Fostering Video Sharing and Discourse Among STEM Educational Researchers in a Multimodal Environment

JONI FALK, DEBRA BERNSTEIN, BRIAN DRAYTON
TERC, USA
joni_falk@terc.edu
debra_bernstein@terc.edu
brian_drayton@terc.edu

Multimedia environments provide multiple resources for expression, collaboration, and knowledge-creation. Yet there is much to be learned about the design of such environments, the forms of collegial discourse that take place, and the benefits of participation. To this end, we study the 2017 STEM for All Video Showcase, a multimodal environment, that enabled educational researchers to share and discuss short videos depicting their federally-funded work to improve STEM education. The event (http://stemforall2017.videohall.com) featured 171 video narratives, each accompanied by meta-data, an abstract, and its own discussion. This Showcase, funded by the National Science Foundation (NSF #1642187), has been held annually for 4 years and has attracted thousands of researchers and practitioners engaged in science, technology, engineering, mathematics, and computer science education. In a mixed methods study, we investigate the forms of participation that took place and the benefits that accrued to those who presented. We provide a thematic analysis of the textual discussions that took place, to further an understanding of the potential of a multimodal environments to facilitate rich collegial exchanges. Finally, the paper describes design decisions and embedded features that promoted different forms of interactivity among participants.

THEORETICAL FRAMEWORK

Research is a deeply social enterprise and communication is an essential, perhaps constitutive element of research. This is as true in the field of STEM education research as it is of other fields. Faraday's famous maxim, "Work, finish, publish," still rings true as a description of the scientist's work. Yet it oversimplifies the process by which ideas are developed, tested in use, and adjusted and refined through informal and formal analysis and debate. Scientific communication in all fields has changed to take advantage of new technologies and social developments over the years, and in turn the various fields of inquiry have themselves been changed (Star 1999). The development of increasingly accessible video technology is one recent example.

Video is increasingly accepted as a key tool for scientific communication and dissemination— both with peers in the scientific community and with the general public (León & Bourk, 2018). Long established as an integral tool for data, video is now seen as an accepted medium for reporting on and describing methodology in scientific journals (Pritsker, 2013). Video is a powerful medium with which to identify key claims and novel findings, inviting the viewer to investigate the research more deeply (Darzentas, Goldvosky, Ouzounis, Karapiperis, & Karapiperis, 2007). Video can further scientific progress within and between fields of research, as well as further the public understanding of science, and thus increase the impact of scientific research (Liang et al., 2014; Pasquali, 2007). It is more accessible to non-specialists than an article or abstract. Especially when mediated online, video enables learning from each other at a geographic distance, in different time zones, at one's own convenience and at one's own pace (Falk & Stroud, 2013).

Science (and indeed any field of research) is a social endeavor, and communication is an essential, and indeed constitutive scientific process (Brod, 2014). It has been estimated that scientists spend as much as 25-40% of their work time in communication related activities (Abelson, 1980, Nielson, 2012), and the same is likely to be true in any field where knowledge, methodology, and applications are developing rapidly (Perry-Smith & Manucci, 2015). As research has shown, much of the work at every stage is embedded in social processes mediated by discourse and the use of representations in multiple media (Darzentas, et al. 2007, Pasquali 2007, Lemke, 2011). In such exchanges, language is only one of several media; talking is essential, but so are showing, computing, and experiencing. Communication in the STEM fields is inherently multimodal (Lemke 1998).

Most commonly, researchers disseminate research and results through the formal processes of peer-reviewed publications, and the less formal process of presenting papers and posters at face-to-face conferences. Such gatherings constitute a temporary community of discourse, sharing news, seeking collaborations, evaluating related work, negotiating theoretical frames, methodologies, and interpretations of results. There is considerable research showing the importance of conferences and poster sessions as a key element for the building of knowledge, as well as its dissemination (Carter-Thoma & Rowley-Jolivet, 2010, Rowley-Jolivet 1999). Conferences are the most common first public expression of research products when presentations are at a stage of development in which improvement and modification are still possible. Researchers gather evidence about the possible value of their findings to the field, through evaluative conversations and comments at presentation events.

A professional conference can be examined within the framework of Lave and Wenger's (1991) construct of the *community of practice* (CoP). Wenger (2004) argues that a CoP is characterized by a *domain*, which is the knowledge or content, the *community*, as well as community structures, and *practice* which includes tools, skills, processes, and constructs by which the practitioners engage. In such a community, the structures and practices offer pathways in which people can increase their participation as their expertise grows. At the core of the community are those whose expertise and experience is such that they generate knowledge, establish norms, and innovate or make refinements to the practice. Among other processes, a CoP also enables "legitimate peripheral participation" by those with less expertise or experience in the domain and practice, enabling and supporting them to change the ways they participate, as their expertise grows (Smith, Hayes, & Shea, 2017).

Conferences focus on the key scientific practice of scientific discourse: presentation, argumentation, and dissemination of research questions, methods, and results and offer opportunities for the elicitation of questions and ideas (Garvey, Lin, Nelson, & Tomita, 1972, Rowe, 2018, Abelson, 1980). Yet researchers have noted several limitations of conferences including the limited number of attendees in a face-to-face event due to space and cost of travel, limited opportunity for broad dissemination beyond conference attendees, lack of accessibility of presentations and posters after the event, and limited time for discussion between attendees during the event. (Falk, Lee, & Drayton, 2009; Rowe, 2018).

Online events, meetings, and platforms have arisen to address these limitations and to supplement the exchanges; almost all now include a video

component. Video is a medium for qualitative communication across boundaries, but for the purposes of collegial exchange, there are limitations to video on its own, as it is not a dialogic medium. For dialogue to emerge, it must be situated in some other context. Yet there is little research on how STEM communication is facilitated in multimodal online environments. Are presenters mostly disseminating their work or are they also communicating, learning from each other's insights, perspective and expertise? And if the latter, how can rich collegial discourse be facilitated online? When it is, what do people actually talk about, and what do they learn from each other? What benefits accrue to presenters and to those who view the videos and comment and offer critique?

The STEM for All Video Showcase, the subject of this paper, represents an innovative environment of this kind. It is designed to promote rich collegial dialogue and to maximize participation, interactivity, and broad dissemination, with multiple modalities for these purposes. The paper analyzes several aspects of this online event, including the types of interactions that took place, an in-depth exploration of the content exchanged in discussions, and the benefits accrued to participants.

DESCRIPTION AND DESIGN OF THE 2017 STEM FOR ALL VIDEO SHOWCASE

The 2017 STEM for All Video Showcase, "Research & Design for Impact," was held online from May 14 - 22, 2017 and can still be viewed at http://stemforall2017.videohall.com. The event featured 171 three-minute video narratives that each depicted a project aimed at improving science, technology, engineering, mathematics, or computer science education in formal or informal settings. The videos include projects aimed at interventions in elementary, middle, high school, under-graduate and graduate school level, as well as in museums, national parks, community groups, games and apps. Each of the projects represented in the Showcase was funded by a federal agency, the great majority by the National Science Foundation (NSF), as well as some funded by ED, NASA, IMLS, NIH, USAID, and USDA. Each presenter was encouraged to include in their video narrative the problem that their project addressed, the innovation or intervention they developed, and the impact of the project and how they measured their success.

