $50,000, and 18.3% reported annual household incomes over $100,000. Responses were received from all 50 states and DC.

Table H1: Demographics for all respondents in Qualtrics Panel

Age (n=2938)	Mean = 55.18 years Std. Deviation = 17.11
Education Level (n=2937)	Some high school = 2.0% High school or equivalent (GED) = 30.9% Associate's or technical degree = 20.3% Bachelor's degree = 28.1% Graduate degree = 17.7% Prefer not to say = 1.0%
Residence Zip Codes (n= 2928) urbanrural (n=1475)	Respondents from all 50 states and DC. The five states with the most respondents are also the five most populous states in the U.S. (CA = 8.6%, FL = 8.3%, NY = 7.6%, TX = 6.7%, PA = 4.5%). In the second panel questionnaire (Elements cohort), respondents were asked to identify where they live as urban, suburban, or rural. Urban = 28.0% Suburban = 47.5% Rural = 24.5%
Income (n=2938)	Less than $30,000 = 26.1% Between $30,000 and $49,999 = 22.0% Between $50,000 and $99,999 = 29.5% Between $100,000 and $149,999 = 12.2% $150,000 or more = 6.1% Prefer not to answer = 4.2%

Ethnicity (n=2928)	White = 77.5% African American or Black = 9.2% Asian = 4% Latino/a/x or Hispanic = 3.6% American Indian or Alaskan Native = 0.6% Hawaiian or Pacific Islander = 0.1% Multiple races/ethnicities = 5.0%
Gender (n=2938)	Female = 65.9% Male = 33.6% Nonbinary = 0.4% Prefer not to answer = 0.2%

Table H2: STEM background of total respondents in Qualtrics panel

Strong educational background in science, technology, engineering, and/or math? (n=2937)	Yes = 34.7% No = 65.3%
Strong professional background in science, technology, engineering, and/or math? (n=2938)	Yes = 26.6% No = 73.4%
I enjoy visiting science museums, zoos, and aquariums in my free time (when it is safe to do so) (n=2938)	Mean = 5.27 Std. Deviation = 1.75 *7-point scale - 1 = not at all me; 7 = very much me (same below)
I seek out opportunities to attend science festivals and other science-focused events (n=2938)	Mean = 3.46 Std. Deviation = 1.97
I seek out opportunities to attend arts festivals and other arts-focused events (n=2938)	Mean = 4.09 Std. Deviation = 2.02

I enjoy radio shows/movies/TV programs/podcasts that are science- or technology-focused (n=2938)	Mean = 4.34 Std. Deviation = 1.94
I like to stay up-to-date on news related to science and technology (n=2938)	Mean = 4.31 Std. Deviation = 1.91
I generally find scientific topics to be dry or boring (n=2937)	Mean = 3.57 Std. Deviation = 2.03

General linear model specification and items

Outcome variable =
intercept + [Bcont][Xcont] + [Btreat][Xtreat] + [Bdemo][Xdemo] + [Bid][Xid] + error

Where:

intercept is the intercept estimated by the model

Xcont are control variables, including:

> RetroPre is a retrospective and self-reported value of the outcome variable, on a scale of 1 = very little to 7 = a whole lot (only for models 1 - 4; 5 - 8; 11; 12 - 15; 16 - 19; 22).
>
> DK_sports is the difference in self-reported knowledge of sports retrospectively before (1 = little to 7 = a whole lot, scale), and after (1 = little to 7 = a whole lot, scale) seeing a presentation. This variable is used to control for respondents who may overestimate their outcome variable measurement, because none of the presentations talked about sports.

Xtreat is a series of treatment dummy variables, whose reference is a treatment of one individual presentation video (when all of the variables = 0). The treatment variables include:

> Multiple_treatment is a dummy variable that indicates that a respondent saw more than one individual presentation video (1 = yes; 0 = no).
>
> Convergent_treatment is a dummy variable that indicates that a respondent saw a convergent video presentation (1 = yes; 0 = no).

Xdemo is a series of demographic variables, including:

EduN is a self-reported, ordinal education attainment variable approximated as continuous on a scale of 1 = Some high school; 2 = High school or equivalent (GED); 3 = Associate's or technical degree; 4 = Bachelor's degree; or 5 = Graduate degree.

IncomeN is a self-reported ordinal household income variable approximated as continuous on a scale of 1 = less than $30,000; 2 = between $30,000 and $49,999; 3 = between $50,000 and $99,999; 4 = between $100,000 and $149,999; or 5 = $150,000 or more.

