Convergent Learning from Divergent Perspectives: An Executive Summary of the Pilot Study

Mrs. Renee Rigrish Pelan, The Ohio State University

Renee Rigrish Pelan is an Engineering Education graduate student at The Ohio State University. She is working on the AISL grant as a Graduate Research Associate under Dr. Rachel Louis Kajfez. She holds an M.S. degree in Industrial & Human Factors Engineering and a B.S. in Industrial & Systems Engineering from Wright State University. Her research interests include diversity in engineering, teaching methods, and informal learning environments.

Tylesha D. Drayton, Ohio State University

Tylesha D. Drayton, EIT is pursuing a PhD as a graduate student in the Engineering Education Department at The Ohio State University. She earned a BS in Civil Engineering, a MS degree in Environmental Engineering, and a MS degree in Engineering and Public Policy from Carnegie Mellon University. Her research interest includes engineering education, student entrepreneurship and innovation, culture and identity, makerspaces and technology-assisted learning.

Dr. Rachel Louis Kajfez, The Ohio State University

Dr. Rachel Louis Kajfez is an Assistant Professor in the Department of Engineering Education at The Ohio State University. She earned her B.S. and M.S. degrees in Civil Engineering from Ohio State and earned her Ph.D. in Engineering Education from Virginia Tech. Her research interests focus on the intersection between motivation and identity of undergraduate and graduate students, first-year engineering programs, mixed methods research, and innovative approaches to teaching.

Julia Armstrong, The Ohio State University

Julia Armstrong is the Director of the OHI/O Informal Learning Program at the Ohio State University (OSU). She combines engineering (BS ECE), public teaching of gifted education (M.Ed.) and industry experience (PMP, CSM) to grow the offerings and strength of the program and build rapport with the industry partners. She uses her diverse interests and skills to bridge the gap between curricular education and skills of the working professional. In 2018, Armstrong was part of a multi-disciplinary team from Ohio State to receive a 3-year NSF award for Advancing Informal STEM Learning.

In her two years at Ohio State, Armstrong designed and partnered on a wide variety of educational events for students to explore through active learning experiences. She focuses on current trends and connecting students to industry representatives, emphasizing open-ended problem-based learning, encouraging students to continue exploration of topics and challenges of interest. Armstrong has grown the OHI/O Informal Learning Program from a few events to two dozen, now serving over 1,200 students annually, including several K12 outreach events.

©American Society for Engineering Education, 2020

Convergent Learning from Divergent Perspectives: An Executive Summary of the Pilot Study

Introduction

Science communication is an important issue as our global society continues to grow [1] .While most researchers are comfortable conveying their findings to their peers, especially within their discipline, through publications and conference presentations, there is room for improvement when communicating scientific discovery to the general public. Communicating with the general public requires knowledge of the audience and engagement techniques that are not always needed when faculty present to a room of peers. Additionally, these skills are typically not taught in graduate school. While efforts have been made to support faculty in this type of dissemination through professional development, most faculty remain underprepared for such endeavors [2] This lack of preparation may cause faculty to minimize their scientific impact if they avoid presenting in these types of settings as these settings are rich opportunities to share knowledge and spark an interest in STEM in non-academics. Since there is a pressing need for both stronger public engagement with science and improved communication of science [3], we set out to develop a collaborative program that connects and prepares researchers from divergent science, technology, engineering, arts, and mathematics (STEAM) disciplines to creatively and effectively communicate science around convergent themes to public audiences of varying ages.

Theoretical Framing

To better understand the impact our program had on faculty, we framed our work in the Longitudinal Model of Motivation and Identity (LMMI) [4]. The LMMI brings together Self-Determination Theory [5], [6] and Possible Selves Theory [7], [8] so that motivation and identity development can be studied simultaneously. This provided a rich lens to not only understand the impact of the program holistically but to also understand how specific individual elements of the program have an impact on individuals.

Previously the LMMI was used to investigate graduate teaching assistants' motivation for teaching and identity development as teachers [4]. Since the model was previously used in a context dependent situation, we believe it could be used as a lens for this program which is also very context dependent. Specifically, the LMMI will allow us to understand how faculty develop their researcher identity and motivation to engage with the public.

Methods

This program involves multiple stakeholders and participants. For this paper, we are focusing on the following: faculty participants, the settings in which they engage with the public, and initial findings from our pilot cohort. Future work will describe the other cohorts and main takeaways from the program.