Before the event: Four hundred and seventy-eight lead and co-presenters submitted 171 videos before the beginning of the interactive event.

Each video was accompanied by an abstract, presenter profiles, and other metadata such as intended audience (e.g. teachers, researchers, policy makers), keywords (e.g. citizen science, broadening participation, instructional materials), state, and funder. Many of the presentations were accompanied by supplemental resources which included papers, case studies, or links to project websites. Videos are all reviewed by a technical team at the host institution (TERC) and closed captions are added before they are posted to the Video Showcase site.

A significant outreach effort occurred before the event to invite the participation of researchers, teachers, administrators, policy makers and the general public. The outreach was a distributed effort: TERC and collaborators from six NSF-funded resource centers publicized the event to individuals, organizations, and institutions (e.g. AAAS, ASTEC, NSTA). Many of the presenters also spread word of the event through their project and university websites and through their social and collegial networks. While the event officially started on the 15th of May, presenters were invited to post a welcome message on the discussion board associated with their video on the evening of May 14th.

The eight-day interactive event: The interactive event took place May 15th – May 22nd 2017. During this time, thousands of visitors participated (~ 29,000). Visitors to the site were invited to view the videos, participate in facilitated discussions, and vote for their favorites for a "Public Choice Award" through Facebook, Twitter, or online ballot.

When arriving at the Video Showcase site, users saw three types of webpages which they used to navigate through the Showcase: the homepage, the main video presentation page, and individual video presentation pages.

Homepage: The homepage displayed introductory text, thumbnails of recent visitors, latest site activity, an event schedule, and featured presenters (which were randomly chosen for a rotating display) and social media links. (See Figure 1). This page was customized for each individual. Logged-in attendees also saw a history of their personal activity on the site. Presenters were able to see the number of queries related to their presentation, including those that they had answered and those that were unread. Facilitators were able to track the videos that they had viewed and the videos on which they had commented. They were notified when replies to their comments were posted.
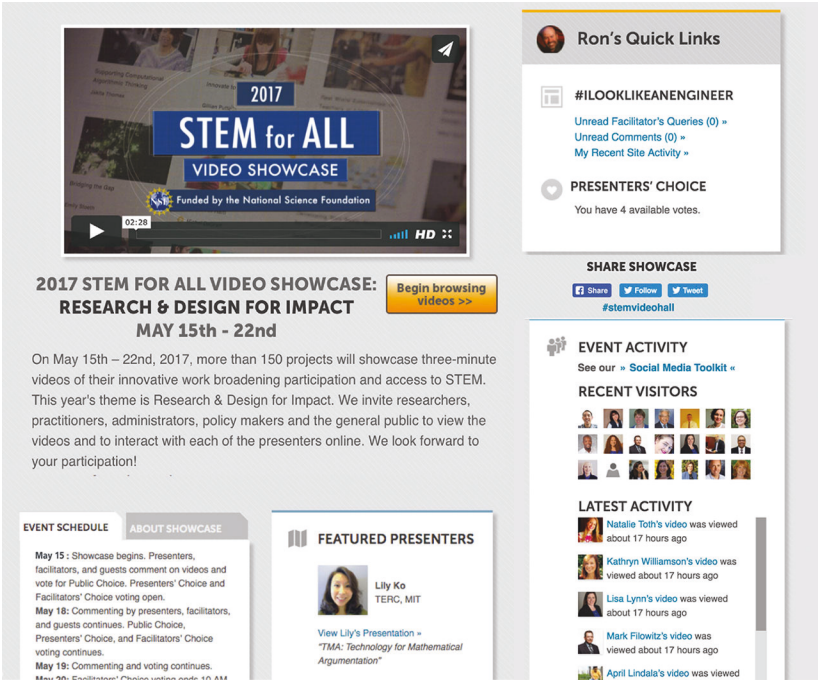
Figure 1. STEM for ALL Video Showcase, Home Page.

Main video grid page: The main video page provided thumbnail images of all 171 videos. In order to quickly locate videos of interest, users could use a text search or use the multiple filters provided. Filters included keywords, age/grade level, intended audience, resource center, funder institution, and state. (See Figure 2 below)
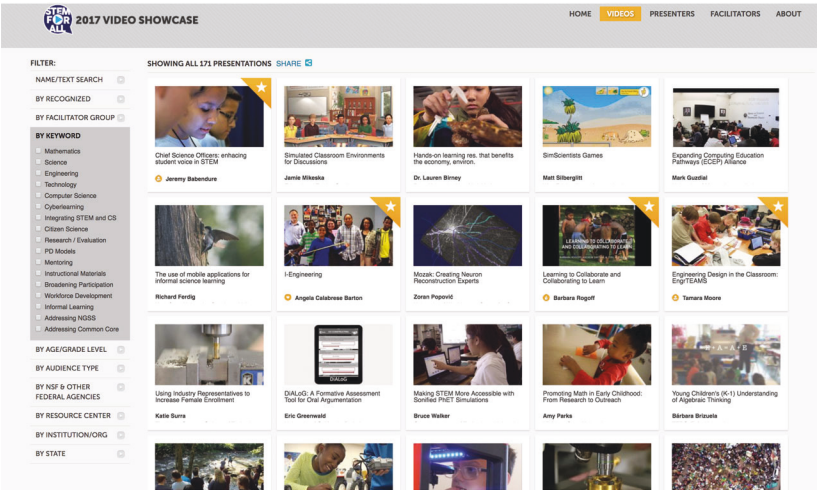
Figure 2. STEM for ALL Video Showcase, Main Video Grid Page.

Individual presentation pages: Once a visitor selected a presentation to view from the main video grid, they were directed to the individual presentation, which displayed the video, an abstract, and the discussion (see Figure 3). From this page, visitors were able to view the video and engage the presenters in discourse. The presentation page also displayed three or more "related videos" that were determined by a relevancy-ranking algorithm leveraging video transcripts and metadata. The related videos helped attendees to quickly locate additional videos of interest.

Figure 3. STEM for ALL Video Showcase, Individual Presentation Page.

Recognitions: Embedded structures to scaffold broad dissemination, discourse, and interactivity. The event included three types of presentation awards: Presenters' Choice, Facilitators' Choice, and Public Choice. As described below, these forms of recognition were instituted to reward excellence and to motivate different forms of interactivity.

Presenters' Choice: Presenters and co-presenters saw a customized view of the site that provided them with the ability to vote for four presentations that they thought were most creative in using video to depict an innovative project. Presenters were allowed to vote for their own but needed to vote for three other presentations as well for their vote to count. This encouraged presenters to navigate away from their own presentation page and it also gave presenters special status within the community to choose videos that they felt were most deserving of recognition.

Facilitators and Facilitator's Choice Award: Facilitators were chosen in advance of the event. These were recognized members of the community, who were known researchers, teacher leaders, or policy makers. Groups of three facilitators were assigned to 12 videos. Each facilitator was asked to view and to leave at least one comment on each presentation within their group. This ensured that each video would receive at least three comments or queries, effectively seeding the discussions so that others would join. Fa-

cilitators were coached in advance through webinars, as to how to engage presenters in discussions around their work in constructive, creative, and congenial ways.

