Using Storytelling as an Approach to Researching, Teaching and Learning about Complex Community-based Socio-Scientific Problems

Abstract

Resolving global problems (e.g., climate change) requires decision-makers who can see problems through an intersection of disciplines and perspectives, and identify the root causes of disparate and inequitable outcomes between groups. As such, there is an urgent need to develop systems-thinking skills in learners so that they are able to address the interdisciplinarity and intersectionality fundamental to complex socio-scientific challenges when acting as decision-makers. This session highlights how storytelling can be used as a pedagogical approach to building systems-thinking and collaboration skills in informal learning environments. Research presented include examples of how podcasts, graphic novels, and theatre can be used as storytelling approaches. This interactive session brings together scholars who work in community-based partnerships around North America, India, and Bhutan.

I. Objectives of the Session

This symposium will:

- Showcase current research on various storytelling approaches to researching, teaching and learning about complex socio-scientific issues.
- Examine outcomes of storytelling as a mechanism for developing systems-thinking skills, and connecting learners to science, their identities, and their community.
- Provide opportunities for dialogue among researchers interested in community-based research regarding research methods, epistemological stances, and building partnerships.

II. Overview of the Presentation

This session will consist of six presentations; a discussant to connect and extend the ideas presented, and facilitated conversations among the presenters and the audience. An important feature of this session is bringing together researchers who work in a diverse set of contexts and within a range of cultures across North America, and South Asia. Presenters will be strongly encouraged to invite community partners to participate in the session.

III. Scholarly or Scientific Significance

Some of the most challenging global problems are housed within complex systems, and retain a “wicked” nature (Grohs et al., 2018) i.e., are unique and ambiguous in terms of causality, possess no clear solution, and change when addressed (Rittel & Webber, 1973). Socio-scientific problems, in particular, require cross-disciplinary thinking given the social, economic, scientific, and political factors that steer the direction and impact of these kinds of challenges. As such, exploration of complex systems has become a key idea in science education (Vattam et al., 2011) as we want learners to be able to think in more integrated and non-linear ways.

It is therefore critical that we explore avenues for fostering the ability to systems-think in ways that are engaging, culturally relevant, and grounded in relevant complex socio-scientific issues that impact local communities of which learners are a part. Storytelling is one such avenue worth exploration because it not only allows learners to leverage funds of knowledge (Moll et al.,1992) from their communities, but also provides a pathway for them to make deep connections between these funds of knowledge and learned knowledge in order to see complex systems and problems more comprehensively. Further, research and practice on storytelling pedagogy advances educational equity generally, as centering and affirming the lived experiences of diverse student populations challenges both dominant educational narratives (Ladson-Billings, 2016; Solorzano and Yosso, 2016) and colorblind educational policies which have been found to maintain white supremacy (Bradbury, 2020; Gillborn, 2013, 2016). This session will explore how various forms of storytelling can help learners navigate the different "levels" (Resnick & Welinksy, 1998) within a system in order to understand system complexities.

IV. Structure of the Session

This 120-minute symposium session will allow for engagement between presenters and session participants. The format will be as follows:

- The chair will introduce the session theme and research teams. (15 minutes).
- Each research team will provide a 10-minute overview of their project. (60 minutes)
- Discussant will provide an integrated summary of the research presented and identify critical themes and new directions for research. (15 minutes)
- Large group discussion facilitated by session chair. (30 minutes)

“Misinformation” as Socioscientific Expertise in Student Podcast Development

Objectives

Advancing socioscientific issues requires coordinated insight and expertise across a range of knowledge domains and stakeholders. Podcasting projects leverage story-based epistemologies to create opportunities for marginalized stakeholders to collaborate in problem solving as experts. We explore the role of “misinformation” in buttressing narratives that ultimately make valuable headway on complex socioscientific issues. We show that there are important junctures in which standards around knowledge and knowing can conflict with privileged forms of scientific understanding.

Perspective(s)

Engaging classroom experiences is essential for ensuring persistence in science education for middle-school aged students (Maltese & Tai, 2010). When such narrative engagement taps valued community funds of knowledge and identity (Esteban-Guitart & Moll, 2014), learning can deepen students’ connections to communities and build cultural well-being (Immordino-Yang, Darling-Hammond, & Krone, 2018). However, understanding of complex issues is often based on imperfect combinations of knowledge across a range of sources. Even “incorrect” knowledge (Wells, 2008) in the form of *spontaneous concepts* (Vygotsky, 1987) is a viable means of problem solving in some forms of everyday understanding.