Researcher Selection

In Fall 2018, a survey was distributed to university faculty to gauge interest in participating in the program and to collect baseline data on their attitudes towards research and public engagement. A section of the survey was developed based on a pre-existing instrument by the FINS/RIESS project team [9]. The original instrument was used to examine how post-PhD researchers view themselves as researchers as well as their feelings towards research and the research community [9]. Questions were adapted from this survey to apply to faculty members in our context.

Survey questions asked about the researchers' engagement with research and their current research community. We related these items back to Self-Determination Theory. These questions were scored on a 7-point Likert-style scale. The researchers were also asked to answer open-ended questions to give researchers' the opportunity to elaborate about how they viewed themselves as a researcher, their current research, and the challenges they have faced as a researcher. These questions connected to Possible Selves Theory. Finally, the survey also gathered demographic information as well as polled the researchers about their interest in various themes (i.e., convergent general topics of focus in the program).

In order to select participants for each cohort, the project team met and ranked the researchers based on their survey responses. The responses to the questions about researcher engagement and research community were analyzed using descriptive statistics to aid in the ranking. Of these responses, participants who rated higher levels on research engagement and responded positively about their research community were considered by the project team; however, the team also aimed for diversity in approaches. The researchers' field of study was taken into consideration as well in order to have a cohort from divergent perspectives (we focused on all disciplines in STEAM making sure we had at least one arts (music, dance, theater, etc.) member in each cohort). The project team considered how participants and their research related to the selected themes as well. The research team also prioritized participants who were earlier in their careers at the university due to a recent hiring initiative that focused on interdisciplinarity. The project team discussed their preferences and selected researchers to participate in each cohort. The pilot cohort, which is the focus of this paper, initially included four researchers; however, one researcher had to withdraw from the program so the pilot cohort included three faculty participants, henceforth referred to as "participants".

Training

Once participants were selected and committed to the project, a training session was scheduled for the pilot cohort. Two 4-hour training sessions took place at our local science center, COSI [10]. The training sessions gave an introduction to informal learning and how to better communicate research to the community. Strategies included how to incorporate visuals, objects, demos, or hand-on activities into research presentations. The trainer engaged each researcher and provided personalized feedback about strategies to better present their research to the public during the upcoming treatments of the program.

Treatments

Following training, the pilot cohort participated in a series of 'treatments' to demonstrate their academic expertise by communicating to a public audience. Each participant considered their material against the setting and audience to identify the content and method for engaging the public. The three settings (STEAM Galleries, COSI After Dark, and High School I/O) and two presentation modes (individual or collaborative) that make up the treatments are presented below.

In the first setting, the STEAM Galleries [11], the cohort member presents an element of their research that aligns with the cohort's provided theme to a seated, attentive audience. The event audience is generally well-educated, adults, and some older children. The connections between presentations is minimal, related only to the given theme. In this setting both individual and collaborative presentations are given.

The second setting, COSI After Dark, is an event for adults only (21+), where the audience will walk through the COSI science museum on their own path and schedule, visiting current exhibit spaces and a large variety of tables set up by COSI specifically for this event. A portion of the audience will walk by various tables, and some will stop at select tables for a talk, engaging activity, or discussion. Energy is high as the museum offers a cash bar and catering options, and the event draws a crowd of mostly young professionals. Each study participant hosts an individual table at the event and is able to talk with small groups of museum guests who pass by. After the individual table presentation event, participants present at a collaborative table during a subsequent COSI After Dark event.

The third setting is an annual high school hackathon, High School I/O, hosted by the university through the OHI/O Program [12]. Preparation for the event requires participants to spend several hours working together to identify a convergence of their research areas on a theme or topic, and generate a problem statement where a solution may weave their areas together in the final product. The problem is carefully worded and then presented by the participants to approximately 80 high school students from Columbus, Ohio's greater metropolitan area who partake in the one-day hackathon. There is no individual component to this setting.

Data Collection

Multiple forms of data collection were used. For this paper, we will focus on the interview data which was collected. Each is detailed below and follows IRB approved procedures.

Onboarding/Exit Interviews

Before the training and treatments, an onboarding interview was conducted to establish a baseline for each participant to understand how they viewed themselves as researchers and what motivated them to share their research with the public. A similar exit interview took place one month after the end of all presentation to understand what elements of the experience resonated most with the participants and to better understand their personal development. Both of these interviews were guided by the LMMI [4] and included personally tailored questions based off of

open-ended questions from the recruitment survey data (for the onboarding interview) and experience within the program (exit interview).

Pre/Post Event Interviews

Before and after the participants presented in each treatment, they were interviewed for 5-10 minute to establish a snapshot of how they were feeling about the public engagement presentation. These interviews gathered real-time information about the impact of these presentation on their motivations.