Panels of three facilitators judged videos within their assigned group using an embedded online rubric. The rubric was visible only to facilitators, from each individual presentation page within their assigned group. At the end of the event, one video from each group was awarded the Facilitators' Choice award resulting in 19 such awards. This award was instituted to create a fairly objective way for all videos to be considered for excellence based on a common rubric (which was shared with all presenters before they created their videos). The rubric consisted of four items, each scored on a scale of 1-5. They were:

- Creatively uses video to share work with a large public audience.
- Provides an effective narrative that conveys the intervention, innovation, or research.
- Shares the promise and/or impact of the work (depending on the stage of the project).
- Contributes insights about broadening participation and/or improving access to STEM and CS learning experiences.

Public Choice Award: The public was invited to select presentations that they felt were most meritorious by voting on Facebook (*likes* and *shares*), Twitter, and through an online ballot. The Public Choice award encouraged presenters to engage in broad outreach to their own communities in order to invite them to visit the site and to view and vote for their presentation. As voting took place through Facebook, Twitter and online ballot, it disseminated the event through social media and brought thousands of visitors to the site. Visitors who came for a particular presentation were often drawn to view other related videos. This form of voting was very effective in achieving one of NSF's strategic goals to share NSF funded work with a broad public audience.

After the event: All videos and all of the discussions that took place during the eight day event remain available to presenters, researchers and the public at large. However, after the active event ended, visitors could no longer vote or post. Despite this, visitors continue to access the site every day.

RESEARCH QUESTIONS

1. What was the extent of participation that occurred during the STEM Video Showcase event? Given the multimodal environment, what were the different forms of interaction that took place? What subset of participants were most likely to engage in each?
2. What content and themes emerged from the discussions related to the video presentations?
3. What benefits did participants report as a result of their participation in the Video Showcase?

METHODS

The project utilized a mixed-methods approach, collecting both qualitative and quantitative data to address the three research questions stated above. Data was drawn from site-based Google analytic data, participant surveys, and the discussions archived on the site.

To address research question #1, we used Google Analytics and server-side analytic data to generate reports on the number of unique Video Showcase users, the location of users, types of interactions by role (i.e. presenter, co-presenter, facilitator, visitor/public), and the number of comments generated by role.

To address research question #2 we coded discussion posts associated with a stratified sample of presentations. The data corpus was divided into thirds based upon the number of discussion posts associated with each presentation (low number of posts/medium number of posts/high number of posts). The mean number of discussion posts for videos in the top third of the data corpus was 27.4. The mean number of discussion posts for videos in the middle third of the data corpus was 15. The mean number of discussion posts for videos in the bottom third of the data corpus was 9.6. Ten videos were then randomly selected from each group (low, medium and high) for additional coding and analysis of discourse content.

Through an inductive data analysis process, three researchers developed an initial set of codes that represented the range of topics present in the data (Miles, Huberman, & Saldaña, 2013). The researchers began this process by reading through and analyzing posts from seven presentations in the 2016 Video Showcase data corpus and noting common themes that emerged.

These themes formed our initial coding manual, which we then applied to the 2017 data corpus, adding new themes as necessary. The coding manual underwent iterative revisions, until a final set of categories was agreed upon by three researchers. Following agreement, a single researcher coded all discussion posts to see if they were pertinent to one of the categories. The researcher conferred with a second researcher when uncertain of the coding category and agreement was negotiated through this process. The majority of discussion posts (97%) fit into at least one of the categories. Posts that addressed more than one topic were coded into multiple categories.

To address research question # 3, benefits to participants, we conducted an online survey immediately following the STEM for All Video Showcase event. The survey contained both open and closed-ended questions, to better understand the user experience and the benefits, if any, derived from participation.

RESULTS

Research Question 1: What was the extent of participation that occurred during the STEM Video Showcase event? What were the different forms of interaction that took place? What subset of participants were most likely to engage in each?

Between May 15 and May 22, the STEM for All Video Showcase was viewed by over 29,000 unique users from 165 countries. The site continues to be accessed and videos continue to be viewed. As of Nov 1, 2018, there have been over 66,000 visitors from over 190 countries.
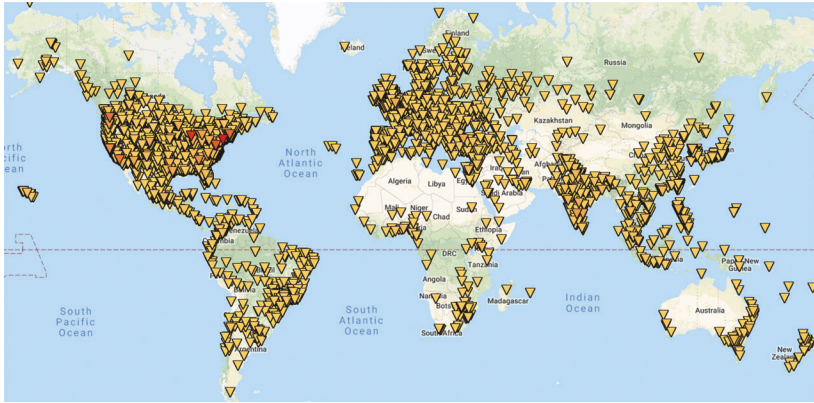
Figure 4. Map Displaying Origins of Site Visits.

Users of the site fell into the following categories: Presenters and Co-presenters, Facilitators, and all other attendees. (1) Presenters and Co-presenters (n=478), created the videos and responded to discussion posts on their presentations and voted for videos for the Presenters' Choice award. In large measure, the presenters self-identified as researchers or higher education faculty. (2) Facilitators (n=44), were recruited to represent well known researchers practitioners and policy makers. They were assigned to a group of 12 videos and were asked to seed conversation while setting a positive tone for the event. They also judged each presentation in their group on an online rubric to select the Facilitators' Choice award. (3) Other attendees (n= >28,000), the vast majority of site users, included researchers, K-12 teachers, administrators, STEM higher education faculty, graduate students, policy makers and the public at large. All attendees were invited to view the videos, vote for their favorites for a Public Choice award, and contribute to the discussion.

Visitors to the Video Showcase engaged in different ways. Most participants viewed videos and voted for their favorites. Many read the discussions, project abstracts, and followed links to additional resources or papers. A relatively small minority, 583 people, contributed to the discussions. Those who did, exchanged queries, and offered feedback, new ideas, and resources to each other. Below we discuss different modes of interacting with the site.

Viewing videos. During the 8-day period there were a total of 22,621 video plays. (Not all attendees viewed videos. Some came to vote or read the abstract or the discussion.) Video plays on individual projects ranged from 14 to 1,180, indicating that some videos were viewed far more times

than others. The average number of video plays per project video was 132. Of the total number of 22,621 video plays, 3,524 video plays were played by presenters, co-presenters and facilitators, and 19,097 by other attendees. Video viewing was the primary way for attendees to engage in the site. Videos are still being viewed daily.

Voting. The site offered three different types of voting (as described above). All visitors had the option of voting for the Public Choice award, via Twitter, Facebook or online ballot. A total of 16,561 public choice votes were cast during the 9 days of the event. Of these, 1,601 were cast via online ballot, 1,777 were cast via Twitter, and the remaining 13,183 via Facebook. We are not able to differentiate how many votes were cast by presenters vs. facilitators vs. other attendees, however given that there were over 16,000 votes, it is certain that this was a common way for attendees, even those who were not presenters or facilitators, to engage in the event.

