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Supporting a Museum-Based Network of Science Teacher Leaders

Connected Science Learning May-June 2022 [Volume 4, Issue 3]

By Sara C. Heredia, Michelle Phillips, and Julie H. Yu



It is common practice for the formal K–12 system to rely on science teacher leaders (STLs) to improve the science instruction within their local contexts. Science teacher leadership can take various forms, from leadership roles in district or county offices to science teachers advocating and working toward change in the classroom (Luft et al. 2016; Whitworth et al. 2022). This variation in leadership roles and activities can create a challenge when working to provide professional learning supports for STLs. We argue that Informal Science Institutions (ISIs) are well positioned to support the variety of leadership roles in science education and present a model for STLs' professional learning.

ISIs have the potential to provide unique and powerful supports for science teachers and STLs through teacher professional learning programs, science content expertise, field trips, and expertise in providing hands-on, inquiry-based approaches to understanding science phenomena (Adams and Gupta 2017; Phillips et al. 2007; Cigdemoglu and Köseoglu 2019). At an ISI, STLs can be active learners in a free-choice environment, are able to ask questions, plan and carry out investigations, connect observations to natural phenomena, and engage in continuous reflection (Yu and Heredia 2016). Science teachers themselves have reported that ISI-based professional learning is often more relevant and helpful than many other (especially district- or county-mandated) professional learning opportunities (Phillips et al. 2007).

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While it is important for ISIs to understand and stay connected to formal education partners, they can also take advantage of their position outside the formalized system to support science educators (Yu and Heredia 2016). Typically, ISIs are not required to limit themselves to a specific district or school policy or curriculum, and instead can engage teachers across a range of contexts to bring to bear their expertise and modeled pedagogy to local formal systems. Further, an ISI can also serve as the intermediary infrastructure that helps STLs hone their skills as teachers and leaders, and act as a hub of a network that supports collaborations and partnerships between policy, scientific, and educational research communities (Yu and Heredia 2016; Sgouros and Stavrou 2019).

In this article we describe an ISI-based professional learning program for STLs developed within the context of a research-practice partnership (RPP). The RPP model supports practitioners and researchers to engage in joint inquiry, as they work together to understand and improve designs for learning (Coburn and Penuel 2016; Farrell et al. 2022). Here, museum educators and university researchers leverage their collective knowledge and experience with science teacher education to design a professional learning program for STLs.

In what follows, we describe the ISI teacher learning context, the design of an online professional learning program for STLs, and the first iteration of implementation of that design. We end with suggestions for supporting science teacher leadership based on what we (researchers and practitioners) have learned from this initial iteration of the program.

Museum Professional Learning Context

For nearly 40 years, the Exploratorium has provided science teacher professional learning that supports teachers throughout their career trajectories, ranging from new teacher induction programs to ongoing workshops, to teacher leadership development, to a statewide initiative for which the Exploratorium is the hub for a network of teacher leaders positioned to further the implementation of *NGSS* in their local settings. The core elements of the Exploratorium's teacher professional learning programs are aligned with the characteristics of effective professional learning (Darling-Hammond et al. 2017), as well as features of informal learning environments. These core elements include providing teacher choice in learning activities, joyful participation in community, meeting teachers where they are, connecting teacher learning to teaching practice, and modeled pedagogy.

Prior to the design work of the RPP, the Exploratorium had supported a statewide network for STLs to connect with other STLs across the state and share professional resources for science education reform. To be involved in the network, each STL participated in at least one week of professional learning in-person at the Exploratorium. During this weeklong workshop, STLs were immersed in learning experiences that centered their different roles as science learners, teachers, and leaders. They engaged as science learners in phenomena-based activities, as science teachers in activities that supported them to reflect on instructional practices modeled by museum educators, and as STLs to identify professional learning opportunities they could provide modeled after the museum-based experiences. After their one-week immersive experience at the museum, STLs had access to a listserv of all the STLs in the network, online workshops offered by the Exploratorium throughout the academic year, and one-week alumni institutes offered at the Exploratorium every summer.

Program Design

Working with STLs over the past five years, museum educators noticed that STLs often commented on how beneficial it was to have access to other STLs across the state. They often reported that they lacked peers within their context and appreciated the opportunity to discuss common challenges with reform efforts and share meaningful resources across contexts. Others noted that while they had peers doing similar work in their local contexts, they rarely had time to engage in their own learning to move through challenges that surfaced in their work. In response to this, the Exploratorium partnered with researchers from the University of North Carolina at Greensboro (UNCG) to design an online community of practice (CoP) for STLs to provide them with the time, space, and social resources to improve their leadership practice. However, given the variation in science teacher leadership across the state, we started the design process by interviewing STLs within the existing network to surface challenges or problems that STLs could work on together.