Methods

We examine podcasts from a short-term environmental podcasting collaboration between university students and educators from the US, and ecology professionals, teachers and students from partnering middle schools and community programs in Goa, India. School-age students worked with community members to make podcasts about locally relevant environmental issues.

Data

This paper focuses on critical incidents of factual inaccuracy in students’ podcasts. Thematic analysis of translated and transcribed podcasts is supplemented by project team notes and exit interviews.

Conclusions

We focus on “expert misinformation” from a student podcast on waterway pollution. Students report that decreased supply of fish in recent years (a) is the result of household pollution, and that demand is being met by fisherfolk (b) using chemicals to make inferior fish appear “bigger and tastier” at market. Both (a) and (b) function as key narrative anchors and were central to the stories they heard from community members; however, are likely scientifically false. In the podcast, a local scientist points out that overfishing, and perhaps not household pollution, is a key culprit of decreasing fish supply. Another local scientist points out that the intentional chemical contamination of fish was a source of considerable community speculation, but was likely isolated.

The “expertise” revealed in this story is an expression of community priorities – perhaps, the desire to continue consuming fish at levels that were accessible to households in the past. We describe a possible limitation of podcast and community storytelling in which “good stories” carry a requirement that problems are personified, which is not easy to do with aspects of some socioscientific issues. This misalignment of genre and fact creates narrative space that misinformation helps to fill.

Significance

Our findings describe how the flexibility of misinformation can reveal aspects of socioscientific issues that are “value hot spots” for community members. Epistemological and political divisions between school and communities often obscure the value of false facts, despite their ubiquity in all communities and ways of knowing that all people engage with worldwide.

Voices to Hear: What Podcasts as a Storytelling Avenue Reveal about Systems Thinking

Objectives

Voices to Hear (V2H), a design-based research project focused on the oral tradition of storytelling, empowers Native American students ages 12-25 to learn about complex environmental challenges faced by the Coeur d'Alene (CDA) community. Students create podcasts about environmental systems affecting their community like the impact of invasive Northern Pike on native Cutthroat Trout and the continued impact of historic silver mining on Tribal waters. Through this process, students learn about the problems at hand through the lens of different knowledge systems (Indigenous and Eurocentric) by hearing stories told by CDA Elders, explanations provided by natural resource scientists, and observations made by other community members. While the strength of podcast making is in resonance with Native American oral storytelling traditions, the V2H process also provides a mechanism for conducting scientific inquiry and reflection on the inherent complexities of socio-scientific challenges.

Data/Methods

This research focuses on student ability to systems think through the analysis of interviews, concept maps, and podcasts. Pre- and post- program data include student analysis of a pre-designed problem-based environmental story and concept maps as visual representation of the components that they saw as integral to solving the problem at hand. Data from podcasts focuses on how students chose to represent local environmental issues that are grounded in complex systems.

Analytic Framework

The V2H research examines how student program participants analyze complex systems that are embedded in a community with a rich cultural and environmental history. The CDA culture inherently emphasizes what they call the Core Values. As such, this research analysis uses the Core Values (CV) framework, which draws on five core values (stewardship, membership, guardianship, scholarship, and spirituality) that reflect the worldview and heart of the CDA Tribal people. Framing the analysis within these core values highlights relationship, protection, and care.

Results

The V2H program enables students to realize the interconnections within systems, as is revealed in their interviews, stories, and the podcast narratives. The data reveals that students value (1) caring that emphasizes responsibility, accountability, and social awareness in *all* spheres of life, (2) learning to understand the world by applying knowledge meaningfully in the community, and (3) care, responsibility, and protection for fellow people and natural resources. Meadows, Randers & Meadows (2004) posit that our increasing obsession with growth has resulted in the persistence of unsustainable environmental decision-making. We assert that CV, as a teaching framework, offers an ideal ideology approach to living that works to reinforce the notion that environmental systems are in a delicate balance which must be maintained in order for them to remain sustainable.

Scholarly significance

Learned science is often incompatible with students' worldview forcing students to abandon or marginalize their way of thinking or knowing (Aikenhead & Jegede, 1991). As such, we explore how to leverage sociocultural worldviews and utilize pre-existing student schemas as cultural capital for systems thinking through our use of the CV framework. These findings will support development of culturally relevant frameworks for systems thinking education.