Only presenters and co-presenters were permitted by the site to vote for the Presenters' Choice award. In total, there were 845 Presenters' Choice votes cast by 244 presenters and co-presenters (110 lead and 134 co-presenters). Fifty-one percent of presenters and co-presenters participated in this form of voting. Of these 244 people, 214 voted for presentations other than their own, showing that this form of voting encouraged presenters to leave their own presentation and view and interact with the presentations of their colleagues.

Only facilitators were able to determine those that would be awarded the Facilitators Choice award. They did so by scoring each video within their assigned group on an embedded online rubric.

Posting to the discussion. All participants in the Video Showcase were able to post to the discussions related to each video. Yet, while a high proportion of all site visitors viewed videos and voted, a smaller "core" community posted to the discussions. A total of 2,958 comments were posted to the discussions during the 8-day event. These were posted by 583 people: 44 facilitators, 155 lead presenters, 165 co-presenters, and 219 attendees. Whereas 100% of facilitators, 91% of presenters and 54% of co-presenters posted to the discussions, only <<1% of other attendees posted. (See figure 5). Instead, most attendees choose to view videos, read discussions, and vote for their favorites through online ballot, Facebook, and Twitter, and by doing so they shared the site with their collegial and social networks.
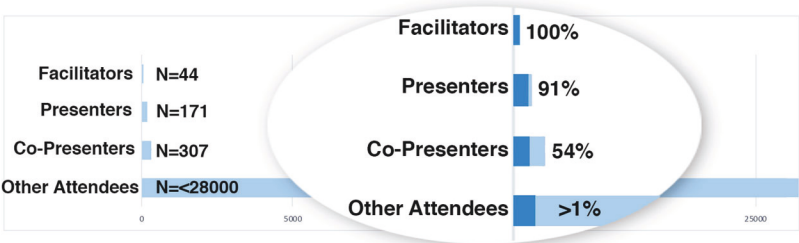
Figure 5. Contribution to Discussion Relative Number of Participants in each Role.

Figure 6 show a breakdown of the 2,958 discussion posts that occurred during the event. Approximately 47% (1,398) of comments were posted by presenters or co-presenters to their own presentation, with presenters posting more than co-presenters. An additional 13% (383) of comments were posted by presenters or co-presenters to presentations other than their own. Twenty-six percent (768) of comments were posted by facilitators and the remaining 14% (409) were posted by other site attendees.
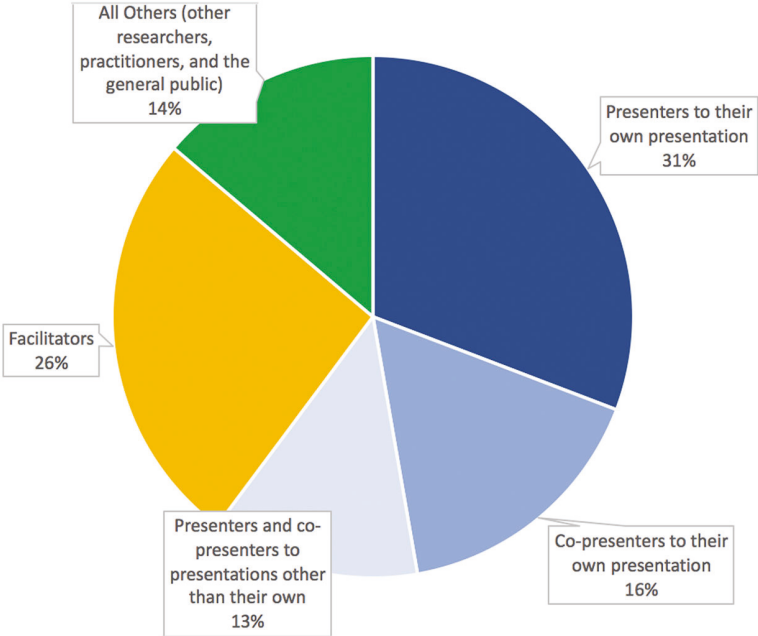

Figure 6. Constituencies that Contributed Discussion Posts.

The number of discussion posts per presentation ranged from 4 to 117, with an average of 17 comments per presentation. The average length of a discussion post on the STEM For All Video Showcase was 103 words, although posts ranged from 1 to 1,646 words. The fact that the average post was over a paragraph long suggests that the content of the discussions went beyond simple praise or collegial exchange. Rather, the posts represented dialogue between colleagues on a broad spectrum of topics of interest.

Research Question 2: What were the content and themes that emerged within the discussions related to the video presentations?

While video narratives shared project work, the discussions of each video provided participatory interchange between visitors and enabled the negotiation of meaning (Pea, 2007). It is critical to examine the discourse to understand the nature of the interchanges that took place. The discussions, which remain accessible to all, allowed for community interpretation, analysis, critique, and feedback. Below we categorize nine topics that emerged from our coding of thirty presentation discussions. They were: 1. Project Details; 2. Research and Impact; 3. Collegial Support; 4. Theory of Action; 5. Collaboration and Connections; 6. Resources; 7. Plans for the Future; 8. Challenges; and 9. Conceptual Framework.

Figure 7 shows the distribution of the 1,211 coded segments by topic. Of all these segments, 'project details' was discussed the most and 'conceptual framework' the least.
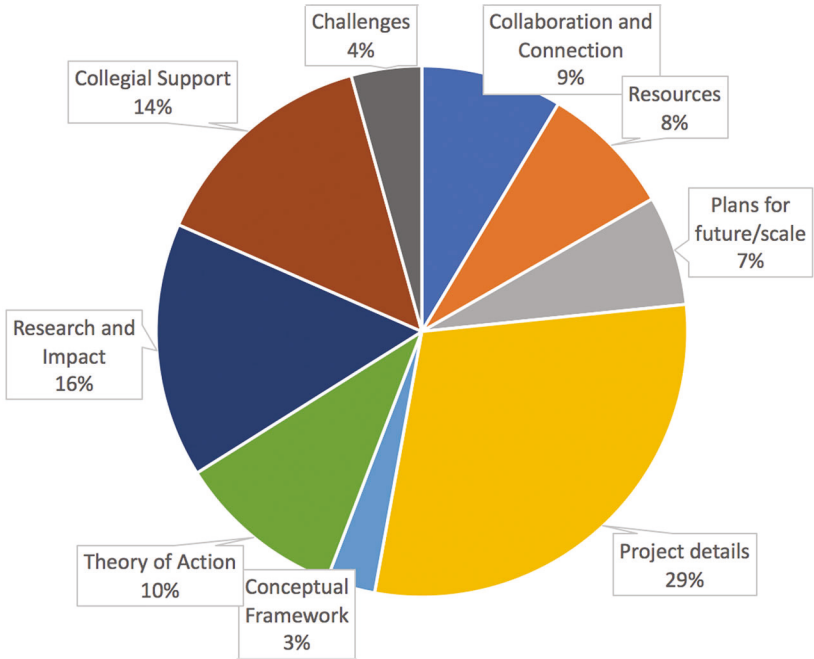
Figure 7. Distribution of Topics Addressed in the 30 Coded Discussions.