During the summer (2020) prior to our first implementation of the online CoPs, we recruited STLs for interviews through the network listserv. We interviewed seven STLs from the current network from a

variety of leadership roles, including full-time STLs, part-time STLs, and full-time science teachers with leadership roles. The interviews happened over the summer after the initial shutdown due to the COVID pandemic, and we wanted to understand how the pandemic impacted their instructional and leadership practice. From these interviews, we were able to surface common problems of practice for the STLs in our network. These problems of practice included (a) implementing equitable hands-on, phenomena-based science activities remotely, (b) using collaboration tools and processes for increasing online engagement in science, (c) developing and using equitable teaching practices (pedagogy, assessment) in science, and (d) working toward antiracist and culturally responsive science education.

To support STLs to work on these problems of practice, we offered a series of online professional learning opportunities organized as CoPs. Each CoP consisted of four to five STLs partnered with a consistent Exploratorium facilitator, and at least one researcher (from UNCG or the museum). Each CoP met online monthly for approximately 90 minutes. In addition, STLs completed at least eight hours per month of work outside the group meeting time during which they were encouraged to draw on the experience and expertise of other STLs, the science museum facilitators, and the university researchers as much as possible. This work included gathering data from their local contexts, piloting new tools and practices, and finding and sharing resources. At the end of the academic year, all the STLs in the program came together with researchers and facilitators for an end-of-year online symposium to report on their experiences and findings, share what they had accomplished, and identify remaining questions and concerns.

Facilitators met twice a month to discuss the work of individual CoPs, and share activities and protocols used to facilitate CoP meetings. Further, individual facilitators met with their CoP researcher to debrief meetings, plan for future meetings, and share resources. The researchers acted as participant observers, both collecting data and participating in the work of the CoPs. Researchers collected data during CoP meetings (video, field notes, and artifacts from the meeting). This data served several data analyses to better understand the work of science teacher leadership in practice (Heredia et al. 2022a), how the different activities supported STLs to develop or modify resources for their local context (Heredia et al. 2022b), and to support facilitators to track STL learning. Researchers also facilitated small breakout groups during CoP meetings and shared resources directly with STLs.

Participants

We selected a cohort of 25 participants from 49 applicants to participate in five CoPs based on: their district and county; specific role/responsibilities as an STL; and number of teachers with whom they work per year (one TL had to withdraw from the program resulting in 24 in the entire cohort). Selected applicants represented a quarter of the state's 58 counties. The STLs worked across a variety of settings, including rural districts, as well as the largest and most urban school districts in the state. Table 1 provides an overview of STL participants.

TABLE 1. DESCRIPTIONS OF STL PARTICIPANTS IN COHORT ONE.

Context	Description	Number
Role	Full-time science teacher	10
	Full-time science teacher leader	10
	Part-time science teacher leader	4
Geographic	Urban	6
	Suburban	16
	Rural	2
System level	County	2
	District	8
	School	13

Features of Professional Learning Program

While there was variation in how individual facilitators supported their CoPs to be responsive to the needs of participating STLs, there were some common activities from the CoPs that STLs highlighted as productive for their learning. Researchers analyzed the first iteration of the design to understand the structure of these activities, and how they supported STL learning. These activities included: defining the CoP's problem of practice, creating individual actor-network maps (Reidy et al. 2018) to illustrate their positions within their contexts and their respective spheres of influence, modeled pedagogy of learning activities as a CoP, and project time during CoP meetings to work with other STLs or museum facilitators on their leadership projects.

Defining problems of practice

When STLs applied to participate in the CoPs, they indicated their preferences for working on previously identified problems of practice (described above). One of the first activities of all the CoPs was to collectively define their group's problem of practice. Facilitators took STLs through a process that asked STLs to first define the problem of practice from their individual perspectives. Then each STL read their definition, while the other STLs noted areas of convergence and divergence with their own definitions. Once all the definitions were read, the facilitator worked with STLs to incorporate each of their individ-

ual definitions to come to consensus on what they would work on together in their CoP. During the end-of-year interviews with STLs, some commented on the importance of coming to consensus about what they were working on and to define their collective work. Here's an example from an interview with an STL that participated in one of the groups focused on antiracist and culturally responsive science teaching.