Learning about Environmental Decision-Making in the Bhutan Himalayas through podcasting

Objectives

Climate change is a complex phenomenon and an effective climate change education program likely requires a form of collaboration among experts and community members that brings to the table scientific knowledge, cultural understanding, pedagogical expertise, and community engagement (Bang & Vossoughi, 2016, Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2012). This project brings together narratives/stories of environmental change that the communities have observed in the rural parts of Bhutan and tries to understand environmental change/ climate change from a community perspective.

Theoretical framework

Attitudes and behaviors with regards to climate change are complex and dynamic, and likely influenced by personal experience and knowledge, as well as cultural and political knowledge and values systems (Leiserowitz et al., 2012). Learning about this complex problem requires different pedagogical approaches. We used podcasting as an approach to merge community-based knowledge and science together.

Modes of inquiry

The project described in this presentation eengaged rural communities in Bhutan to understand how community members resolve issues related to environmental change in their everyday lives. We collected stories/narratives from local people about how they observe and react to environmental sustainability situations in their communities. Finally, we used museums as community gathering spaces, to listen and share stories about environmental change as observed by the local communities.

Data sources and Results

The project involved a partnership between two Universities (Bhutan and United States), two museums (Bhutan and United States) and a non-governmental organization in Bhutan. 10 undergraduate students from the United States (n=5) and Bhutan (n=5) travelled to parts of rural Bhutan in order to record stories from local community members about the environmental change that they have observed within the community over the last several years. The students collected the stories and then worked with the museum personnel to curate the stories in the form of podcasts.
Our qualitative analysis suggested that in several instances' students connected the narratives that they heard to their own lives in different ways. For example, a student from the United States who grew up on a farm that was in their family for eight generations made the following connection while analyzing stories told by farmers in Bhutan,

I learned some things about myself...I remember getting home and feeling different. It helped me find my roots, and reconnect with the environment. This has helped me recognize the importance of my family's land. It has made me want to protect it and take care of it so I can continue to pass it to future generations."

Scholarly significance

Often, the issues related to climate change and environmental change are discussed from a perspective of science, which is impersonal and unattached to the emotional and personal disturbances that are faced by individual community members. The stories were a powerful medium of communication as they gave a voice to the emotional and personal impacts that climate change is having on the lives of the community members in rural Bhutan.

Creating Comics about COVID-19 to Understand the Intersections between Science, Community, and Equity

Objectives

We developed a virtual program where 13 high school age youth from India, the U.S., and Mexico explored socio-scientific phenomena relevant to COVID-19. Students were tasked with authoring comics that illustrated their particular experience with COVID-19 in light of their local context. We encouraged students to consider inequities exposed among and within communities as a result of the pandemic (Katamneni, 2020) by asking students to consider three questions throughout the development of their comic stories: (1) What is COVID-19?, (2) How does COVID-19 impact community?, and (3) How does COVID-19 impact different members of the community? We used these three questions to examine student understandings of the interconnectedness between science, local context, and equity.

Perspective(s) or theoretical framework

The design of this program was grounded in theories of complex systems thinking that advocate learning about complex problems through a thinking-in-levels approach (Resnick & Welinsky, 1998). We devised and utilized three main goals, each with an associated question in student- friendly terminology, to frame our program design and learning content, such that students were constantly thinking about (1) How can I make sense of, and address, complex problems?, (2) How do scientific phenomena impact different communities, and in what actions can/do communities take in order to respond to scientific phenomena?, and (3) How does inequity further complicate a complex problem, and what can be done to address inequity in order to better address the complex problem?

Methods/Data sources

Students designed comics that fell into one of three themes: Life at Home, Education, or Finding Solutions. Using the three questions we asked students to consider in the design of their comic stories, we qualitatively analyze comics for ways students commonly and contrastingly represent science, local context, and equity.

Results

The results of our investigation reveal differences in complex systems thinking abilities between students who primarily viewed the pandemic as a personal issue versus a communally shared issue. The results also render different representations of community and the extent to which community played a role in the students' pandemic experience. Lastly, the results help us to differentiate between stories that narrated the injustice of the pandemic as a personally experienced inequity versus a larger social injustice.

Scholarly significance

In this study, the process of creating comics presented an opportunity for youth to apply systems thinking to scientific concepts in creative and personally relevant ways. We conclude our paper with the significance of the processes of authoring comics; the

representation of science, community, and equity using graphic elements and storylines; and the relationships among students' identities, knowledge, and experience.