All of the above topics were discussed by each of the 30 project presentations analyzed (See Figure 8 below). The topics: 'project details,' 'collegial support,' 'research and impact,' and 'resources' were discussed by over 96% of project presentations analyzed. 'Plans for the future,' 'theory of action,' and 'collaborations' were discussed by more than 73% of project presentations analyzed. 'Challenges' faced was addressed by 63% of presentations and 'conceptual framework' was addressed by 47% of presentations. This shows that these topics were of interest across projects regardless of the number of posts per presentation.

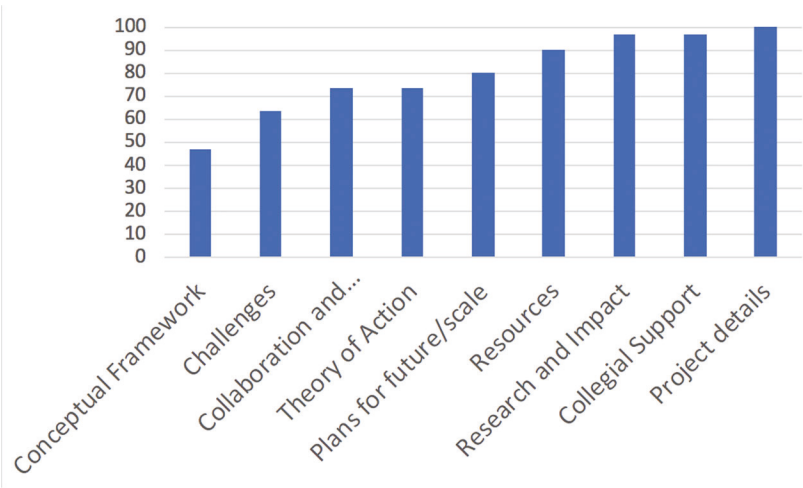**Figure 8.** Percent of Coded Presentations That Discussed Each Topic at Least Once.

Each of the coding topic categories is discussed in detail below:

1. Project Details. This category included the nitty-gritty of project work. It included discussions about participant recruitment and demographics, strategies for engaging participants, detailed descriptions of programs interventions and implementation, the project's design process, and descriptions of the roles that partners played on the project. An example of a post discussing 'project details' is shared below.

> The undergraduate curriculum modules… are aimed at the introductory undergraduate level... and were designed to be implemented in a 3 hour face-to-face lab setting with an instructor present to act as a facilitator. Knowing that the time it takes students to complete a module will vary by skill level, background knowledge, and the speed of their device, we have made suggestions to instructors that they might consider doing the Engage and Explore sections during class time and assign the Synthesize section as homework...

'Project details' was the most frequently discussed of all the coding categories. Each of the 30 projects discussed this topic. Twenty-nine percent of coded segments (357 out of 1,211 coded segments) included a discussion of 'project details.'

2. Research and Impact. This category included questions or comments related to measurement of impact, research methodology, and research dissemination. A sample exchange is included below:

> [Facilitator]: Do you have any evidence for
> how the program impacts students' career interest?
> [Presenter]: We have surveyed students after they engage in
> EiE units, and their attitudes towards engineering do become
> more positive. They are more likely to say that they would
> like to be engineers when they grow up. Our research summary page [URL] has some great data on this. You may also
> be interested in taking a look at our Engineering Interest
> and Attitudes survey [URL] to see how we arrived at those.

Of the 30 projects analyzed, 97% discussed this topic. This coding category was represented in 15.5% of coded segments (188 out of 1,211 coded segments).

3. Collegial Support. Comments coded within this category provided collegial praise and appreciation. A typical comment was "Thank you for this excellent resource. You've stimulated my thinking about how to support other genres of argumentation, and application in other disciplines!" Of the 30 projects, 97% had messages that expressed collegial support. 'Collegial support' was represented in 14.1% of coded segments (171 out of 1,211 coded segments).

4. Theory of Action. This category included questions or comments about pedagogical approaches, and the use of STEM to accomplish project goals. For example:

> [Facilitator]: …Saying that you are grounding in Common
> Core Mathematics and NGSS tells me about the content you
> are targeting but not how you are helping the kids go from
> having experiences to learning from their experiences. What
> does learning from their experiences look like? What is done
> in the activities themselves that fosters reflection on what
> they are doing and making sense? What kinds of reflective
> activities do you expect teachers to facilitate so that students
> learn from the activities?
> [Presenter]: In terms of sense making activities many of the
> ones currently in the curriculum are exercises that build the
> understanding/intuition about the engineering models…
> that they will need to develop to create and evaluate their

> designs. Here is an example. Students conduct a physical
> 3 point test to determine a material's strength (before break-
> ing) we use several types of material, several types of cross
> section, and several sizes. They get test results and while
> some trends are obvious there are some other results which
> are more difficult to make sense of immediately after the
> test. Then we have them conduct a 3-point test in EDISON
> to isolate independent parameter impacts… At the end
> of this process they are asked to examine and revise their
> conclusions from the physical testing with the mountain of
> virtual test data to support these conclusions…

Of the 30 projects, 73% discussed their theory of action. This coding category was represented in 10.2% of coded segments (124 out of 1,211 coded segments).

5. Collaboration and Connections. Comments in this category in-cluded those that noted connections or commonalities with other projects, or mentioned interest in connecting after the Showcase. For example:

> [Presenter]: Would be interesting to try and get CSOs [Chief
> Science Officers] out in Kenya. Is this something you would
> be interested to talk more about?
> [Attendee]: Sure this would be great! I need to connect you to
> our coordinator … to have further discussions with him! …

Of the 30 projects, 73% had posts that addressed 'collaboration and connections.' This coding category was discussed in 8.6% of coded seg-ments (104 out of 1,211 coded segments).

6. Resources. Posts coded in the 'resources' category included those re-questing or sharing resources related to project implementation or to related work in the field. For example:

> Be sure to take a look at our Wee Engineer webpage (http://
> eie.org/earlychildhood) and blog roundup (http://blog.eie.
> org/blog-roundup-early-childhood-education) to learn more
> about our development process and check out some videos
> of our youngest engineers in action.

Of the 30 projects, 90% requested or shared resources. This coding cat-egory was represented in 8.1% of coded segments (98 out of 1,211 coded segments).

7. Plans for the Future Posts in this category included details about how an intervention could be sustained or scaled up. For example:

> We are currently exploring scale with three groups in Southern Oregon, the Great Lakes Bay MI and St. Louis to develop CSO cabinets in their areas. We have an additional 8-10 groups also exploring the feasibility to develop a cabinet in their area. Overall, we are trying to keep core facets of the program consistent (election, curriculum objectives, support of CSOs) but find the regions are adapting on what they provide for training and what the CSOs do is dependent upon the area.

Of the 30 projects, 80% discussed this topic. This coding category was represented in 6.7% of coded segments (81 out of 1,211 coded segments).

8. Challenges. Codes in this category included any question or comment about a challenge faced by the project. For example:

> The strongest challenge was, by far, working with all aspects of a school system, from top administration to students and parents, which has a very strong tradition based on lecture and recall of facts. Our Egyptian counterparts and our USAID program officer had such a strong vision of the potential for this project, however, that we were able to overcome or work around this and other challenges.