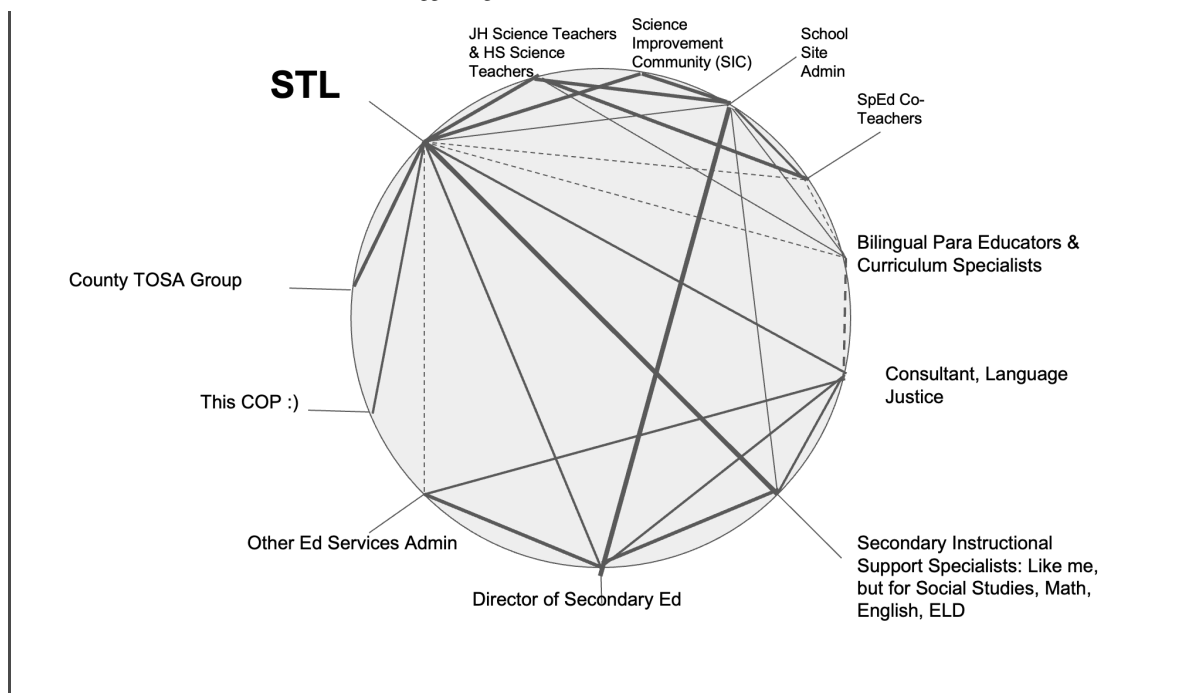
"Initially, we were comparing antiracist teaching and culturally responsive teaching and trying to decide what is our end game: 'Where are we trying to steer? What are we trying to get out of these conversations?' And then we understood that it is inclusiveness. It is reaching our teachers and students and making our content accessible to every learner, because if they're not seeing themselves in the teaching or if the teaching says something that makes them feel bad about themselves, why are we teaching it?"—Former Teacher on Special Assignment leading NGSS; returned to the classroom during the pandemic

Creating actor-network maps

Once STLs in each CoP defined their common problem of practice, we asked them to describe their organizational context using an actor-network map (Reidy et al. 2018). In this activity, STLs used a circle with nodes to identify the stakeholders for their problem of practice within their context (Figure 1). Then they were asked to identify weak, emergent, and strong connections between each of the nodes. On each of the nodes they identified key stakeholders (district staff, administrators, other teachers, community organizations) that were connected to this work. Then they drew lines connecting each of the stakeholders, using different colors or line weights to describe the strength of that connection. Once STLs made their maps, they shared them with one another and worked to identify key partners in their work (strong connections) or areas that needed attention within their context (no or weak connections). This work supported STLs to understand their sphere of influence and to focus their CoP project work.

FIGURE 1. AN EXAMPLE OF AN ACTOR-NETWORK MAP OF AN STL IN THE ANTI-RACIST AND CULTURALLY RESPONSIVE COP. DARK LINES DENOTE STRONG CONNECTIONS AND DASHED LINES REPRESENT WEAKER CONNECTIONS.