ETH_White is an on/off variable distinguishing whether a respondent identified as White, non-hispanic only (1) or whether they identified as an additional race/ethnicity (0).

Gender is a self-reported, categorical variable with the values of 'Male', 'Female', or 'Nonbinary.'

Age is a continuous variable, calculated using self-reported year of birth data.

Xid is a series of STEM identity variables, including:

STEMid.museums is a self-reported variable measuring how much someone enjoy[s] visiting science museums, zoos, and aquariums in [their] free time on a scale of 1 = not at all [] to 7 = very much [].

STEMid.scifest is a self-reported variable measuring how much someone seek[s] out opportunities to attend science festivals and other science-focused events, on a scale of 1 = not at all [] to 7 = very much [].

STEMid.artsfest is a self-reported variable measuring how much someone seek[s] out opportunities to attend arts festivals and other arts-focused events, on a scale of 1 = not at all [] to 7 = very much [].

STEMid.media is a self-reported variable measuring how much someone enjoy[s] radio shows/movies/TV programs/podcasts that are science- or technology-focused on a scale of 1 = not at all [] to 7 = very much [].

STEMid.news is a self-reported variable measuring how much someone like[s] to stay up-to-date on news related to science and technology on a scale of 1 = not at all [] to 7 = very much [].

STEMid.boring is a self-reported variable measuring how much someone generally find[s] scientific topics to be dry or boring on a scale of 1 = not at all [] to 7 = very much [].

edSTEM is a binomial variable indicating whether a respondent has a strong educational background in science, technology, engineering, and/or math (1) or not (0).

profSTEM is a binomial variable indicating whether a respondent has a strong professional background in science, technology, engineering, and/or math (1) or not (0).

Logit model results

Table H3: STEM interest logit models

	Science interest increased	Technology interest increased	Engineering interest increased	Math interest increased
Model #	1	2	3	4
(Intercept)	-0.97 ***	-1.16 ***	-0.56 ***	-1.03 ***
	(0.17)	(0.17)	(0.16)	(0.17)
BI_science	-1.26 ***			
	(0.08)			
BI_tech		-1.10 ***		
		(0.07)		
BI_engine			-0.98 ***	
			(0.08)	
BI_math				-0.86 ***
				(0.07)
DK_sports	0.37 ***	0.39 ***	0.40 ***	0.46 ***
	(0.05)	(0.05)	(0.05)	(0.06)
multiple_treatment	-0.09	0.11	-0.05	0.18
	(0.12)	(0.12)	(0.11)	(0.12)
convergent_treatment	-0.05	0.10	-0.04	0.22 *
	(0.11)	(0.11)	(0.10)	(0.11)
EduN	0.00	0.04	0.03	0.11 *
	(0.05)	(0.05)	(0.05)	(0.05)
IncomeN	0.11 *	0.02	0.10 *	0.02
	(0.05)	(0.05)	(0.05)	(0.05)
ETH_White	-0.07	-0.08	-0.05	-0.16
	(0.12)	(0.13)	(0.12)	(0.12)
GenderMale	-0.17	-0.12	-0.04	-0.01
	(0.10)	(0.11)	(0.10)	(0.10)

GenderNonbinary	-0.06	0.39	-0.48	-1.76
	(1.04)	(1.27)	(1.11)	(1.38)
Age	-0.10	-0.01	0.00	-0.06
	(0.05)	(0.05)	(0.05)	(0.05)
STEMid.museums	0.13 *	0.22 ***	0.07	0.00
	(0.06)	(0.06)	(0.06)	(0.06)
STEMid.scifest	0.22 **	0.23 **	0.35 ***	0.32 ***
	(0.08)	(0.08)	(0.08)	(0.08)
STEMid.artsfest	0.12	0.04	0.12	0.13 *
	(0.06)	(0.07)	(0.06)	(0.06)
STEMid.media	0.32 ***	0.29 ***	0.25 **	0.29 ***
	(0.08)	(0.08)	(0.08)	(0.08)
STEMid.news	0.35 ***	0.18	0.24 **	0.14
	(0.09)	(0.09)	(0.08)	(0.08)
STEMid.boring	-0.15 **	-0.20 ***	-0.16 ***	-0.07
	(0.05)	(0.05)	(0.05)	(0.05)
edSTEM	0.25	0.38 **	0.10	0.08
	(0.14)	(0.14)	(0.13)	(0.14)
profSTEM	0.37 *	0.00	0.14	0.18
	(0.15)	(0.15)	(0.14)	(0.14)
N	2771	2769	2769	2774
AIC	3052.74	2977.18	3317.22	3148.77
BIC	3165.35	3089.78	3429.82	3267.33
Pseudo R2	0.27	0.23	0.20	0.22
All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroskedasticity robust. *** p < 0.001; ** p < 0.01; * p < 0.05.				