Of the 30 projects analyzed, 63% discussed this topic. This coding category was represented in 4.3% of coded segments (52 out of 1,211).

9. Conceptual framework. This category included questions, and positive or negative feedback about the project's theoretical framework. For example:

> [Facilitator]: The video indicates how the work is grounded (to your credit!) in Self-Determination Theory. Can you say more about the choice of this referent? .....
> [Presenter]: Thanks for the question. We really liked the underlying assumptions of SDT-- how it is based on the assumption that all students have deep reserves of intrinsic motivation, and the job of educators to create learning activities that ignite and channel that motivation toward deep

learning. Too often students from ethnic minority and low income backgrounds are labeled as "unmotivated," which prevents us from thinking carefully about the nature of the academic work that we ask students to undertake. We found SDT very compatible with notions of culturally responsive pedagogy, which can provide guidance about creating learning environments (like SciLG) that promote intrinsic motivation for all students.

Of the 30 projects, 47% discussed this topic at least once. This coding category was represented in 3% of coded segments (36 out of 1,211 coded segments).

Research Question 3: What benefits did participants report as a result of participation?

Following the eight-day STEM for All Video Showcase event surveys were sent to lead presenters, to co-presenters, to facilitators, and to other attendees who choose to create a user account that provided an email address. The presenter survey had a response rate of 37% for lead presenters and 22% for co-presenters. The facilitator survey yielded an 80% response rate.

Participating in the Showcase was seen as a worthwhile experience. Ninety-six percent[1] of presenters, 100% of facilitators, and 97% of other attendees responded that participating in the STEM for All showcase was a worthwhile experience.

Ninety-six percent of responding presenters, 100% of facilitators, and 97% of other attendees reported that they would encourage a colleague to participate in a future showcase. Additionally, 93% of presenters, 100% of facilitators, and 100% of other attendees said they found something of interest to them in the videos they viewed (outside of their own).

Another indication of satisfaction with the experience was that 96% percent of presenters, 97% facilitators, and 97% of other attendees who responded to the survey indicated that they would be likely to participate in a future showcase. There were many comments indicating that the event was highly engaging and for many preferable to a face-to-face event. One presenter commented: "I think the interaction that this event provided was better than at any live conference I have attended." Another presenter opined,

---

1 Not all questions were answered by each survey respondent. Percentages were calculated based upon the number of responses for each individual question.

"As a presenter, the quality of engagement in the comments was very impressive. The opportunity to make virtual connections and learn from colleagues around the world is always worthwhile particularly when you can do so without physically traveling to a conference."

Participating in the Showcase yielded different kinds of benefits to projects represented. We discuss each of these benefits below:

A. Valuable dissemination tool. Ninety-two percent of presenters ranked the Showcase as 'good', 'very good', or 'excellent' as a dissemination vehicle for their work. Ninety-seven percent of presenters reported that they shared their videos with others. Most commonly they did so via email, Facebook, collegial networks, through their university or institution (e.g., institutional newsletter), or via Twitter. As the figure below suggests, presenters shared videos with diverse professional and personal audiences.
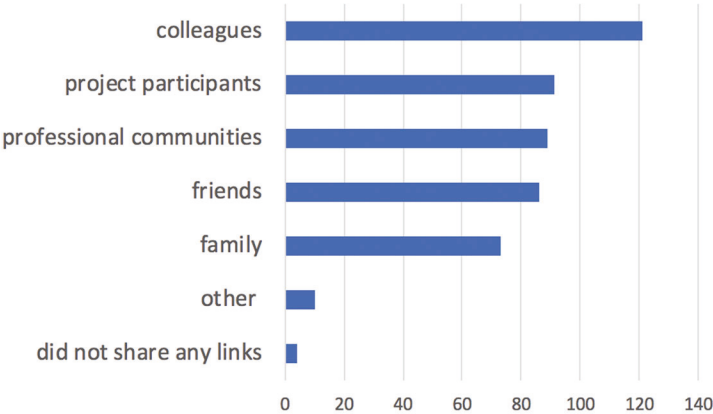

Figure 9. Number of Presenters Who Reported Sharing their Video with Different Audiences.

B. Valuable feedback on project work. The discussions that took place were an integral and very important aspect of the Video Showcase. These discussions shared details about the work, such as how project participants are recruited and motivated to participate, details about the curricula, details of creating apps or designing interventions, discussions of theoretical and conceptual framework, and information as to the how the impact of projects were being measured. Often such details were not present in the video itself. Presenters reported that they found the discussions of their videos to be of interest to their projects, providing an average rating of 3.9 out of 5 (on a scale from 1-5, where 1 is "not at all interesting", 3 is "somewhat interest-

ing", and 5 is "very interesting").

In many instances, this caused project staff to reflect about the development of their work in the future. One presenter wrote:

> We got a sense of what other people value and find interesting, so perhaps it gave us a big of a push for what a subsequent spin-off project might be... and the comments seemed reminiscent of what we might hear as feedback in the publication process at some point. So, it is helpful to have those questions/insights now in order to explain better, or provide supporting information around those areas of concern or interest.

C. New ideas and resources that were valuable to the project. Sixty-four percent of presenters reported that the Showcase provided them with new ideas or resources useful to their work. This indicates that the showcase has the potential to improve project work while it is still developing. One presenter commented "I saw examples of how PD is facilitated in other projects that may translate into future work that we do….." Another presenter wrote:

> I viewed a video highlighting a STEM Agriculture High School. This connected directly to the work we are currently doing in our community working to address agricultural needs via human-centered robotics technology with middle school students. I was inspired by the video, and it led me to several online resources.

D. New contacts and possible future collaborations. Forty-five percent of presenters reported that the Showcase provided new contacts or possible future collaborations. This is an indication that the showcase has the potential to enrich partnerships and to influence the development of future proposals. One presenter wrote : "Our video was widely viewed and we've had several teachers and administrators contact us via email expressing interest in working with us." Another commented, "We received suggestions of multiple organizations and contacts … as well as some organizations developing products … all of whom might be potential collaborators in the future."

E. Reaching new audiences interested in becoming involved with the project or in using or adapting their work. Fifty-three percent of presenters surveyed responded that participating helped them to reach new audiences interested in their work. One respondent commented: "I found people

in K-12 spaces that wanted to use my work, so it served as a networking event." Another reported "It was exciting to hear people wanting to use our curriculum, and asking how they can get ahold of it, or participate." This has important implications for how projects can potentially scale their projects for greater impact.

F. Learning about the work of others. Many presenters wrote that the Video Showcase was valuable in that it allowed them to learn about related work in the field. One presenter commented: "The videos, especially when gathered together, are a really wonderful way to see what's happening in a way that reading everyone's research papers wouldn't allow for!" Another wrote: "The focused time period to interact with colleagues, and to view the videos of other projects, was a great way to see what else is out there, and to reflect again on our research…"

G. Value to projects of creating a video. Ninety-five percent of presenter respondents said that producing the video was a worthwhile investment of project time. One presenter commented: "It teaches you about what it is you truly value in your project when you have only 3 minutes to tell the world about it." Another presenter wrote: "Putting together a video to tell the story of our project was in itself valuable as a way of reflecting on the important elements of the project. The Video Showcase was a great way to disseminate our project, both internally at our institution, and to external colleagues."