A number of STLs commented on how this actor-network map supported their leadership work, including identifying key stakeholders in their work, resources that they may or may not have known existed, and where they had influence within their work context. For example, one STL said this about the activity,

"I really appreciated the networking map that we made. When we first started working on that networking map, it seemed kind of abstract. But it really did help me not only identify the connections, or just recognize the connections that I was already using, but also kind of expanded that definition to understanding who I was affecting and who I could potentially be using that I wasn't. I thought that was a really fascinating tool just as far as understanding and just as far as kind of aiming my interactions with people and understanding how those things interact. So taking the time to visualize that, I think was really beneficial... we talk about stakeholders a lot in school, and they're always the same people, and they always have the same relationship, and we don't really think about what the give and take of those stakeholder relationships are, and kind of putting in the perspective of an actor network map and thinking about not just stakeholders, but what are the resources we tap and what are the communication pieces that are involved, kind of just like broadened my scope of who I was working with." —

Teacher on Special Assignment

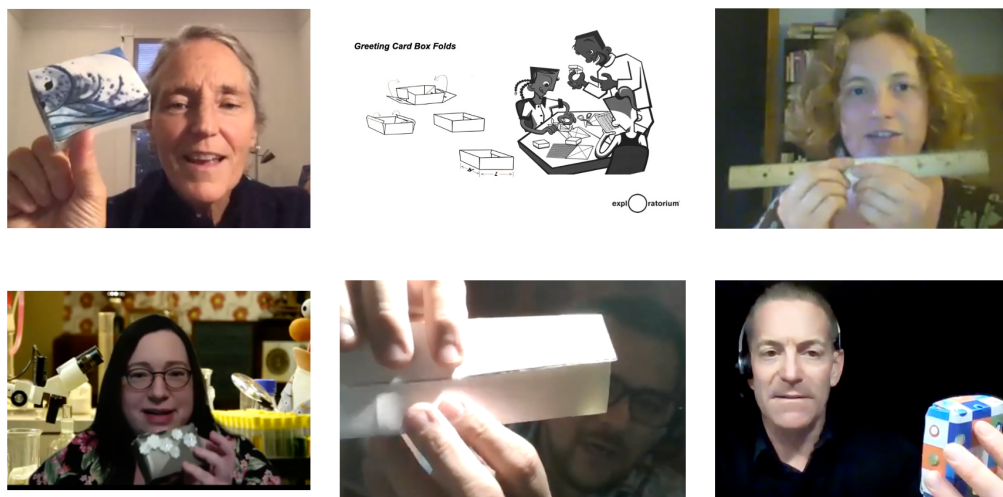
Modeled pedagogy

The professional learning program provided models of phenomena-, equity-, and inquiry-based science that STLs can incorporate into the work they do with science teachers and students in their local contexts. Facilitators or one of the STLs regularly shared a science activity that embodied the focus of their group. Collectively, group members would participate as learners in the activity and provide feed-

back on that activity. Further, they would have conversations about modifications or changes they would need to make to use the activity in their context.

One example of this work comes from the CoP focused on developing inquiry-based STEM activities that could be facilitated through online instruction. The facilitator led the STLs through an activity where they took a greeting card and made a small gift box out of it. The facilitator supported the STLs to make the top half of the box (Figure 2) and then challenged them to come up with a way to modify that design to make a smaller box that would fit inside the first one they made. The STLs used a variety of strategies to make the smaller box, which they then discussed as a group. They also shared important skills or resources students might need to do a similar activity, discussed a variety of materials that could be used if students did not have greeting cards at home, and ways that the activity embodied science and engineering practices that might be difficult to facilitate in the online learning environment.

FIGURE 2. THE FACILITATOR SUPPORTED STLs TO MAKE A GIFT BOX OUT OF A GREETING CARD AND THEN CHALLENGED THEM TO MODIFY THE DESIGN TO MAKE A SMALLER BOX THAT WOULD FIT INSIDE THE FIRST ONE.



Project time to work with other STLs

The CoP program model provided STLs with connections and collaborations with STLs in similar roles from different geographic regions within the state. Facilitators provided time within the CoP meetings for STLs to work on their projects collectively and often provided protocols to facilitate their work de-

pending on where they were in their process. These connections facilitated the sharing and development of resources, as well as alleviated feelings of isolation experienced by some of the STLs.

"The time spent being able to talk to the other leaders throughout the state is an amazing experience because I realized I never really had that opportunity before. I am very isolated where I am in my role. I have people who support me, in that they believe in me and they know I can do it and that type of thing, but to have a conversation about STEM and how it should be implemented from more of a leadership perspective, it is really cool, rather than thinking of it on my own and running it by someone who might or might not have expertise in that area." —Science Instructional Support Specialist

The communities of practice were a consistent time and space for STLs to hold themselves accountable and also gave them the latitude to reflect on and better align their values, actions, and practices as they worked together to deepen their leadership practice.