Coding Process

After interview data for the pilot cohort was collected, interviews were transcribed and coded using an initial coding approach [13]. Based on the research questions, we made sure to be aware of concepts regarding, motivation, identity, collaboration, increased or decreased interest in collaboration or engaging the community, and communication techniques. The transcripts were initially randomized to ensure that we looked at each individual interview rather than assessing for trends or connections either by event, participant, or chronological order Our coding was used to develop a codebook for future use. The interviews were evenly divided among two researchers. Dedoose was used for initial coding of the interviews. Once all interviews were coded, all codes were exported to Excel where the researchers coordinated to merge similar codes, and create primary code categories, and sub-codes [13]. We iterated on the codes to create consistent terminology and encompass all the codes and concepts we saw during our initial coding. providing As a final step, definitions for each code were provided. However, as we are still in the process of analyzing the pilot cohort, the codebook may grow as new themes are discovered in the interviews.

To test the codebook, the researchers swapped the randomized interviews and used only codes from the codebook. The “blind coding” functionality in Dedoose was used to ensure that the researchers were not influenced by the prior codes. The codes from both researchers were compared line-by-line to ensure that the researchers agreed on codes. Any mismatches were discussed and one code was assigned. To date, we have begun the analysis on the pilot cohort. For the remaining pilot cohort interviews, the finalized codebook will be used to help us establish reliability between project team members when coding transcripts. The codebook also acts as a resource to project team members while coding new interviews to apply common themes that have been previously defined and provide structure to the process.

Pilot Results

Once the codebook was created, we looked across codes and began to develop themes [13]. Overall, we had three initial themes emerge from the pilot. As we continue analyzing future cohorts, we expect the themes to evolve and for more to be developed.

Impact of Training

The first theme that emerged involved the impact of training on presentation and communication techniques. This theme included reflections on how the participants changed their presentation or how they communicated with the public. Some examples of this theme included participants talking about how they planned their presentation or how their presentations and communications were received by the public.

> "I was thinking about a slide presentation. But after Monday's training I realized that's probably not a good idea." – Alena

> "I definitely was trying to think about how to engage in a way that makes people think about their personal lives, and examples, and pull in some of those pieces." – Kacey

> "So I decided to put up 4 pictures that look like they are not connected in people's eyes, but they are actually connected." – Kacey

In these quotes, both Kacey and Alena were reflecting on how they prepared for their first presentation to the public at the STEAM Galleries. Alena mentions how she originally thought of reusing a slide presentation but realized she needed to change her strategy based on the environment at COSI After Dark. Kacey mentions how the training from COSI not only changed the content of her presentation by finding ways to relate to the audience but changed the format of her presentation to engage the audience. She chose to present four pictures on a slide to have the audience at the STEAM Galleries reflect upon the connection instead of her original plan of having text explain her research and the type of connection.

Another participant stated his strategy to engage an audience at a table at COSI After Dark, as it was different from giving a presentation to a seated audience at the STEAM Galleries.

> "I asked them a couple questions to hook them last time, and now I'm letting them do about half the talking sort of thing. That seems to keep them engaged." – Jack

This quote illustrates how Jack reflected on how he engaged the audience after presenting at COSI After Dark. He mentions how he used a "hook" to grab the audiences' attention as they walk by his table, which was a strategy mentioned in the COSI training. Once he uses his "hook" about his research with the audience, he engages them in a conversation in order to have a deeper conversation about his research.

Interdisciplinary Collaboration

The next theme concerned instances of interdisciplinary collaboration. This was where the participants would acknowledge the challenges to incorporate their divergent research topics into the convergent theme. An example of this theme includes this excerpt about coming up with a challenge for the High School I/O hackathon challenge.

> "There's no way you can come up with something, you know to accommodate all three of us. So, I guess because my business at least wearables relate to medical applications. The first thing that triggered my mind was maybe we can combine others and that Kacey is doing wearables and then talking and talking I think we found out the smart way to incorporate Jack's research so the environment. And at the end, surprisingly, we came up with a really good challenge. So, yeah, I'm really excited." – Alena

Alena was talking about the process of coming up with a convergent challenge that would fit in all of their divergent research topics. During this meeting, Alena mentions the challenge of finding a way to incorporate everyone's research into a hackathon challenge prompt for High School I/O. There was a discussion on how everyone's research topics connected, and Alena mentions how the group first made connections with Kacey's and her research. The participants then incorporated Jack research into the challenge. Although the group faced an initial hurdle of finding connections in their research, Alena expressed her excitement once they successfully created a challenge for High School I/O.