While most projects reported producing the video specifically for the STEM for All Showcase, 92% reported plans to reuse their video for other purposes and several reported that their video is already up on their project website.

DISCUSSION

The STEM for All Video Showcase is an example of a multimodal environment in which various modalities combined and interacted to convey different quantities and qualities of interaction (Lemke 1998). The Showcase supported multiple levels of participation and engagement from a wide range of constituencies. The paper presents the extent and forms of participation that occurred during the event, as well as how different attendees participated. It explores the content and themes discussed in conjunction with the videos, and the benefits reported as a result of participation.

The success of the event was influenced by design decisions and also an understanding of community structures. Both are critical to take into account when trying to adapt or recreate a similar multimodal environment

that fosters extensive interactivity.

Design decisions: Design matters. It subtly nudged participant behavior (Thaler and Sunstein 2009) in essential ways that contributed to the success of the event. Embedded design features influenced the extent of presenters' outreach and the resulting number of visitors who attended as a result. Design influenced how attendees navigated through the site, how many videos they viewed, and how they interacted with one another. Design decisions influenced the tenor of the discussions on the site as well as extent of the collegial exchange that took place. Embedded design features such as Public Choice, Presenters' Choice, and Facilitators' Choice "nudged" the behavior of those who participated to interact with one another. Below we detail some of these design decisions and their impact

Design decisions affected reach of the event: It is unusual for an academic interactive site to attract tens of thousands of people in an eight-day online event. The design decision to create the Public Choice award and the associated voting though social media, was critical to the event's success in attracting the large number of attendees.

The Public Choice award motivated presenters and co-presenters interested in being recognized to ask their colleagues, friends, and family to vote for their presentations. Presenters and co-presenters reached out to their contacts and professional communities by broadcasting the event through their email, collegial networks, blogs, personal websites and university publications. As Public Choice voting was done largely through Facebook and Twitter, it spread the word from presenters and co-presenters to their friends and followers, and then exponentially to the friends and followers of those who voted on social media platforms. Visitors who came to a specific presentation to vote often viewed several "related videos" that featured on that presentation page. This sustained and deepened their participation. While the vast majority of visitors may have been hesitant to post to the discussions they did share their favorites with others through social media, magnifying the reach of the Video Showcase.

Design affected the tenor and depth of discourse: While the 171 videos provided shared visual artifacts, meaning was further interpreted and negotiated through the facilitated discussions that accompanied each presentation. The multiple modalities, (e.g. video sharing, mediated discourse, voting) within a rich social environment, contributed to a transformative learning experience (Pea, 2007).

Over the eight day event there were 2,958 posts. They tended to be thoughtful, reflective, and quite lengthy averaging 103 words per post. Those who run discussion forums know that it is hard to get discussions

started and harder still to sustain them. A pivotal design decision was to engage 44 facilitators to seed the discussions in the first two days of the event and also to encourage presenters to post a welcoming message. In pre-event webinars both facilitators and presenters were offered tips for writing probing yet respectful posts. The webinars discussed the importance of creating a sense of trust, and of the importance of posts that created an opening for others to join in the conversation. It takes some "nudging" to get people to post at all, and there is reticence to be the first one to post to a discussion. The seeding of the discussion by facilitators and presenters early in the event helped in this regard. The Facilitators' Choice award also motivated presenters interested in receiving this award to take the facilitator comments seriously and to answer them in depth.

The tone of the posts was often academic and this might have inhibited peripheral visitors from joining in. Yet on the flip side, researchers found the discussions to be interesting and insightful. Discussions included posts on the theory of action, how to scale projects in the future, and how to measure impact. They shared challenges encountered and conceptual frameworks used. They identified new collaborators, shared resources, and provided collegial support. Last but certainly not least, they discussed many, many, project details. The category 'project details' included how one negotiates roles with partners within a project, recruitment challenges, strategies to engage participants and other posts related to managing a project. In the sharing of project details researchers and practitioners shared "wisdom of practice" (Shulman 2004) and "craft knowledge" (Grimmett and MacKinnon 1992) with each other.

Projects presented in the Showcase are often works in progress, suggesting that project staff are actively thinking through details and are eager to share, and hear feedback from, different potential audiences of their work. This sort of exchange is valued in professional conferences (Rowe 2018, Illic and Rowe 2013), and studies have provided evidence that such exchanges alter the course of research projects (Garvey et al. 1972, Lacey and Busch 1983). Yet the design of face-to-face conferences often limits and circumscribes such collegial exchanges (Rowe 2018, Rowe and Ilic 2015). A rich online, environment with shared video narratives and facilitated discourse, allowed for such conversations to take place without the constraint of allotted conference session time. It allowed presenters to share the backstory and the details of their intervention. It also invited peripheral participation that enabled novices to benefit at levels of agency and risk that they judged appropriate.

Design decisions that motivated presenters to interact with each other: The presenters and co-presenters were understandably most interested in posting and responding to posts on their own presentations. Yet it was critical to motivate presenters to leave their own page in order to interact and post on their colleagues' presentations. The creation of the Presenters' Choice award (and related voting) effectively provided a "nudge" for presenters to interact with each other. The Presenter Choice voting rules were that presenters could vote for their own presentation (acknowledging the natural interest to promote one's own work) but needed to vote for three other presentations for their vote to count. Eighty-seven percent of presenters who voted for their own presentation also voted for presentations of their colleagues. While doing so they viewed, commented, and provided feedback to other presentations, enriching and fueling the discourse.

Community structures: Our research sheds light on the extent and nature of participation in an online multimodal event devoted to sharing videos and discourse on innovations in STEM education. The Video Showcase was successful in attracting 29,000 unique visitors from 165 countries to the site within an 8-day period. Participation on the site was stratified, with the content on the site produced by a group of 697 people who either submitted the 171 video presentations, or contributed discussion posts during the eight day event. Yet the multimodal environment provided a variety of means for all other attendees to interact. The vast majority of the attendees viewed videos, read abstracts and discussion posts, and participated in 'public choice' voting on Facebook, Twitter or online ballot.

At the core of our community were researchers and practitioners who presented work funded by six programs within the Directorate of Education and Human Resources (EHR) at the National Science Foundation. These programs were each affiliated with NSF funded resource centers who encouraged projects within their center to present. Further afield were presenters of projects of 24 other programs, funded by multiple directorates within NSF. These presenters heard of the event through word of mouth or by visiting past Video Showcases. Further still were presenters of projects funded by six other federal agencies including ED, IMLS, NASA, NIH, USAID, and USDA. From there site participation grew to include many attendees loosely affiliated with presenters and the programs showcased. They included friends, colleagues, teachers, administrators, policy makers, aspiring researchers and the public at large. We suggest that the pattern of engagement evident in the Video Showcase can be understood with reference to Lave and Wenger's "communities of practice" (CoP; Lave and Wenger 1991), with the community of researchers and practitioners funded by NSF

to improve STEM teaching and learning at the 'core', and other researchers, practitioners, policymakers, and the general public in the periphery of the community.