Table H4: STEM knowledge logit models

	Science knowledge increased	Technology knowledge increased	Engineering knowledge increased	Math knowledge increased
Model #	5	6	7	8
(Intercept)	-0.73 ***	-0.74 ***	-0.45 **	-0.96 ***
	(0.18)	(0.18)	(0.17)	(0.19)
BK_science	-1.28 ***			
	(0.09)			
BK_tech		-1.16 ***		

		(0.08)		
BK_engine			-0.86 ***	
			(0.07)	
BK_math				-0.95 ***
				(0.07)
DK_sports	0.49 ***	0.56 ***	0.55 ***	0.69 ***
	(0.06)	(0.07)	(0.07)	(0.07)
multiple_treatment	0.04	-0.01	0.07	0.11
	(0.12)	(0.12)	(0.12)	(0.13)
convergent_treatment	0.07	0.03	0.01	0.22
	(0.11)	(0.11)	(0.11)	(0.12)
EduN	-0.10	-0.08	-0.14 **	-0.08
	(0.05)	(0.05)	(0.05)	(0.06)
IncomeN	0.06	0.04	0.13 **	0.02
	(0.05)	(0.05)	(0.05)	(0.06)
ETH_White	-0.07	-0.12	-0.18	-0.21
	(0.12)	(0.13)	(0.12)	(0.13)
GenderMale	-0.05	0.01	-0.08	-0.06
	(0.11)	(0.11)	(0.10)	(0.11)
GenderNonbinary	-0.65	-0.12	-1.70	-0.67
	(1.17)	(1.23)	(1.52)	(1.41)
Age	-0.08	-0.04	-0.02	-0.10
	(0.05)	(0.05)	(0.05)	(0.05)
STEMid.museums	0.03	0.04	-0.04	-0.12
	(0.06)	(0.06)	(0.06)	(0.06)
STEMid.scifest	0.27 **	0.23 **	0.26 ***	0.41 ***
	(0.08)	(0.08)	(0.08)	(0.08)
STEMid.artsfest	0.17 *	0.14 *	0.21 ***	0.19 **
	(0.06)	(0.06)	(0.06)	(0.07)
STEMid.media	0.22 **	0.24 **	0.23 **	0.26 **
	(0.08)	(0.08)	(0.07)	(0.08)
STEMid.news	0.49 ***	0.42 ***	0.31 ***	0.21 *
	(0.10)	(0.09)	(0.08)	(0.09)
STEMid.boring	-0.08	-0.02	-0.03	0.09
	(0.05)	(0.05)	(0.05)	(0.05)
edSTEM	-0.13	-0.22	0.08	-0.29
	(0.15)	(0.15)	(0.14)	(0.16)
profSTEM	0.21	0.18	0.03	0.14

	(0.15)	(0.15)	(0.15)	(0.16)
N	2774	2773	2771	2772
AIC	3038.78	3015.31	3249.86	2777.08
BIC	3151.41	3127.94	3362.47	2889.70
Pseudo R2	0.27	0.25	0.22	0.27
All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroskedasticity robust. *** p < 0.001; ** p < 0.01; * p < 0.05.				

Table H5: Other outcome logit models

	Highly likely to share	Highly likely to learn more	Increased perception of disciplines as related
Model #	9	10	11
(Intercept)	-0.42 *	-0.27	-0.26
	(0.18)	(0.18)	(0.17)
prepoll_score			-0.92 ***
			(0.05)
DK_sports	0.27 ***	0.23 ***	0.16 **
	(0.06)	(0.06)	(0.05)
multiple_treatment	-0.16	0.06	-0.17
	(0.13)	(0.13)	(0.12)
convergent_treatment	0.04	0.08	0.50 ***
	(0.12)	(0.12)	(0.11)
EduN	-0.01	-0.03	-0.02
	(0.06)	(0.06)	(0.05)
IncomeN	0.03	0.03	0.00
	(0.06)	(0.06)	(0.05)
ETH_White	0.06	-0.05	-0.06
	(0.13)	(0.14)	(0.13)
GenderMale	0.10	0.01	-0.18
	(0.11)	(0.11)	(0.11)
GenderNonbinary	0.39	0.30	2.00
	(0.92)	(1.13)	(1.36)
Age	-0.39 ***	-0.32 ***	-0.06
	(0.05)	(0.06)	(0.05)
STEMid.museums	0.08	0.06	0.17 **

	(0.07)	(0.07)	(0.06)
STEMid.scifest	0.57 ***	0.61 ***	0.04
	(0.08)	(0.08)	(0.08)
STEMid.artsfest	0.29 ***	0.32 ***	-0.02
	(0.07)	(0.07)	(0.06)
STEMid.media	0.44 ***	0.45 ***	0.19 *
	(0.09)	(0.09)	(0.08)
STEMid.news	0.37 ***	0.46 ***	-0.02
	(0.09)	(0.09)	(0.08)
STEMid.boring	0.06	0.01	-0.08
	(0.06)	(0.06)	(0.05)
edSTEM	0.23	0.15	0.01
	(0.15)	(0.15)	(0.14)
profSTEM	-0.51 ***	-0.28	0.38 *
	(0.15)	(0.15)	(0.15)
N	2775	2775	2445
AIC	2626.48	2625.58	2917.91
BIC	2733.19	2732.29	3028.15
Pseudo R2	0.46	0.48	0.25

All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroskedasticity robust. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Linear model results

Table H6: STEM interest linear models

	Science interest	Technology interest	Engineering interest	Math interest
Model #	12	13	14	15
(Intercept)	4.86 ***	4.82 ***	4.44 ***	4.37 ***
	(0.07)	(0.07)	(0.07)	(0.08)
BI_science	1.19 ***			
	(0.04)			
BI_tech		1.25 ***		
		(0.03)		

BI_engine			1.26 ***	
			(0.04)	
BI_math				1.41 ***
				(0.03)
DK_sports	0.19 ***	0.19 ***	0.22 ***	0.28 ***
	(0.03)	(0.03)	(0.03)	(0.03)
multiple_treatment	-0.05	0.01	-0.04	0.05
	(0.05)	(0.05)	(0.05)	(0.05)
convergent_treatment	0.01	0.03	0.01	0.15 **
	(0.05)	(0.04)	(0.05)	(0.05)
EduN	0.00	-0.01	-0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)
IncomeN	0.02	0.02	0.04 *	0.02
	(0.02)	(0.02)	(0.02)	(0.02)
ETH_White	0.06	-0.08	-0.06	-0.11
	(0.05)	(0.05)	(0.06)	(0.06)
GenderMale	-0.01	0.04	0.06	0.05
	(0.04)	(0.04)	(0.04)	(0.04)
GenderNonbinary	-0.06	0.21	-0.74	-0.63
	(0.23)	(0.35)	(0.41)	(0.33)
Age	-0.02	0.03	-0.01	0.03
	(0.02)	(0.02)	(0.02)	(0.02)
STEMid.museums	0.09 **	0.09 ***	0.05 *	0.07 *
	(0.03)	(0.03)	(0.03)	(0.03)
STEMid.scifest	0.08 *	0.06	0.11 **	0.14 ***
	(0.04)	(0.03)	(0.04)	(0.04)
STEMid.artsfest	0.00	-0.02	0.04	0.01
	(0.03)	(0.03)	(0.03)	(0.03)
STEMid.media	0.22 ***	0.16 ***	0.18 ***	0.14 ***
	(0.04)	(0.04)	(0.04)	(0.04)
STEMid.news	0.16 ***	0.18 ***	0.15 ***	0.10 *
	(0.04)	(0.04)	(0.04)	(0.04)
STEMid.boring	-0.09 ***	-0.06 **	-0.06 *	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)
edSTEM	0.05	0.13 *	0.08	0.02
	(0.06)	(0.05)	(0.06)	(0.06)
profSTEM	0.06	0.00	-0.02	0.01
	(0.06)	(0.06)	(0.06)	(0.06)

N	2771	2769	2769	2774
R2	0.71	0.73	0.72	0.73

All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroskedasticity robust. *** p < 0.001; ** p < 0.01; * p < 0.05.

Table H7: STEM knowledge linear models

	Science knowledge	Technology knowledge	Engineering knowledge	Math knowledge
Model #	16	17	18	19
(Intercept)	4.50 ***	4.36 ***	3.89 ***	4.32 ***
	(0.07)	(0.07)	(0.08)	(0.07)
BK_science	1.16 ***			
	(0.04)			
BK_tech		1.20 ***		
		(0.03)		
BK_engine			1.22 ***	
			(0.04)	
BK_math				1.39 ***
				(0.03)
DK_sports	0.27 ***	0.29 ***	0.34 ***	0.33 ***
	(0.03)	(0.03)	(0.03)	(0.03)
multiple_treatment	-0.02	-0.03	0.05	0.03
	(0.05)	(0.04)	(0.05)	(0.05)
convergent_treatment	0.02	-0.02	0.02	0.03
	(0.04)	(0.04)	(0.05)	(0.04)
EduN	-0.03	-0.04 *	-0.06 **	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)
IncomeN	0.02	0.03	0.05 *	0.00
	(0.02)	(0.02)	(0.02)	(0.02)
ETH_White	-0.02	-0.03	-0.07	-0.09
	(0.05)	(0.05)	(0.06)	(0.05)
GenderMale	0.01	0.06	0.04	0.06
	(0.04)	(0.04)	(0.04)	(0.04)
GenderNonbinary	0.31	0.17	-0.38	-0.09
	(0.41)	(0.33)	(0.31)	(0.40)

Age	0.00	-0.02	0.01	0.00
	(0.02)	(0.02)	(0.02)	(0.02)
STEMid.museums	0.03	0.01	0.01	-0.02
	(0.03)	(0.03)	(0.03)	(0.02)
STEMid.scifest	0.07	0.04	0.12 **	0.11 ***
	(0.03)	(0.03)	(0.04)	(0.03)
STEMid.artsfest	0.03	0.06 *	0.06	0.04
	(0.03)	(0.03)	(0.03)	(0.02)
STEMid.media	0.12 **	0.14 ***	0.12 **	0.12 ***
	(0.04)	(0.04)	(0.04)	(0.03)
STEMid.news	0.24 ***	0.21 ***	0.23 ***	0.07 *
	(0.04)	(0.04)	(0.04)	(0.03)
STEMid.boring	-0.02	-0.01	0.00	0.03
	(0.02)	(0.02)	(0.02)	(0.02)
edSTEM	-0.13 *	-0.11 *	-0.08	-0.13 *
	(0.05)	(0.05)	(0.06)	(0.06)
profSTEM	-0.01	0.00	-0.01	-0.05
	(0.05)	(0.05)	(0.06)	(0.06)
N	2774	2773	2771	2772
R2	0.74	0.76	0.72	0.78
All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroskedasticity robust. *** p < 0.001; ** p < 0.01; * p < 0.05.				

Table H8: Other outcomes linear models

	Likely to share	Likely to learn more	Perceived relatedness of disciplines
Model #	20	21	22
(Intercept)	4.14 ***	4.20 ***	3.05 ***
	(0.11)	(0.11)	(0.10)
prepoll_score			0.54 ***
			(0.03)
DK_sports	0.21 ***	0.19 ***	0.11 ***
	(0.03)	(0.03)	(0.03)
multiple_treatment	-0.08	-0.01	-0.16 *
	(0.08)	(0.08)	(0.07)
convergent_treatment	0.09	0.11	0.42 ***

	(0.07)	(0.07)	(0.07)
EduN	-0.10 **	-0.07	-0.01
	(0.04)	(0.03)	(0.03)
IncomeN	0.09 **	0.06	-0.03
	(0.04)	(0.03)	(0.03)
ETH_White	-0.21 **	-0.16 *	-0.09
	(0.08)	(0.08)	(0.07)
GenderMale	-0.03	-0.03	-0.02
	(0.07)	(0.07)	(0.06)
GenderNonbinary	0.17	-0.03	0.55
	(0.75)	(0.94)	(0.42)
Age	-0.25 ***	-0.26 ***	0.02
	(0.03)	(0.03)	(0.03)
STEMid.museums	-0.04	0.00	0.07 *
	(0.04)	(0.04)	(0.03)
STEMid.scifest	0.61 ***	0.52 ***	0.12 **
	(0.06)	(0.06)	(0.04)
STEMid.artsfest	0.26 ***	0.25 ***	-0.02
	(0.05)	(0.05)	(0.04)
STEMid.media	0.34 ***	0.41 ***	0.11 *
	(0.06)	(0.06)	(0.05)
STEMid.news	0.26 ***	0.34 ***	-0.03
	(0.06)	(0.06)	(0.05)
STEMid.boring	0.01	-0.02	-0.01
	(0.03)	(0.03)	(0.03)
edSTEM	0.10	0.13	0.04
	(0.09)	(0.09)	(0.08)
profSTEM	-0.30 **	-0.27 **	0.09
	(0.10)	(0.10)	(0.08)
N	2775	2775	2445
R2	0.45	0.48	0.23

All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroskedasticity robust. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.