Stakeholder Roles in an Action-Oriented Science Space

Sara Hagenah

When curriculum is purposefully connected to the local community, classrooms can build on and strengthen students’ ties to their communities as they engage with disciplinary concepts. However, teachers have little guidance on how to connect curricula to the communities in which the schools are situated in and there are few studies that focus on community-based instruction that describe the roles needed to design science curricula that is meaningful and relevant to a community’s needs and ways of living (Bang & Medin, 2010). One challenge for teachers in designing community-based instruction is knowing how to engage community members in designing and implementing curriculum alongside teachers as they collectively work with students. Drawing on constructs found in design-based implementation research, this study explored what it meant to incorporate multiple stakeholders in research-to-practice conversations centered on the design and enactment of science curriculum that is connected with students’ communities (Penuel & Fishman, 2012; Penuel, Fishman, Cheng, & Sabelli, 2011).

This chapter examines the roles of middle school students, teachers, and community members as they negotiated curricular aspects of an afterschool science club, MARS (Making Authentic and Relevant Science). Framed as an action-oriented project, MARS aimed to build scientific explanations for why a local lake, Lake Evergreen, was toxic and use this knowledge to take action in the community. There were no resources that provided a complete explanation behind why Lake Evergreen was polluted and few resources around actions that were needed to clean it up. Teachers and students acted as explorers as they worked with community members, who were the holders and clarifiers of lake knowledge for both teachers and students. Students were thus part of a larger community that consisted of multiple stakeholders, and what was taught and how it was taught took into consideration the ideas and roles of each stakeholder. In this chapter, I first describe a set of design principles that framed the action-oriented science teaching and learning in this study. I then describe how teachers, students, and community members jointly negotiated the curriculum in MARS, focusing on the roles that each stakeholder took. Finally, I synthesize findings and provide implications and suggested steps for community-designed instruction in both formal and informal science spaces.

Action-Oriented Teaching and Learning Design Principles

Drawing across theoretical constructs from social justice pedagogy, mathematics education, and science education literature, I describe three action-oriented design principles that framed the MARS teaching and learning space. Action-oriented science focuses on producing a more just and equitable society through students learning and using rigorous science knowledge to take action in their lives and communities for an issue about which they care deeply (Bell, Lewenstein, Shouse, & Feder, 2009; Cochran-Smith, 2008; Gay, 2000; Grant, 2012; Hagenah, 2015; Hagenah & Thompson, 2013; Rose & Calabrese Barton, 2011; Windschitl, Thompson, Braaten, & Stroupe, 2012).

Design Principle One: Students’ Assets as Resources
The first design principle treats students’ assets, their funds of knowledge, as teaching and learning resources. This shifts who holds the knowledge and ideas from authoritative figures like facilitators or teachers, to the students. This principle is based on research that has shown an increase in learning, interest, and efficacy in science when students’ lives are considered and leveraged in learning and teaching (Basu & Calabrese Barton, 2007; Calabrese Barton & Tan, 2009; Carlone, Haun-Frank, & Webb, 2011; Moje et al., 2004; Moll, 1992; Rosebery, Ogonowski, DiSchino, & Warren, 2010). Although students’ assets are a resource in disciplinary teaching, what it looks like to incorporate these assets in connection with community assets remains ambiguous (Thompson et al., 2016).

**Design Principle Two: Critiquing and Expanding Canonical Knowledge**

The second design principle calls for teaching and learning that aims to critique and expand canonical knowledge. This principle is based on research that states that critical and expansive teaching and learning allows students to question power structures, critique established science, consider multiple perspectives of science, and expand the idea of who holds science knowledge (Basu & Calabrese Barton, 2007; Bouillion & Gomez, 2001; Freire, 1970; Grant, 2012; Roth & Calabrese Barton, 2004). Drawing on critical pedagogical research in mathematics, this principle is based on developing curriculum that provides students with opportunities to critique science knowledge and shape the progression of in-depth science with evidence-based ideas (Frankenstein, 1983; Gutstein, 2003, 2007; Ladson-Billings, 1997; Martin, 2003; Matthews, 2005). This principle asks for teaching and learning not to be about accepting canonical knowledge, but rather questioning it and seeking answers to questions that are relevant and meaningful to students.

**Design Principle Three: Using Science to Engage in Transformative Action**

The third design principle calls for using science to engage in transformative action. The research that supports this states that pedagogy needs to not only raise awareness of complex science issues, but also have students take action with this knowledge to make changes in their world (Calabrese Barton, 2003; Cochran-Smith, 2008; Gay, 2000; Gonzalez, Moll, & Amanti, 2005). This principle implies that disciplinary content needs to focus on a scientific phenomenon that is relevant and has action components. This shifts the focus from planning curriculum around science events that are nominally related to students’ lives, to curriculum focused on issues that are relevant and require transformative action. In an action-oriented science space both the teacher and students are aware of their roles in using rigorous science explanations to take action in society (Bouillion & Gomez, 2001; Grant, 2012; Roth & Calabrese Barton, 2004; Thompson et al., 2016). Awareness of these roles can be shaped with the careful planning of and use of participation structures that explicitly discuss roles in terms of using knowledge to make change in a community.

While there is ample evidence to support the idea that action-oriented science projects enhance important forms of learning for students (Bang & Medin, 2010; Calabrese Barton, 2003; Calabrese Barton & Tan, 2009; Rose & Calabrese Barton, 2011), less is understood about the design process and the various roles that multiple stakeholders take when developing and adapting action-oriented curriculum. Studies that use community resources lack clarity on the
practices of determining what and how an action-oriented phenomenon should be taught and learned. Employing the outlined design principles, I explore how these design principles were leveraged and operationalized through the following research question: What roles do students, teachers, and community members take on when action-oriented science is jointly negotiated in an afterschool science club?

**Context and Methods**

MARS was an afterschool program for nineteen middle school students that attended a high poverty school, Mountain Middle School, with a free and reduced lunch rate of 86%. Two teachers co-led MARS with myself and another university researcher. MARS took place twice a week on Tuesdays and Thursdays for one school year. Tuesday meetings focused on design and production of a professional documentary film, which students used to communicate the conditions of and actions needed for the local lake to the larger community at the end of the school year. In Thursday meetings, students engaged in sense making activities, evidence-gathering investigations, and discussions to construct an understanding around why a local lake was becoming toxic and how they could take action to remediate it. Multiple community members were an intricate part of the MARS planning, instruction, and reflection process. Lead teachers and university researchers met with different community members on a weekly basis throughout the afterschool program to co-plan and co-instruct meetings. Community members included the county senior limnologist, chemical engineers, restoration ecologists, park personnel, community environmental stewards, storm water engineers, and microbiologists. In addition to co-planning and co-instructing meetings, community members were involved in evaluating student artifacts and providing connections to numerous community resources including archived maps, historical knowledge, local experts, and resources for taking action.

Data sources included video recordings of weekly MARS meetings, lead teacher planning and debrief meetings, interviews, student-produced artifacts, and emails with community members. Data were analyzed to gather evidence around how a group of stakeholders—students, teachers, and community members—jointly negotiated action-oriented science curriculum. Employing an ethnographic approach, analysis involved multiple iterations of analysis of activity in MARS were performed using a coding scheme based on the design principles (Calabrese Barton et al., 2012; Merriam, 2009). I selectively transcribed themes and ideas that were tagged within areas of action-oriented curricular negotiation and the roles that each stakeholder had in these negotiations. Through analysis of transcribed discourse and triangulation with artifacts, a descriptive picture of stakeholder roles in negotiation conversations emerged.

**Stakeholder Roles in Negotiated Elements of Curriculum**

Findings provide a descriptive picture of the stakeholder roles as they worked as a collective group across the year in planning, enacting, learning, and reflecting upon MARS afterschool club activities. Evidence focuses on not only how the stakeholders participated in MARS, but also how and why co-constructing science takes time, allowing for all voices to be considered. Roles of stakeholders are described within the context of the curricular elements that were negotiated by stakeholders: (1) meaning makers of action-oriented science, (2) communicators of...
experiential and intergenerational aspects of the science explanation, (3) mappers of community-based knowledge, and (4) responders to community-based design solutions.

*Meaning Makers of Action-Oriented Science*

One point of negotiation that emerged when working with the MARS group was determining a viable and worthy issue that students would want to and could take action on in their community. The challenge was how to elicit the students’ ideas about a practical problem that might engender a sense of pride for tackling the issue. Rather than focusing on what content would encourage students to take a stand, the teachers focused on how students described the act of standing up for ideas they believed in. Attending to this need for clarification on what taking a stand meant to the group, the students took on the role of meaning makers and teachers as synthesizers of what it meant to take a stand as students were interviewed about ‘taking a stand’ in multiple dimensions of their lives.

Through student interviews, students reported taking a stand for people in their lives, ideas they were passionate about, and (for some) science issues they cared about (Figure 1). Social issues ranged from standing up for gay rights, questioning acts of racism, and acting against bullies. These personal and social stories led to a focused conversation between students of what science issues they, close friends, or family took a stand for or against. Similar to social issues, a variety of science issues arose including health care issues, environmentally friendly choices, and animal rights. For example, Darlene shared, “One thing that makes me soft is like shark fin soup. Animal endangerment. Like other cultures using animals as food and in Spain with bull fighting. Those catch my attention.” Other students expressed family rules about considering environmentally friendly choices. What was interesting about the range of both social and science issues that the students took a stand on was that they all echoed the idea of standing up for others, especially those that cannot speak up for themselves, doing the right thing, and at times feeling uncomfortable about the situation.

< INSERT FIGURE 1 HERE>

Acting as synthesizers, the lead teachers reflected on the importance of these common messages in a teacher debrief session. Teachers shared students’ ideas from across the different interview groups and revealed similar conclusions about what it meant for this group of students to take a stand for or against something. The following is an excerpt from the debrief meeting after the take-a-stand interviews, where teachers reflected on the key ideas that students shared:

(LT = Lead Teacher)

LT1: We want science that is responsive to students, I heard, as Darlene stated, ‘this is what makes me soft’ that they want to take a stand for animals.

LT2: A ton of students said taking a stand for animals and I heard a lot about that they care a lot about the environment. They stated ‘when we are gone this has to be our stamp of what we leave for other people. Like the environment can’t talk for itself.’ To me they sound like a group of environmentalists and animal activists. These are the two things they are willing to take a stand on.
LT3: Yeah, I heard Janet say ‘It’s like I have to speak up for someone that can’t speak up for themselves. Like with animals I have to speak up for them because they can’t speak up for themselves.’
LT1: That is like Lai who was saying that ‘I have a deaf cousin that I have to speak up for because he can’t, so I have to.’ She has a lot of family in Africa that are blind and she has a beautiful way for speaking up for those that can’t.
LT4: Gloria and many others were talking about being ‘proud of myself.’ ‘Taking a stand means being confident and proud in yourself.’

It was through the small group interviews, post-interview whole group student share-outs, and teacher reflective conversations in debriefs that the teachers worked with students to construct an overall message about what it meant for the whole group to take a stand, landing on the following:

To take a stand for or against something means that we are committed to speaking up for those that can’t speak up for themselves, whether that be animals, the environment, or younger or future generations of organisms.

From this ‘take a stand’ definition the group inquired into science issues in their community. Multiple students in MARS brought up the idea of investigating the toxic lake, Lake Evergreen, which was located outside of the afterschool classroom’s window. It was the same lake that many of them frequently visited and walked by to go to and from school. There was excitement around exploring this lake and when the group decided to focus on it a few students even shouted, “Woohoo!” in delight over our anchoring question of “Why is it so hard to clean up polluted bodies of water?” This delight was around exploring a lake they all cared and wondered about. They wondered why it was a dead lake, why it was polluted, and why people were not cleaning it up.

Communicators of Experiential and Intergenerational Aspects of the Science Explanation

With the lake being part of students’ everyday lives, students became carriers of intergenerational and experiential stories of interactions with the lake to MARS. Many of the students walked to and from school by the lake, visited the lake on weekends with family, or watched the lake activity outside their school windows. Legends around cars being at the bottom of the lake, a horse trying to swim across the lake and dying, and past and present drug/criminal activity surfaced in conversations as stories around why students and the community were no longer able to enjoy the lake recreationally. Parents shared stories with their children from the past of jumping into Lake Evergreen for a swim after Mountain Middle School let out each day. Grandparents shared stories of having picnics by the lake, fishing in the lake, and walking out on the lake dock. As these stories trickled into MARS conversations around the science behind the phenomenon, tension around how the lake “used to be” versus its present condition arose for both the students and the teachers. These stories painted a completely different picture of the lake that existed at the time of MARS; with past stories about a place of recreation and beauty and present day conditions consisting of a lake with no dock, no signs of wildlife, and no picnicking. These historical stories of the lake reinforced the students’ curiosity about why the lake was
polluted. There was a sense of “it not being fair” that the lake used to be a place of recreation and now it was surrounded by signs warning of toxicity.

As activity centered on developing an understanding of the anchoring question in MARS progressed, teachers and students recognized a separation of knowledge about the toxic lake held by students’ families and neighbors and community scientists and stewards. A gap in communication or sharing of the social and scientific knowledge was recognized by the teachers and students, as was the lack of the connection between the science and social stories in thinking about phenomenon. These gaps motivated the group to think about their role in opening up communication about the science behind Lake Evergreen. This communication needed to include an expanded science explanation that incorporated the social ideas and interactions with the lake to dispel myths, inform the community, and ultimately open interactions between families, neighbors, and scientists working with the lake about the real reason behind the lake pollution.

Addressing these gaps between community-based knowledge and scientific knowledge of pollution led teachers and community scientists to plan a variety of ways of communicating the science in concert with students’ and families’ lived experiences. Planning the causal explanation of why Lake Evergreen was polluted and why it was taking so long to clean up naturally called for the incorporation of social aspects of why the lake was polluted. An example of the incorporation of students’ stories was information shared by Katie, an eighth grade student, who frequently came to MARS with new stories about Lake Evergreen in the past. She shared with her family what she did in MARS and in return her family told their stories of past interactions with Lake Evergreen. Teachers took on the role of gatherers of these stories from both informal and formal conversations with the students. The teachers would then use these family stories in debrief meetings to think about implications for broadening what was known about this scientific phenomenon, not just for the students, but also for the community.

LT: You know Katie - that conversation was all about her dad and he used to go to Mountain Middle School and he would go jump in the lake afterschool and he remembers when he stopped going because it was too gross. There are all these myths about the lake, back in the day a horse tried to swim across the lake and it didn’t make it and he drowned. So everyone is like oh. Then she added to it, yeah, someone told my dad that there is a big hole in the bottom of the lake and it drains to Mountain Sea, so there is so much folklore about this lake. That is why nothing is happening in this lake, because people like Lisa (county limnologist) don’t talk to people like Katie’s dad and they have no idea what is really going on.

Teachers worked with students and community members to fold in social aspects into the scientific explanation. Specific social elements that students discussed and included in their scientific explanatory models were: observations of who used the lake and the surrounding park, how the park was used by the community, what structures surrounded the park, how pets interacted with and left waste in the park, the use of excess lawn fertilizer by surrounding schools and houses, and the lack of knowledge about old, forgotten sewer pipes that entered into the lake.

Mapper of Community-Based Knowledge
Planning the curriculum around why Lake Evergreen was polluted meant that the teachers acted as teacher-learners as they planned for instruction around an unmapped phenomenon and that students were synthesizers of different forms of evidence from multiple resources. Teachers and students looked to community members to be community teachers, helping them understand the biochemical explanation behind the toxic lake. An example of this was in planning how floating islands, built and installed in Lake Evergreen to filter water, worked to filter the lake water. Lead teachers and students consulted the county limnologist, a state watershed scientist, and two restoration ecologists. It was through communication with these scientists in planning and co-teaching of afterschool MARS meetings that the lead teachers and students were able to construct ideas and a full explanation of the role of the floating islands in filtering the lake water.

Across the year, community scientists critiqued student explanatory models and helped all students construct a deeper understanding of the unobservable and observable entities within the phenomenon. For example, in the cyanobacteria group Lisa helped students understand how cyanobacteria outcompeted all other organisms in the lake. The conversation started when students stated that the “cyanobacteria killed everything (in the lake).” This statement prompted the limnologist to engage in a conversation that ultimately led to a deeper understanding of what it meant for the cyanobacteria to outcompete other organisms.

(S = student, CL = county limnologist)
Lisa (CL): Cyanobacteria in lakes can actually control where they are in the water, ok, they can make gases that allow them to rise to the surface and these are the ways in which they can compete with algae. Because they can rise to the surface and shade out other algae. So yes, when you get enough cyanobacteria that rise to the surface, they will shade out the sunlight and that allows them to do better than the algae, gives them an advantage.
S: So, yes, it can kill other plants besides algae?
Lisa (CL): Well, when you get enough of them, it’s like nobody is all bad or all good, cyanobacteria are not all bad or good. If you get too much of them, yes they can have bad effects…cyanobacteria were the very first creatures on Earth and when they started evolving there was no oxygen on Earth.
LT: The other thing we have on our poster is the decomposers sucking up all of the oxygen.
Lisa (CL): Yes, that’s right. The cyanobacteria have a short life cycle, so when they die the bacteria at the bottom decompose them. So it isn’t the cyanobacteria using all of the oxygen, it’s the bacteria that are decomposing that use all the oxygen.
S: Ah, so the fish, they die because they don’t have any air, I mean oxygen.
Lisa (CL): Yes. Oxygen in the water comes from the air above it, aquatic plants, and algae…

This excerpt is an example of how a community member acted in the role of community-teacher. From this conversation, the six students and two lead teachers that made up this small group were able to clarify what it meant for cyanobacteria to outcompete and how the lake became eutrophic, meaning a body of water with no oxygen or life. More significantly this altered how the students represented this on their explanatory model and the information they shared with the whole group.
Responders to Community-Based Design Solutions

Designing curriculum around an action-oriented issue called for teachers and community members to take on responsive roles to ways that students could discuss and plan for action as they constructed a science explanation. Addressing this curricular element happened at different levels of interactions in and outside of the classroom and required negotiation of students’ design solutions with community members.

Lead teachers and students looked to community members as consultants on how to use students’ solution ideas to take action on the lake. The lead teachers consulted with Lisa about various solution hypotheses that students had raised in meetings. For example, early on in MARS after examining county-collected data on the amount of toxic cyanobacteria in the lake, one student proposed that the lake be filled with dirt. Although this sounded like an extreme way to take action, the lead teachers asked the county limnologist about her insights on this idea.

LT1: One of our students suggested just filling up the lake so it was no longer a toxic water site. What do you think of that idea? Has that been an option you have considered? Lisa (CL): I think there has been a lot of neglect in regards to Lake Evergreen. I think it is important to ask what could you do with this lake? What would you like to see happen? Sure you could fill it in and then it wouldn’t be a hazard anymore. But what else could we do. Maybe someday it could be something useful for animals and the community if we cleaned up the water. What would happen if it was filled in? You still would have the storm water with excess phosphates. I would suggest being right up front about why should we care?
LT1: Important to think about what are you working towards? Two main goals—be safe for people to swim in it and be able to eat fish out of it. Very practical goals that everyone can relate to.
LT2: It makes me think of this water system in China and people swimming in the cyanobacteria as you (Lisa) talked about.
LT1: Asking them ‘when you are 63 what do you want Lake Evergreen to look like?’

It was through conversations such as these that actions toward solutions were tossed around in conversation, negotiated, and remained the focus of all work.

As the students worked on their science models that explained why the lake was toxic, they decided to focus on designing a nature walk that used four signs posted around the lake to inform the community about the lake’s condition and what actions were needed by the community to better Lake Evergreen’s future. Collectively students weighed action ideas that they brainstormed and others suggested by community members, such as taking a younger group of kids on an informative field trip, designing and installing a bioswale, and holding a community party at the lake.

LT: What solutions do you think you would like to pursue? You have talked about connecting to youth, designing a sign to help the community learn about the condition of
the lake, connect with community by holding a party, and build a model of the bioswale that is needed to clean the water.

S: I think we need the bioswale because we have to clean the water—actually we should do the youth one and the sign one. The fourth one, the bioswale, will take a lot of approval and a lot of time, so we could think of the first one, the signs, as the first thing to do.

S2: It (the nature walk signs) would be our first thing to do, which could hopefully lead to a bioswale.

In multiple meetings based on negotiating and brainstorming using knowledge to take action, the students decided that four signs that combined all of the knowledge and action needed would be the best “first step” in taking action. Through communication with community members and verification that the signs were a viable option in terms of taking action, students took up the nature walk sign design process. This idea to design signs originated from a planning session with the limnologist three months prior to the students deciding to focus on it. She suggested that the students design signs with warnings and needed actions for all ages. She stated, “Some of them (current lake signs) aren’t appropriate for children, but you know with this group do a child’s version of this. Here is what adults can do and here is what kids can do. Students should brainstorm a kid’s version of this.”

Throughout the sign-making design process, students set criteria for how the signs should be constructed and what key information and images should be included on each sign. As drafts of the signs were produced according to set criteria, drafts were sent to community experts for verification of information, quality, and adherence to county regulations. In email correspondence with the Park’s Department Manager about the student-produced nature walk signs, he suggested that the students revise particular parts based on his knowledge of human interactions in and with the lake. Students edited their signs based on feedback from the park manager and limnologist, shared them with the whole group by finding the location near the lake where they wanted their sign to be posted, and then the park manager posted the signs (Figure 2).

Communication of action needed to help the future of the lake with the community was also tackled through the production of a professional documentary film. In the documentary film, the students showed the community a story that mapped how they were using their science knowledge to help the community think about how to better the future of Lake Evergreen. What the film was about and what the film would say to its audience was up to the students in MARS. Narrated around the idea that they (the students) were “just a small group” and could only do so much on their own, the students decided that the film would tell the story around the science behind Lake Evergreen and what their group decided to do to take action in and with their community.

If we stop focusing on the bad about the lake and start thinking about the good then we can start to accomplish our mission to clean up the lake. We decided to create a walking tour that consists of four informational signs. Each sign has information and ways for individuals to take action. (Film Script)
Through film storyboarding and scripting, the students shared that their first steps were to inform community about the condition of the lake and what the lake could be like if the community took certain actions leading to the design and installation of a bioswale.

**Dynamic and Responsive Roles in Community-Based Instruction**

This study operationalized design principles based on using students’ assets as resources, critiquing and expanding canonical knowledge, and using science to engage in transformative action to explore the research question of what roles stakeholders took on when action-oriented science was jointly negotiated in an afterschool science club. Teaching and learning in this science space required roles to be dynamic and responsive to the unique needs found in action-oriented science. As students learned about the toxic lake and ways to clean it up in MARS, stakeholder roles had to quickly shift to address the in-the-moment questions, stories, and uncharted science knowledge. Students took on the role of meaning makers, communicators, and synthesizers of community knowledge, teachers acted as teacher-learners and co-responsive consultants, and community members acted as community teachers, action reminders, and communicators of expert community knowledge. Shifting stakeholder roles centered on the collective goal of the need for a deep understanding of the science behind the lake toxicity and the desire to help the extended community learn ways that they could help the lake’s future. This common goal bonded the stakeholders and focused conversations as they shared ideas, employed these ideas, and ultimately shared understandings and actions with the extended community.

The dynamic and responsive roles allowed for construction of science knowledge and action to be taken in real-time, with community members as invested in the overall goal as teachers and students. With community-based instruction aiming to capitalize on and be responsive to the social, material, and human resources found within and across multiple stakeholders (Bang & Medin, 2010; Medin & Bang, 2014), questions around the feasibility and sustainability of community-based instruction exist in both formal and informal science spaces. Planning for, being responsive to, and exploring uncharted science curriculum in MARS was extremely exciting and gratifying for all stakeholders, but also required an extraordinary amount of coordination on the lead teachers’ part and volunteer time from the community members. Findings suggest that in designing and enacting community-based instruction, such as action-oriented instruction in MARS, practitioners and researchers need to consider who are the willing stakeholders and how to capitalize on stakeholder’s diverse resources and ideas. I discuss these two ideas providing implications for future research on stakeholder roles and voices in action-oriented science spaces.