"It's a unique space where we can share and talk about racial issues and look at what hasn't worked in the past with our students, and it provides us with new strategies to move forward in restructuring our system. It's a lot of information as well. It's a lot of thinking and digesting of sometimes difficult things... I realize it's a slow process. And it motivates me, going to these community of practice meetings, actually, to keep working on it and not... try for a little bit and then fall back into some old ways of doing things. So, it is about making progress and a way to hold myself accountable for what my intentions are." —Full-time veteran (21 years) high school biology teacher and mentor for new teachers

The activities described here supported STLs to come to consensus about their collective work, understand their sphere of influence within their context, experience different activities as learners, and provided the time and resources to develop personal, social, and material resources for their leadership work through a network of support from museum educators and other STLs in their CoPs.



STLs engage as learners at a museum exhibit with their CoP at the end of the year symposium.

Conclusion and recommendations

This formal-informal RPP examines how a series of online CoP meetings organized around local problems of practice supported STLs to develop their leadership practice. Specifically, we highlighted key activities that supported STLs to come to consensus about how to describe and define their CoP's problem of practice and to situate that problem of practice within the context of each of their local educational systems. Further, through modeled pedagogy and project time to work with other STLs, these CoPs supported STLs to interpret and translate resources for professional learning into their local context. We argue that the ISI, which exists outside of the formal accountability system for education, can offer STLs a hub for interaction that supports their ongoing reflection and learning to provide teachers with access to learning opportunities that support science education reform within their local contexts. Our recommendations for designing similar programs at other ISIs include:

- Drawing on the strengths of an informal science institution that are unique from yet also support formal learning environments.

- Engaging STLs in learning experiences that support their range of roles including science learners, science teachers, and science teacher leaders.
- Emphasizing the importance of consistently showing up for one another in community. Regular attendance and participation in the work is expected and yet the group is also responsive to one another's personal and professional challenges.
- Providing time for participants to reflect on their sphere of influence within their school and/or district and translate their new insights and learning into real-world application for their local contexts.

Acknowledgments

This material is based upon work supported by the National Science Foundation under grant no. 1907460. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. We also acknowledge and thank the science teacher leaders without whom this work would be impossible.

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citation: Heredia, S.C., M. Phillips, and J.H. Yu. 2022. Supporting a museum-based network of science teacher leaders. *Connected Science Learning* 4 (3). <https://www.nsta.org/connected-science-learning/connected-science-learning-may-june-2022/supporting-museum-based-network>

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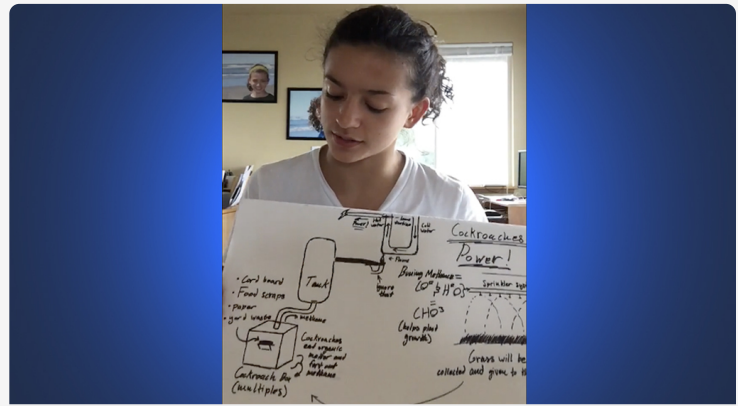
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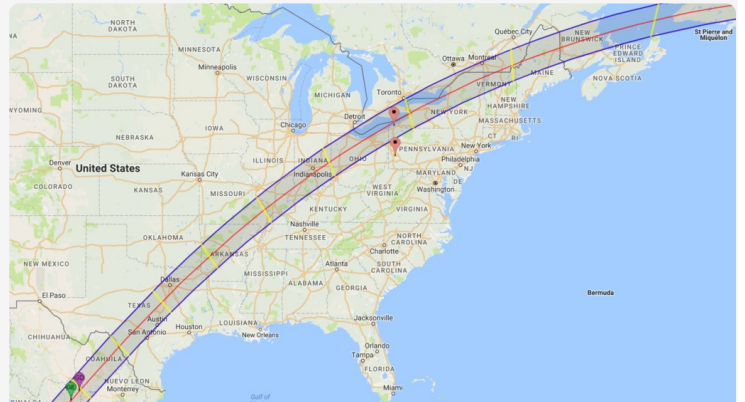
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