Investigating Artist-Scientist-Educator Collaborations for Informal Science Learning and Environmental Decision Making

Objectives

There is a need for evidence-based, innovative approaches to education for real-world problem- solving about issues related to environmental change and adaptation. Building and improving environmental resilience is important for populations at risk from impacts of environmental change - including increasingly intense and more frequent weather events (Caillouët et al. 2008). In addition, there is a need to engage people in educational dialogue about how sustainable decisions can be made in order to address the environmental problems which they face in their daily lives. Research indicates that some of the most successful strategies for adaptation and decision-making are learned through community participatory processes (Smit et al. 1999). This paper explores how a community participatory theater-based approach can enhance community members' environmental decision-making processes.

Perspective(s) or theoretical framework

Arts-based informal science learning programs are often largely focused on learning through exposure to a *product* (i.e. a museum or science center exhibit), rather than on learning through the *process* of making art – especially within a collaborative environment (Adams et al. 2010; Anyfandi 2014; McCallie et al., 2009). In contrast, our project concept focused on investigating the informal science learning potential of the *process* of community– and arts–based collaboration (the learner as collaborator and maker of artwork). While participatory theater is not new, our research is innovative as it aims to measure its impact when created in service of informal science learning and applied to a particular scientific issue.

Methods

Using interviews and participant observation methods, we examined two research questions: 1. How can artists, scientists and educators collaborate to engage general public understanding of a complex scientific problem, such as flooding in New Orleans?; and 2. How can a participatory performance enacted by the general public in collaboration with the artist, scientist and educator team impact learning and decision making?

Data

We recruited a team of Artists (n=2), Scientists (n=2), and Educators (n=2) to understand each other's processes, and to work in collaboration with 10 adult participants from a neighborhood dealing with the problem of flooding in order to script and perform a theater piece about this topic.

Results

Preliminary results drawn from observation and interviews show that: 1. The general public wants, but does not have easy access to, scientific information; and 2. The process of creating the participatory arts-based performance indicated that climate

change learning cannot be addressed only by science, but requires the incorporation of social and policy issues as well.

Scholarly significance

The outcomes from this project will enable the Arts, Science and Education fields to understand how to create interdisciplinary teams so as to engage the general public about pressing issues such as climate change. Outcomes also point to understanding what are innovative pedagogical approaches (theater) that can be used to engage and engender deep learning on complex climate-based issues among the general public.

Stories for Change: Storytelling as a Strategy for Critical Action Education

Objectives or purposes

This paper describes a two-year design-based research project in which we have developed the Critical Action Learning Exchange (CALE), a professional learning community for educators around the world who seek to develop and exchange critical action curriculum, share resources and empower students in responding to issues including: climate change, social and environmental justice, pandemics, and the economy. This paper reports our research of how to help teachers develop understandings of critical action, and guide their designs of new critical action curriculum.

Theoretical framework

Our project applies critical pedagogy (Freire, 1970) within a modern context of empowering teachers to empower their students.

Methods

Within CALE, teachers participate in synchronous and asynchronous professional development activities to develop understandings of critical pedagogy and engage in design of new curriculum. In the first meeting, storytelling was featured as an example of critical action curriculum, with explicit connections made to our CALE design framework (Author et al., 2021). Each group engaged in a series of 3 synchronous meetings (90 minutes each) over the course of 3 months, with teachers working in small design teams during the periods between meetings. We applied the Change Laboratory model (Engeström et al, 1996) to capture the shifts in teacher discourse that occur over the course of the 3-month period. After engaging in such activities during the summer months, the teachers stay in contact using the CALE online community, and share their experiences enacting the new designs.

Data

In Spring, 2021 we organized two teacher cohorts: (1) 60 elementary and middle school teachers in Bangalore India, coordinated by local partners, and (2) 45 teachers in Canada who focused on climate change education. Teachers worked collaboratively to design and implement critical action-oriented storytelling curricula, using the CALE professional development intervention.

Results

Over the past two years, we have designed the CALE activities, resources, and technology environments in close concert with our teacher programming, testing design ideas and continuously improving our various frameworks and design guides to help CALE become a sustainable community of practitioners (Author et al., 2021). Our presentation will begin by detailing the CALE professional development intervention, together with an analysis of teachers' learning progressions as they designed storytelling curriculum. We will present several case studies of teachers who produced storytelling lessons, analyzing how these designs reflected teachers' new understandings.

Scholarly significance of the study or work

The CALE project contributes to the body of scholarly literature concerning critical pedagogical practice and storytelling by offering: 1. a new professional development intervention; 2. analyses of educators' processes of developing and enacting a critical action stance toward teaching; and 3. steps toward making such critical orientations sustainable.

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