**Engaging Willing Stakeholders and Expanding the Voices of Enacted Curriculum**

In this study stakeholders shared a common object of work yet incorporated different perspectives and took on different roles. All stakeholders had legitimate interest and concern over the polluted lake next door to Mountain Middle School and they all could find ways to map their interests and concerns onto a common project. The root of interest and concern in the lake was different for each stakeholder, with these differences nurturing the same issue, but in different ways. Student interest and concern was rooted in the desire to make the lake a place of safe recreation for all organisms. Teacher interest and concern was rooted in helping students use
in-depth science to make a worthy change in their community. Community member interest and concern was rooted in collaborating with a new group to help clean up the lake and help inform the community of the issues and actions needed to clean up Lake Evergreen. It was through negotiation conversations that called on various roles over the course of the MARS afterschool club that these roots came together to design responsive curriculum and actions.

One stakeholder’s voice that was not accessed as much as it could have been in this study was the voice of the students’ families. In MARS, family stories that were brought in by students were capitalized upon in terms of using them to reframe what was the science focus and how it was communicated with the larger audience. Literature on community-based designed instruction has described examples of how families have been involved in the planning, but we need examples of how family voices become part of the negotiation process in enacting action-oriented science curriculum and instruction (Bang & Medin, 2010; Medin & Bang, 2014). Family voice in action-oriented science needs to be highly present if we are to fully explore what using science to take action means in students’ communities. Therefore, future research and practice should not only consider how to intentionally involve multiple community members such as scientists and environmental stewards, but also family members in the planning of and instruction of community-based instruction such as action-oriented science.

Capitalizing on Diverse Resources and Ideas from All Stakeholders

Community-based instruction not only requires teachers to identify who the stakeholders could be, but also calls for capitalization of diverse resources and ideas that all stakeholders have to offer (Bang & Medin, 2010; Penuel & Fishman, 2012; Penuel et al., 2011). Truly considering students’ assets as resources in MARS, stakeholders had to go beyond the walls of the science space and reach out, listen to, and incorporate the actions and ideas of community members. Students’ assets, their funds of knowledge, were first and foremost used to frame the authentic and relevant science that was taught and learned in MARS. These assets shaped how the MARS participants took a stand for the toxic lake’s future by combining what the community knew about the lake. Community assets were used in combination with student assets to critique and expand canonical knowledge. Scientists and park personnel were able to help students and teachers expand their understanding as they constructed scientific explanation models and designed the nature walk signs for Lake Evergreen and community film. Lisa, the county limnologist, played a critical role when she consistently planned with the teachers and helped instruct students as they simultaneously constructed an understanding of why the lake was toxic and what actions were needed to help the future of the lake.

Capitalizing on diverse resources and ideas in action-oriented science resulted in a cascading effect of responsiveness beyond the intended curriculum. Designing action-oriented science curriculum with multiple stakeholders required a keen sense of responsiveness, humbleness, and curiosity by all parties involved. Responsiveness was broadened in action-oriented science from teachers being responsive to students to all stakeholders being responsible to all ideas regardless of the stakeholder’s role as student, teacher, or community member. An example of how responsiveness cascaded was when the student suggested filling in the lake with dirt the teacher was responsive to this idea by asking the community member about its validity in terms of taking action for the lake. The community member in turn elaborated on this idea offering a new thread
of discussion in MARS about the limitations and benefits of all actions. Students then responded to the community ideas about weighing out benefits and limitations for any proposed solutions. This cascade of responsiveness flowed into negotiation conversations as the stakeholders decided together what and how science knowledge was used to take action for the lake’s future.

In sum, negotiating action-oriented curriculum as it was being enacted meant that the stakeholder roles were ready and willing to nimbly shift ways of thinking about the lake phenomenon across time and activity. The Next Generation Science Standards (NGSS Lead States, 2013) states “students can engage in scientific and engineering practices, crosscutting concepts, and disciplinary core ideas by connecting school science to their out-of-school experiences in home and community contexts” (p. 9 of Appendix D), but what this means in terms of being put to practice still warrants further examples of the dynamic roles that are needed and tools that teachers and community members can use together to implement community-based instruction.

References