Educator and Mentor Identity

The last theme which emerged concerned the educator and mentor identity. When discussing their identity as researchers, the topic of educator and mentor identity was expressed to be greater than their identity as a researcher. Some examples of this theme include:

> "But you know I'm an educator above all, that's why I'm in academia, right? Otherwise I'd be doing engineering in industry. But I see this perception a lot. They think that I'm kind of the weirdo doing outreach stuff. I feel like lots of people see it as a waste of time and resources. I don't know, I enjoy doing it." – Alena

> "I think more teaching. I do teaching for undergrads, as well as I do a fair amount of professional development for teachers, and other types of professionals in the community. I think that those are things that I have translated more closely to something like this, compared to the research domain or research talks, per se, that I would have done before." – Kacey

In the excerpt from Alena, she is recalling a conversation with a student about why she chooses to participate in outreach opportunities and mentor high school student. The student wondered why she chose to commit to these duties given the time commitment and the resources needed to participate in outreach and mentoring students. Alena explains how although she is a researcher at the university, she sees herself as an educator first and chooses to mentor and teach other students beyond her research duties.

The quote from Kacey illustrates how her identity as an educator has helped her prepare for her presentation. She explains how her experience with teaching students and teachers has prepared her to present to a public audience at the STEAM Galleries rather than her experience disseminating her research in a conference type setting.

Future Work

Our initial findings from the pilot have provided us with valuable feedback to inform the full study which is currently underway. Consisting of nine participants divided into two cohorts, our full study will integrate lessons learned from the pilot, such as encouraging participants to view each other's COSI presentations to reflect on how each implemented ideas from the public engagement training. As our program and research evolves, we hope to see an increase in researcher motivation to communicate science to the general public. We expect that participants' creativity and innovation will also increase due to the interdisciplinary interactions amongst the researchers. We hope to see collaborations occurring earlier with participants and that those collaborations may continue beyond the project which will enhance the overall academic ecosystem. Our findings related to educator and mentor identity suggest we continue to explore this topic. Further studies, which takes academic mentorship into account, could be performed with both the research faculty and their graduate students. Sharing their passion for research with their graduate students and the public may have an impact especially on traditionally underserved or underrepresented populations in STEM, engaging them in a new and interesting way.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. 1811119. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

[1] B. Fischhoff, "The sciences of science communication," *Proc. Natl. Acad. Sci.*, vol. 110, no. Supplement_3, pp. 14033–14039, 2013.

[2] S. Miller and D. Fahy, "Can science communication workshops train scientists for reflexive public engagement?: The ESConet experience," *Sci. Commun.*, vol. 31, no. 1, pp. 116–126, 2009.

[3] H. Field and P. Powell, "Public understanding of science versus public understanding of research," *Public Underst. Sci.*, vol. 10, no. 4, pp. 421–426, 2001.

[4] R. L. Kajfez, H. M. Matusovich, and W. C. Lee, "Designing developmental experiences for graduate teaching assistants using a holistic model for motivation and identity," *Int. J. Eng. Educ.*, vol. 32, no. 3, pp. 1208–1221, 2016.

[5] R. M. Ryan and E. L. Deci, *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. New York, NY: Guilford Publishing, 2017.

[6] R. Ryan and E. Deci, "Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being," *Am. Psychol.*, vol. 55, no. 1, pp. 68–78, 2000.

[7] H. Markus and P. Nurius, "Possible selves," *Am. Psychol.*, vol. 41, no. 9, pp. 954–969, 1986.

[8] C. Dunkel and J. Kerpelman, *Possible selves: Theory, research and applications*. New York, NY: Science Publishers.

[9] FINS/RIESS, “Researcher Identity in the Social Sciences (RIESS) Survey.” 2013.
[10] Center of Science and Indusrty, “COSI,” 2020. [Online]. Available: https://cosi.org. [Accessed: 31-Jan-2020].
[11] The STEAM Factory at The Ohio State University, “Franklinton Fridays.” [Online]. Available: /steamfactory.osu.edu/franklinton-fridays. [Accessed: 31-Jan-2020].
[12] OHI/O @ The Ohio State University, “Ohio State’s hackathon Program.” [Online]. Available: https://hack.osu.edu. [Accessed: 31-Jan-2020].
[13] J. Saldana, *The Coding Manual for Qualitative Researchers,* 2nd ed. Los Angeles, Calif: SAGE Publications, 2013.