It is plausible to conjecture that the continuum from read/view, to voting/sharing online, to posting a comment, to participating in a multiple-turn thread of conversation, represents (at least for many participants) a gradient of interest, self-confidence, and perceived expertise within a loosely defined community of practice engaged in STEM education research. Reading an abstract or discussion or viewing a video is a private, rather than an expressive act, and requires relatively little claim or self-perception of expertise within the community's practice. The expressive practice of voting (liking, sharing) through social media is also relatively low risk from this point of view. Posting a single query or comment requires more confidence, as the post, associated with one's name and archived on the site, is a move claiming membership in the CoP's conversation. Participating in a multi-turn conversation thread moves the participant closer to the core of expertise in the community, within which there are increasing possible levels of authoritativeness — as evidenced, for example, in conversations in which a participant adopts a "mentor" tone.

The multiple modalities (expressive and receptive) have the potential to mediate different kinds of participation, from periphery to authoritative core. Different modalities enabled participants to engage at various levels of agency. Moreover, there was no barrier preventing those who began at the periphery from moving towards more in-depth, expressive, and identified participation, as a result of the learning that took place during the event. Indeed, 38% of those people who posted during the event (and 14% of all posts) were contributed by those who were neither presenters/co-presenter or facilitators.

CONCLUSION

The goal of the STEM for All Video Showcase was to share project work in a novel and accessible format while also stimulating discourse that would improve ideas, increase researcher capacity, and advance the field and its impact. Further, it aimed to disseminate a corpus of work to multiple communities interested in STEM education. Doing so successfully relied on a deep knowledge of communities of interest, as well as the careful design of features that enabled all visitors to interact according to their level of comfort. The Video Showcase benefitted the general public who viewed and interacted with funded programs intended to improve Science,

Math, Technology, Engineering and Computer Science education. It also filled unmet needs in the research community. Video Showcase presenters and co-presenters learned of related work in the field which they had not previously encountered. They communicated with colleagues and multiple other communities, and received valuable suggestions, resources and feedback on their work. Finally, they identified potential new collaborators for future projects, and reached new audiences interested in using or adapting the programs, curricula, tools, and resources that their projects generated.

References

Abelson, P.H. (1980). Scientific communication. *Science, 209*, 60-62.

Brod, S. (2014, September 4). The importance of science communication [Blog post]. Retrieved from http://blogs.nature.com/naturejobs/2014/09/04/the-importance-of-science-communication/.

Carter-Thomas, S., & Rowley-Jolivet, E. (2003). Analysing the scientific conference presentation (CP). A methodological overview of a multimodal genre. *ASP, La Revue du GERAS*, 39–40, 59–72.

Darzentas, N., Goldovsky, C., Ouzounis, K., Karapiperis, K., & Karapiperis, C. (2007). Science communication media for scientists and the public. *EMBO Report*, 8, 886-887.

Falk, J., Lee, S., & Drayton, B. (2009). Structuring a virtual conference to facilitate collaboration and reflective discourse. In J. Falk and B. Drayton (Eds.), *Creating and sustaining online professional learning communities* (pp. 175-202). New York, NY: Teachers College Press.

Falk, J., & Stroud, R. (2013, April). *Designing an online video competition to promote professional development, mentoring, public engagement, and collegial discourse.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Garvey, W.D., Lin, N., Nelson, C.E., & Tomita, K. (1972). Research studies in patterns of scientific communication: II. The role of the national meeting in scientific and technical communication. *Information Storage and Retrieval, 8*, 159-169.

Grimmett, P.P. & MacKinnon, A.M. (1992) Craft Knowledge and the Education of Teachers. *Review of Research in Education*, *18,* 385-456.

Ilic, D. & Rowe, N. (2013). What is the evidence that poster presentations are effective in promoting knowledge transfer? A state of the art review. *Health Information and Library Journal. 30*(1), 4-12.

Lacey, W.B. & Busch, L. (1983). Informal scientific communication in the agricultural sciences. *Information Processing & Management, 19,* 193-202.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Lemke, J. L. (1998). Multiplying meaning: Visual and verbal semiotics in scientific text. In J.R. Martin & R. Veel (Eds.), *Reading Science: Critical and
    functional perspectives on discourses of* science (pp. 87-113). London:
    Routledge.

Lemke, J.L. (2012) Multimedia and Discourse Analysis. In J.P. Gee & M. Handford (Eds.), *The Routledge Handbook of Discourse Analysis* (pp. 79-89).
    London: Routledge.

León, B. & Bourk, M. (2018). *Communicating Science and Technology Through
    Online Video: Researching a New Media Phenomenon*. London: Routledge

Liang, X., Yi-Fan Su, L., Yeo, S., Scheufele, D., Brossard, D., Xenos, M., Nealey, P., & Corley, E. (2014). (Scientists) communicating science in new media environments. *Journalism and Mass Communication Quarterly, 91,*
    772-779.

Miles, M., Huberman, M., & Saldaña, J. (2013) *Qualitative data analysis: A
    methods sourcebook*, 3rd. Ed. Thousand Oaks, CA: Sage.

Nielsen, K. H. (2012). Scientific communication and the nature of science. *Science and Education. 22*(9), 2067-2086.

Pasquali, M. (2007). Video in science. Protocol videos: The implications for research and society. *EMBO Report, 8,* 712-716.

Pea, R.D. (1994). Seeing What We Build Together: Distributed Multimedia
    Learning Environments for Transformative Communications. *The Journal
    of the Learning Sciences, 3* (3), 285-289.

Perry-Smith, J., & Mannucci, P.V. (2015). Social Networks, creativity, and Entrepreneurship. In C.E. Shalley, M.A. Hitt, & J. Zhou (Eds.), *The Oxford
    Handbook of Creativity, Innovation, and Entrepreneurship* (pp. 205-224).
    New York: Oxford University Press.

Pritsker, M. (2013). Video saved the scientific publication: how visual materials
    and methods can save scientists time and money. *Scientist*, 27. Retrieved
    from https://www.the-scientist.com/opinion/opinion-video-saved-the-scientific-publication-38419.

Rowe, N. (2018). "When you get what you want, but not what you need": The
    motivations, affordances, and shortcomings of attending academic/scientific
    conferences. *International Journal of Research in Education and Science
    (IJRES), 4*(2), 714-729.

Rowe, N. & Ilic, D. (2015) Rethinking poster presentations at large-scale scientific meetings — is it time for the format to evolve? *FEBS Journal, 282,*
    3661-3668.

Rowley-Jolivet, Elizabeth. 1999. The Pivotal Role of Conference Papers in
    the Network of Scientific Communication. *ASP: La Revue du GERAS* 23-
    26:179-96.

Shulman, L.S. (2004) *The wisdom of practice: Essays on teaching, learning, and
    learning to teach.* San Francisco: Jossey-Bass.

Smith, S. U., Hayes, S., & Shea, P. (2017). A critical review of the use of
    Wenger's Community of Practice (CoP) theoretical framework in online
    and blended learning research, 2000- 2014. *Online Learning, 21,* 209-237.

Star, S. L, (1999) The Ethnography of Infrastructure. *American Behavioral Scientist*, 43, 377-391.

Thaler, R.H. & Sunstein C.R. (2009) *Nudge: Improving decisions about health, wealth, and happiness.* London: Penguin Books.

Wenger, E. (2004). Knowledge management as a doughnut. *Ivey Business Journal*, January/February; 1-9.

Authors Note: