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Crash Encounters: Negotiating Science Literacy and Its Sponsorship in a Cross-Disciplinary, Cross-Generational MOOC

Stephanie West-Puckett

Abstract

This article examines how scientists, classroom teachers, poetry educators, and youth negotiated the domains of science through their engagement in a two-year Massive Open Online Collaboration (MOOC) funded by the National Science Foundation. To make sense of learners' unconventional and interdisciplinary writing and the cultural and disciplinary conflicts that emerged around it, I offer a reframing of science literacy as a series of crash encounters. Such a reframing prompts literacy practitioners to anticipate fallout when diverse bodies, objects, and rhetorics collide and, therefore, to better design and participate in interdisciplinary networks to create more dynamic and vibrant approaches to science literacy.

Keywords

OOC, science literacy, multimodality, interdisciplinary writing,
crash encounters

A Vignette

On a brisk November morning in 2014, an unlikely group of museum scientists, classroom teachers, and spoken word poets met by the black waters of the Scuppernong River to design a radical science learning opportunity for underserved youth in rural eastern North Carolina. No one was quite sure what form this project might take or how each partner's expertise might contribute to building a collaborative learning experience, but they all knew it would be an experience no one partner could design and deliver alone. Nervous apprehension warmed to excitement, however, when one of the scientists presented each member of the group with a pair of plastic goggles, delicate glass vials, graduated cylinders, natural specimens, isopropyl alcohol, and a mixed surfactant—the seductive stuff of science.

To demonstrate the museum's approach to interactive science, the microbiologist led the group in using low-cost everyday household materials, like the aforementioned alcohol and dish detergent, to extract DNA from a specimen of wheat germ. Each member of the group followed along diligently during the procedure, carefully listening, measuring, and agitating the liquids in their vials. The conversations among the groups became more organic as they passed chemicals back and forth and compared the progress of their extractions. Soon each person held a mucus-like glob of DNA on the end of a wooden coffee stirrer, and the scientist praised the group's veritable success. Looking unimpressed at the scientist and the snotty blob on the stick, one of the teachers questioned, "So what? What do we do with this?" The scientist was clearly confounded and replied, "It's the genetic code of life!" But the teacher wasn't satisfied and pressed, "Yes, I see that. I get that. But why does it matter?"

There was an awkward pause before one of the poets suggested that everyone take a few minutes to write a short poem personifying the snot-like blob. "This makes me very uncomfortable," the scientist countered. "We are trained to avoid the humanization of things that aren't human. It's a dangerous practice." But the poets, led by a highly charismatic and persistent director, insisted, and the group, including the reluctant scientists, set to writing haikus and rhyming couplets. Spurred by the spoken word poets, both teachers and scientists shared a few silly and provocative lines, and the poems opened a robust discussion about the significance of DNA extraction. From there, they brainstormed several learning pathways that young people could pursue to make meaning out of this strange matter. The discussion meandered around both fiction and nonfiction texts that take on the implications of hacking the A-C-T-G codes of DNA. It surfaced the cloning of extinct or nearly extinct animals to increase biodiversity à la *Jurassic Park*, medical research involving extracted DNA cell lines as explored in *The Immortal Life of Henrietta Lacks*, and forensic science applications such as those that helped authorities find the infamous Green River Killer. Together, the group began to see how the push and pull of objects and discourses around objects could make matter matter for themselves and for the young people they teach, a realization that resulted from the melding of their diverse disciplinary backgrounds and expertise.

Introduction

The previous vignette represents just one of the many moments of conflict that emerged as formal and informal educators negotiated the domains of science literacy from multiple disciplinary and institutional vantage points. Brought together through a National Science Foundation grant, these diverse practitioners eventually designed and delivered a large-scale, youth-facing, open, online science literacy program titled *Remix, Remake, Curate*. During the program's design and development stage, numerous tensions surfaced among practitioners in the sciences and those in the humanities as well as among youth participants and adult facilitators, and these conflicts played out across physical and digital spaces. Cultural and disciplinary ways of knowing, doing, and writing (Carter 387) were disrupted by the clash of disparate epistemological and ontological traditions. From these "crash encounters," a term coined by Jane Bennett to describe the ways meaning and matter emerge out of conflict (119), non-hierarchical ways of knowing, doing, and writing science as well as sponsoring science literacies emerged.

In this article, I apply Bennett's notion of crash encounters to community literacy work. This application allows me to account for the disruptive processes as well as the unpredictable, uncomfortable, and often untapped potential to create new forms of meaning *by way of difference* in heterogeneous literacy networks. These impacts have the potential to unsettle frameworks that structure cohesive meaning-making and allow new forms of science literacy sponsorship to emerge. A framework of crash encounters prompts practitioners to pay more attention to the diverse materialities, bodies, and experiences that construct science learning and to better anticipate the fallout of those collisions for both literacy leaders and learners. To illustrate the need for reframing science literacy through a crash encounters framework, I discuss the contrasting ways science literacy has been constructed, consider the role of both formal and informal educators in sponsoring science literacy in a digitally networked society, and note that research must attend to how we better prepare facilitators for engaging in this contested work. Next, I provide a rich description of the *Remix, Remake, Curate* programming and analyze moments in which epistemologies, ontologies, and the technē that construct them collide. Here, I focus on two micro-cases—*50 ft. Shark* and *Eagorilla and Other Mashups*—to illustrate young people's capricious and undisciplined composing processes and detail facilitators' divergent reactions to those practices that thread through online and offline spaces. By analyzing these moments and anticipating such crash encounters in diverse and distributed learning environments, I argue that literacy scholars can better equip themselves to design and participate in more vibrant approaches to sponsoring science literacy. I then conclude with practical suggestions for how literacy scholars might form broader coalitions to do so.

Constructing Science Literacy and Sponsorship

Science literacy, as it has historically been understood in Western societies, encompasses the knowledge of scientific principles and theories (such as the principles of evolution, laws of general relativity, or the big bang theory, to name a few); an understanding of scientific methods (hypothesizing, experimenting, collecting data, analyzing data, etc.); and an ability to integrate this knowledge into personal, civic, and professional life (refusing single-use plastics because one understands detrimental environmental impacts; using data regarding sea level rise to inform community planning; preparation for technology-driven work environments, etc.). Science literacy is central to U.S. American economic success and military security, and the renewed focus on science, technology, tngineering, and math (STEM) in U.S. American schools is generally lauded as a strong return on investment; however, the significance of science literacy extends beyond enterprise and national concern. Science literacy and the human actions informed by it impact Earth's ecological sustainability, the quality of life for its inhabitants, and our own survival as a species (Clough 1).

Research suggests that while science literacy in U.S. America has increased modestly in the 21st century, recovering slightly from its plunge at the end of the 20th century, nearly three-fourths of adults lack a "civic scientific literacy" (Miller). In addition, many U.S. American youth experience only surface engagements with science in K-12 classrooms because science curricula, particularly in elementary schools, have tended to privilege breadth over depth. Furthermore, formal science learning often struggles to meet the needs, interests, experiences, and motivations of a wide range of diverse students and can therefore fall short in exciting curiosity and promoting sustained inquiry and engagement. Falk and Dierking argue that "an ever-growing body of evidence demonstrates that most science is learned outside of school" in contexts such as museums, afterschool programs, and community centers (Falk and Dierking 483). That does not mean, however, that formal schooling has no value for the science learner. Formal classrooms can help learners grasp generalized concepts that learners can build on through lifelong, free-choice science learning (Falk). Most importantly, efforts to coordinate science learning across formal and informal contexts hold great promise for supporting lifelong learners and building civic scientific literacy (Falk et al.).

While only a small fraction of U.S. Americans consider themselves well-versed in science and technological advancements, many citizens are unsettled by the ethical issues that are raised by innovation in life sciences such as human and animal cloning (Siang). Such concerns about ethics underscore the problem of disciplinary siloing in U.S. American institutions. Scientists asking questions of "What, when, and how?" haven't traditionally engaged humanists asking, "Why and for whom?" And if these engagements do take place, they often take the form of humanities scholars reacting to scientific practices with questions of *meaning* being taken up after questions of *matter*. Feminist physicist and philosopher Karen Barad argues that this kind of siloing, across or even inside disciplines, is the wrong approach. Barad cautions, "... the notion of consequences [of scientific research] is based on the wrong temporality: asking after potential consequences is too little, too late, because ethics of course, is being done right at the lab bench" (qtd. in Dolphijn and van der Tuin). In other words, we can't afford to ask *retroactively* of science and technology "Why?" or "For whom?" Those questions of ethical responsibility, the kinds of questions that humanists are good at asking and exploring, must instead *inform and guide* scientific and technological research, practice, and literacy sponsorship. Given these ethical challenges, it is apparent that interventions aimed at increasing science literacy need to not only coordinate efforts across learning spheres but also coordinate learning across disciplinary terrain.

In addition to exploring the geographies of learning spaces and disciplinary terrain, researchers argue that we must pay attention to how particular people in particular places and times operationalize the concept of science literacy. In contrast to the more abstract and acontextual notions of science literacy posited by the professional and governmental organizations at the beginning of this section, environmental educators and literacy researchers point to materiality, embodiment, and everyday practice as key aspects of science learning. Drawing on training in environmental biology as well as indigenous cultural knowledge, Anishinabekwe scientist Robin Wall Kimmerer argues for an approach to science that foregrounds "restorative reciprocity" ("Restoration" 260). Restorative reciprocity holds that our scientific knowledge of the natural world is born from our relationship with it. To deepen knowledge, then, is to deepen a reciprocal relationship that involves both caring for and being cared for by the earth. For Kimmerer, science literacy does not arise from objective study but instead grows from being with a diversity of bodies—plant, animal, spirit, human—who have their own stories to tell (*Braiding*). Likewise, Ortoleva's ethnographic study of the Narragansett Indian Tribe's ecological relationship to the Narragansett Bay reveals how embodiment can serve as a catalyst for scientific literacy as well as grassroots environmental advocacy and action. Ortoleva identifies this instantiation of science literacy as "biospheric literacies of the body" (59) and describes its conditions as "transformational moments when body and place connect and the literacy acts that result from this connection" (59). Drawing on Indigenous ontologies, Ortoleva's theory, like Kimmerer's, grounds the material dimensions of science literacy and points to the processes of building science literacy from the individual to the ecological scale. Complementing the everyday practices of science learning such as braiding sweetgrass and bathing in saltwater, Briseño-Garzón et al. found that members of marginalized communities read and write science-informed texts as an ongoing process of building their lifeworlds. Their study found that motivations for engaging in science reading and writing practices outside of formal schooling include, but are not limited to, the human need to be more entertained, informed, equipped, and challenged. Briseño-Garzón et al. argue that traditional approaches to science literacy foreground discrete skills, knowledge, and acontextual understandings of scientific contexts and practices while ignoring science literacy as a lifelong and life-sustaining practice that is "…always contextualized and meaningful when related to the specific needs and realities of people" (103). The approaches described in this paragraph point to the material, embodied, and quotidian nature of science learning informed by culturally diverse perspectives, the likes of which have not traditionally been foregrounded in discussions of science literacy and how to best sponsor it.

Relatedly, as Internet technologies have proliferated over the last quarter century and the World Wide Web has transitioned from a read-only to a more participatory read/write web, both formal and informal science learning organizations in the United States have wrestled with how to sponsor science literacy in networked environments. Semper argues that this shift requires rethinking the concept of a museum. He writes, "Our first challenge may be to get beyond the physical notion of what a museum is. Rather than thinking of ourselves as isolated institutions, we need to think of museums and our audience as nodes in a net of connections." Since the early twenty-tens, science museums across U.S. America have been experimenting with such programming, while researchers have focused on best practices in informal (aka "free-choice") science learning as well as how those best practices lead to better learning outcomes (Ennes and Lee). In this vein, writing studies scholars Sackey et al. investigate an online science literacy program sponsored by the Science Museum of Minnesota (SMM). Their findings illustrate a set of conditions that promotes transformative online science learning, including the careful choice of technological platforms; the design of open-ended activities to prompt participants to become more aware of themselves and their physical, social, and cultural environments; and embedded opportunities for participants to share related perspectives, reflections, content, and media that they encounter in their daily lives. Sackey et al. also highlight the importance of engaged facilitators who are adept at leveraging the capabilities of chosen technologies; proficient in promoting and encouraging critical awareness; and skilled at prompting learners to reflect on new information and perspectives to think differently about science. They argue that such facilitation, as a practice of rhetorically constructing online learning environments through specific writing strategies, can be "seen, taught, and learned" (122).

Pinpointing these specific moves, as Sackey et al. have done, is essential to understanding the performative work of online community facilitation; yet, cultivating the orientations and abilities they have identified is, in practice, a difficult task. It becomes more difficult when online science literacy programming is attempted across formal and informal settings, disciplinary terrains, diverse cultural backgrounds, distributed platforms, and real bodies in particular times and places. As demonstrated in this review of literature, there are a host of discursive and material bodies with different orientations, experiences, and emotions at play in such initiatives. Given these material realities, a purely discursive approach to considering the performance of facilitation moves may struggle to shed light on the embodied experiences, emotions, and motivations of facilitators and learners. Related to this, Palloff and Pratt (2007) argue that focusing solely on the textual performances in online learning communities runs the risk of disembodying learners and leaders. They argue that to ethically build and study online learning communities, we should foreground embodied presence and the ways that such presence can "personalize and humanize" online learning and its scholarship. To be clear, I don't think Sackey et al. are guilty of disembodying their research participants, but I am suggesting that a multiple-methods approach to studying online communities, which I describe in the following section, is useful as scholars seek to learn more about how both facilitators and participants navigate the challenges, conflicts, and crash encounters of vibrant science learning.

Multiple Methods Study Design

The findings shared in this article, which point to the importance of more dynamic and vibrant metaphors and practices for sponsoring science literacy, were analyzed and interpreted from multiple data sets collected between January and May of 2016. These data sets include semi-structured interviews with facilitators; publicly available data on the *Remix, Remake, Curate* online platforms; grant applications, reports, and facilitator notes; as well as experience narratives written by the scientists, spoken word poets, and classroom teachers who designed and delivered this open-ended science literacy programming (MOOC). Borrowing from work in grounded theory (Magnetto; Farkas and Haas), I (with the help of my dissertation director, William Banks) engaged in three practices of data analysis: qualitative coding, reflecting through the co-production of coding memos, and creating 3D representations of the coding schemes. Most important for this article and for the methods that allowed a crash encounter framework to emerge, I employed selective coding to identify and taxonomize participants' affective valences. Affective valence, as I employ the term, refers to the relative comfort or discomfort of experience, and, as Chang et al. argue, affective valence is central to how individuals perceive their agency in each context. In response to prompts that invited participants to elaborate on both positive and negative orientations toward the material aspects of networked production of science literacy, a host of negative valences, particularly anxieties, were expressed. Axial coding methods revealed that these anxieties were overwhelmingly linked to feelings of ill-preparedness in addressing hybrid, ambiguous student compositions. The two micro-cases shared in this article were constructed developing linkages across data sets and provide empirical evidence that suggest that science literacy might be better understood, practiced, and sponsored by frameworks that acknowledge that literacy acquisition is just as much, if not more, about disrupting, crashing, smashing, and breaking as it is about adding to an already existing set of knowledges and practices.

Remix, Remake, Curate MOOC: Context

Recognizing the responsibility of community partner organizations in increasing science literacy, as evidenced in the two-year partnership between the Association of Science and Technology Centers and the National Writing Project funded by the National Science Foundation in 2014, the purpose of this partnership was to engage formal and informal educators in designing science literacy programming that would thread through in- and out-of-school contexts. This funding opportunity, informed by the principles and practices of connected learning (Ito et al.), galvanized the North Carolina Museum of Natural Sciences, the Tar River Writing Project at East Carolina University, and the Poetry Project to imagine online learning opportunities for rural eastern North Carolina youth, primarily low-income youth of color, who had limited access to local or regional science centers.

These imaginings eventually produced the *Remix, Remake, Curate* Massive Open Online Collaboration (MOOC), a variation on the for-credit MOOCs phenomenon that trades the *course* construction for a focus on *collaborative*, social learning and network building across institutional boundaries (West-Puckett et al.). From 2014 to 2016, seven museum scientists, thirteen K-higher education faculty, and six spoken word poets facilitated fifteen weeks of intensive online science programming with more than fifteen hundred youth across grade levels and educational contexts. *Remix, Remake, Curate* was informed by the principles and practices of citizen science, a branch of participatory science that promotes collaboration between scientists and the general public and that fosters public appreciation for scientific knowledge-making (Trumbull et al.; Brossard; Cronje et al.). However, unlike dominant approaches to citizen science, which primarily cast public participants in data collection roles for large-scale scientific inquiry, the *Remix, Remake, Curate* MOOC was designed to afford manifestly divergent, critical, and context-specific participation options.

To span vast geographical distances, age, and experience levels, facilitators designed online opportunities for young people to contribute to ongoing research projects and share science writing produced as part of those research projects. For example, in one community invitation, youth were invited to document flora and fauna in their neighborhoods or on their school campuses with the iNaturalist mobile application. Similarly, young people were encouraged to compose, perform, and digitally record spoken word poetry. Using the museum's in-house application SoundSee (figure 1), students were prompted to upload their recordings to the museum's public collection of human voice files, which enabled participants to visualize the waves that compose the unique timbre of each human voice.

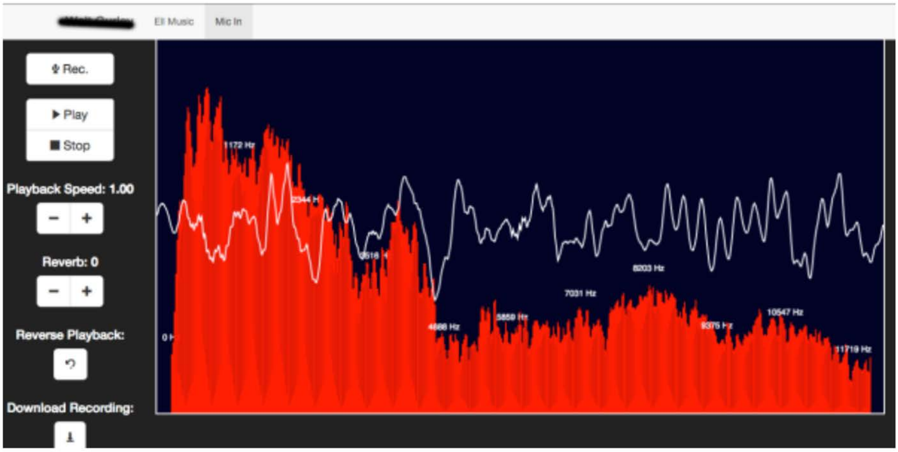

Figure 1. SoundSee application screenshot.

To prioritize access and accessibility, the *Remix, Remake, Curate* team not only used everyday materials to make science but also used openly networked digital tools like WordPress, Twitter, and Google+ to overcome geographical and economic boundaries and connect classroom and youth learners across the state. Each *Remix, Remake, Curate* facilitation team included at least one poet-educator, one scientist, and one classroom teacher from the elementary, middle, and secondary or college level. Each facilitation team designed and facilitated one writing and making unit during each year of programming. The first year, these units lasted one week each; however, the second year, facilitation teams extended the duration to two weeks to allow more time for youth and facilitator engagement. The units focused on the following areas of inquiry:

- biodiversity and backyard citizen science
- the art and physics of sound
- collecting and curating nature and memory
- exploring the microworld of crystals
- insect and arachnid anatomy and physiology
- biotechnology and life codes
- computer programming languages and coding meaning on the web

These units were largely determined by the participating scientists' expertise as well as their affiliation with a particular public science lab at the museum. The poets and teachers chose to work with the scientists based on their own personal and professional interests. Over the two-year project span, facilitation teams met for four extended planning and debriefing retreats and collaborated through hundreds of phone calls, group messages, emails, and collaborative online tools like Google Documents and Google Hangouts.

Scientists and poets participated alongside students and teachers during each unit. They developed and shared video tutorials and poetry performances that showed them working on similar inquiry projects in both their labs and their living rooms. They responded to youth makers' science and poetry compositions, which were shared in the Google+ community. They engaged in live Google Hangouts and Twitter Chats with participants by answering questions and discussing their research and writing. They posed big questions about ethics and responsibility, and they modeled curiosity, engagement, and, at times, failure in open online spaces.

Remix, Remake, Curate MOOC: Design and Delivery

While planning the make cycles, facilitation teams foregrounded three domains of literate practice, which they mapped across the disciplines of science and writing studies: *concepts, practices,* and *values*. These domains provided the basis for open and flexible curriculum pathways in each make cycle. For example, during the first make cycle of year two, which focused on biodiversity and citizen science, facilitation teams developed programming to lead participants in tracing biodiversity (*natural science concept*) by having students document and observe (*natural science practices*) the life forms that assembled around their porch lights by taking field notes (*scientific writing practices*). Participants used their field notes to draw conclusions about the relationships between weather and insect behavior (*scientific practices*) as well as to personify, craft, and perform dialogic poetry between various life forms they observed (*creative writing practices*). Young people and their adult mentors, including classroom educators, youth leaders, and family members, shared their observation notes, photos, videos, drawings, questions, problems, hypotheses, and poem drafts in the various online forums of *Remix, Remake, Curate* (*peer review practices common in both science and creative writing*). Through generous feedback on the participants' shared compositions, facilitators celebrated close attention and curiosity, two *values* that were shared by both scientists and poets. Facilitators also explicitly named and labeled the use of poetic devices such as hyperbole and exaggeration, noting how these strategies created rhetorical significance but were ill-fitting devices for scientific inquiry as they lacked *accuracy* and *precision*, values that undergird effective meaning-making in the sciences. By providing a space for combining poetic, rhetorical, and scientific language practices, youth participants were encouraged to develop critical literacy practices that grapple with disparate ways of knowing, doing, and being across disciplines.

Over the course of two years, the *Remix, Remake, Curate* Google+ community engaged 377 Google+ users as members, with 148 considered "active," meaning they posted at least once in the community. The community doubled its reach in year two by increasing membership in the Google+ community by 65%. Facilitators and participants logged a total of 453 posts in the Google+ community, 590 +1 "like" or "recommend" responses, and 1,098 comments on participants' posts. Appendix A includes a representative listing as well as photos of select science media that were posted and shared in the community as responses to the open-ended invitations to the make cycles. Open-ended invitations were posted on the homepage of the WordPress blog (https://trwpconnect.wordpress.com/) and emailed to participants at the start of each make cycle. They were titled "Welcome to Make Cycle . . ." and signaled transitions to new shared foci within the MOOC. While far from complete, the artifacts in Appendix A indicate the diversity of individually and collaboratively composed products that materialized in the MOOC network in response to such invitations.

These compositions were assembled from a variety of digital and analogue matter threading across online and offline places. In the digital places of the MOOC, they are flattened into code and translated into bits and bytes that can travel across the World Wide Web. It's important to remember, however, that all of these compositions are both material and discursive, as they engaged composers' bodies, other objects, hardware, software, and infrastructures of delivery, as well as the material and embodied practices of meaning-making (Grabill; McKee and Porter; Palloff and Pratt; Banks and Eble; Fleckenstein).

As demonstrated in Appendix A, youth composers shared several playful poems, silly mashups, as well as outrageous science- and science-fiction-inspired compositions. These compositions engendered uneasy tensions between youth and adult desires as well as humanistic and scientific literacies. Throughout the duration of the MOOC programming, facilitation teams struggled with how to respond to unconventional science writing and making. In the two examples that follow, I describe these compositions and discuss how their impacts reverberated through *Remix, Remake, Curate*. These reverberations produced multivalent affective responses including anxiety and dissociation and prompted interventions that would help facilitators cope with the fallout of interdisciplinary and intercultural collision.

Remix, Remake, Curate Micro-case Study: 50 ft. Shark

The anxieties and behaviors around an elementary student's posting in year one became a flash point for the group. During the "Collecting and Curating Nature and Memory" make cycle, a student shared a memory about visiting an aquarium and learning about a shark, using the digital composing tool ThingLink to create an image with embedded digital content (figure 2). The student's teacher, a participating facilitator, posted a link to the student's digital composition, which included a photograph of the student holding the paper drawing with one line of anchored text that reads, "He is about 50 feet long." The teacher added the following comment to the post: "This is [student's] nature story about a shark he saw at the aquarium. We are going to double check on the size of the shark. He may still do some editing so feel free to ask questions and he can add them to his digital story. . . ."

Soon after the posting, two teachers commented on the composition, appreciating the student's work with digital literacy tools and nature narrative; yet there was no response from the scientists. When questioned during a subsequent facilitator meeting about the absence of their feedback, the scientists acknowledged that they were not comfortable responding to digital texts, as their previous educational programming was largely enacted in face-to-face settings with students producing science experiments as opposed to science texts. Beyond their discomfort with responding to student compositions in public forums, the scientists were also unsure how to promote scientific thinking and communication practices in this creative space. “Is it our role in this MOOC,” one asked, “to tell the students they are wrong? Do we just let these kinds of inaccuracies go, or should we be correcting them?”

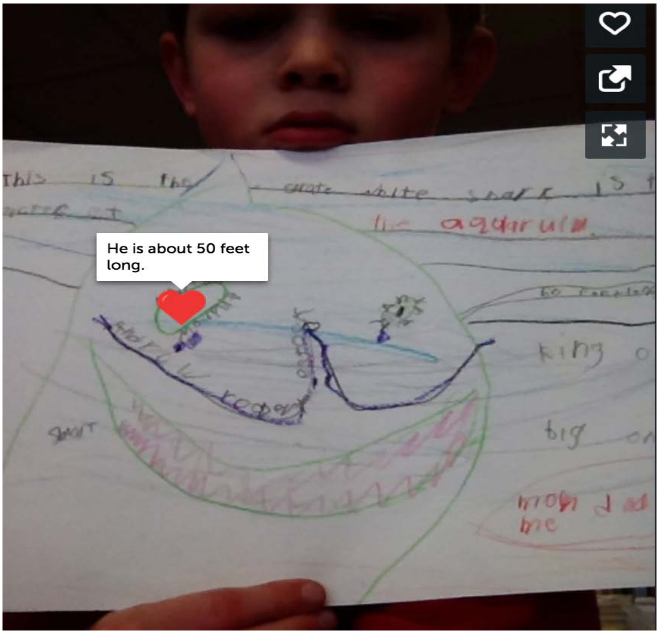

Figure 2. 50 ft. Shark

The case of *50 ft. Shark* exemplifies how youth composers brought together disparate material and discursive domains to make meaning about experiences with other bodies in the natural world. As is characteristic of informal science learning centers such as aquariums, the author of *50 ft. Shark* engaged a material, embodied, and affective encounter with a different species from the natural world, processes described by Ortoleva’s notion of biospheric literacy. Clearly, the student was impacted by this engagement, and, I conjecture, the elementary student’s understanding of the shark’s size is likely understood in terms relative to his own body. In communicating with others in the MOOC about his encounter, the student mashes multiple discourses—visual, narrative, digital, numeric, embodied, and scientific. The resulting text can be read as a collision of discursive, material, affective, and disciplinary ways of knowing and doing science. The student’s classroom teacher later reported that the student was eager to conduct secondary research to determine if the initial size estimation was correct, and, ultimately, the student revised the text to represent a more accurate length. The revised draft, however, was never shared in the MOOC community platforms. Teacher facilitators reported this was common, as the more sustained engagement with revised thinking, writing, and making was often shared in the classroom but not necessarily reposted publicly. These reports indicate that while *Remix, Remake, Curate* was effective at prompting crash encounters that foster openness, curiosity, flexibility, and creativity, classroom educators played a key role in leveraging those collisions in their local contexts to promote persistence, responsibility, and critical reflection on students' processes and products.

Remix, Remake, Curate Micro-case Study: Eagorilla and Other Mashups

Another example of these crash encounters can be seen in ways youth composers participated in "bursting" as they rapidly iterated on each other's compositions in the "Biotechnology and Life Codes" make cycle in the spring of year two. According to Anna Smith et al., "bursting" or the "burst effect" is a networked composing phenomenon that occurs when there are "sharp increases in participant production for a short period of time" (9). During this make cycle, high school students began rapidly producing visual mashups of fictional animal and human-animal mutations using Adobe Photoshop. Those compositions exemplify how youth composers were making meaning of their experiences extracting DNA from wheat germ as the facilitators did in the introductory anecdote. The classroom teacher leading these physical and digital experiments posted to Google+ early that day stating that the class was engaged in "Extracting DNA in a Dreamweaver class. Exploring the connection in Science, Writing/Poetry, and Graphic Design." During that same school day, sixteen different animal mashup images were posted, including two of the most popular posts of all time in the Google+ community (figures 3 and 4).

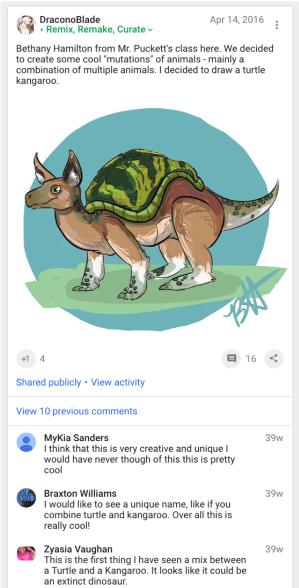

Figure 3. Turtle Kangaroo.

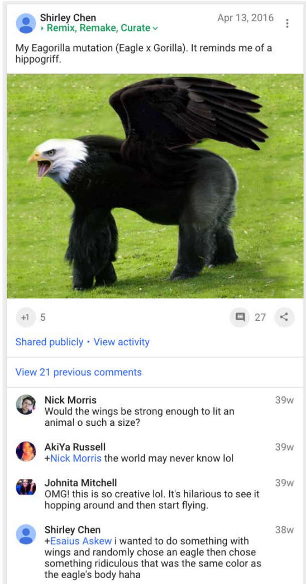

Figure 4. Eagorilla.

These posts were re-shared more than any others in the Google+ community, and they received the most comments from other participants, with *Turtle Kangaroo* (figure 3) receiving 16 comments and *Eagorilla* (figure 4) receiving 27 comments, mostly from other student participants. In the comments section of each post, students asked questions about the mutated animals, prompting the youth mashup artists to compose fictional texts about the animals' anatomy, diet, and mating behaviors. These scientific concepts and natural science discourses threaded through from the previous make cycle about insect and arachnid anatomy and demonstrate how youth transferred learning across their MOOC experience. In addition to this language appropriation, the youth composers also re-appropriated scientific discourse as parody. Their language play created a comedic effect that was recognized and picked up by other students. One student noted that *Eagorilla* is the "definition of America!!!!" and several students agreed and included the hashtag "#murica" in the comments. These students were clearly familiar with the popular (at that time) Internet meme "Murica," which invokes the rural pronunciations of "America" that are often associated with deeply held values of nationalism, patriotism, and American strength. The meme is ambiguous in nature, as it is used to both support and criticize a particular Southern American stereotype, and students' use of the hashtag remains ambiguous as well. It is unclear whether students were expressing support or leveling critique, but what is clear is that they were blending science with Internet culture generally and meme culture more specifically to create a viral mashup sensation.

In response to this activity, a teacher commented, "I love these so much precisely because they seem so impossible. It's the stuff of science fiction . . . ," but that comment was dropped as students ignored the teacher and continued the extended banter among themselves. Another student commented, "If I saw this I would probably take a selfie with it! lol." Another of the participating teachers commented that these mashups invoked questions about authenticity and ethics. The teacher then used the tagging feature of the Google+ platform to invite the make cycle's facilitating scientist into this lively discussion. The classroom teacher asked the scientist to address the plausibility and implications of these fictional life forms; however, the scientist did not respond. The scientist neither engaged the conversation around this post nor commented on any of the related animal mashups or human-animal mashups. This is a peculiar silence considering the same scientist had commented on other posts shared during the same unit, particularly the photos of DNA extraction that were shared concurrently with these Photoshop mashups. While timing may be partially responsible for the silence, this is also likely related to the scientist's expressed frustrations about responding to imaginative content that fell outside the parameters of descriptive science writing and science making. Instead of seeing this as a fault or failure of the participating scientists, we can see this absence as more indicative of a flawed design process that did not adequately prepare facilitators to navigate the unexpected crash encounters that emerged in these Photoshop mashups.

Like the elementary composer of *50 ft. Shark* whose ways of making meaning of the natural world were located at the nexus of multiple modes and discourses as well as embodiment and affect, the high school participants were also demonstrating literacy practices sponsored by the collision of diverse nodes in the *Remix, Remake, Curate* network. The high school students' material and embodied encounters with DNA extraction, digital photo-manipulation tools, and Internet culture prompted them to imagine new life-forms that were framed through cultural, social, and political discourse. As both viral sensation and science that is just/barely fiction, *Eagorilla* demonstrates the adolescent composer's expansive and integrated literacy practices, which are layered and accelerated by emotional valences.

Historically, these emotional valences, including humor, sarcasm, and silliness, have not been embraced as important components of literacy, especially science literacy. The classroom teachers and the poetry educators who are more proximate to students' everyday literacy development were more willing to examine and work through these affective results of collisions and the creative products they engendered; however, even they found it difficult to leverage these crash encounters as a means of approaching more critical examination of issues such as ethics and power that were raised in students' writing and making. For example, none of the facilitators prompted students to contextualize "#murica," to define the ways they were using the term to support or critique or to consider how or why the hashtag could be problematic or offensive to other members of the community.

Remix, Remake, Curate Response Protocol as Conflict (re)Mediation

In response to this unconventional science making, facilitation teams—including scientists, poets, and educators—worked during the intercession of year one and year two to build a student response protocol. The protocol, included in Appendix B, was intended to make the practice of responding more participatory and distributed and to help facilitators guide youth participants to examine and reflect on the rapid production and iteration in the network. The protocol includes three techniques for responding to students' interdisciplinary writing and making across distributed platforms: noticing, appreciating, and encouraging. Facilitators drafted sentence stems that helped them to name the meaning-making moves commonly employed by poets as well as those employed by scientists. They also included options for noticing the disconnects between meaning-making in the humanities and in the sciences with prompts such as, "How might a scientist look at ________ differently than a poet? What would the scientist focus more on here? What about the poet?" In addition, the protocol prompted facilitators to value the unconventional texts students produced and permissioned them to dispense with ranking and evaluating in favor of appreciating. This proved to be one of the affordances of working in informal science learning contexts, as classroom teachers could untether themselves from the common practices of judging and quantifying judgments in the form of grades that are required in formal education contexts.

The final technique embedded in the response protocol provided language to prompt contextual connections and position youth writing and making as the beginning of broader conversations about the value of science literacy in a time of rapid technological advancement. All too often in formal education settings, a student's composition is treated like an artifact or a relic of their learning, but this practice represents a temporal error in thinking about literacy acquisition. Shifting the temporality privileges the messy and undisciplined making, doing, producing, writing, juxtaposing, and experimenting and recognizes composition's potential to serve as a catalyst for more reflective and critical literacy. In discussing the aims and pedagogical actions related to critical literacy, Vasquez et al. note that critical literacy is nurtured when learners produce texts for diverse audiences and "let the texts do the work" (307). In this case, "the work" of *50 ft. Shark* and *Eagorilla and Other Mash-ups* was disruption. Teachers expressed anxiety. Scientists retreated. More could have been done by facilitation teams to address adult anxieties and absences so that youth composers became more aware of those impacts, but, again, this speaks to the possible limitation of informal science learning. Teachers reported that some of these conversations happened in the classroom; however, details of those experiences are not captured in the data collected for this study.

Arguably, the most valuable aspect of the response protocol was its invitation to facilitators to express a diversity of embodied and experiential reactions to youth writing and making. The protocol foregrounded interpretive difference as facilitators developed language to name and communicate their divergent embodied and experience-driven responses to unorthodox science writing. The protocol enabled facilitators to move beyond binary notions of "right" and "wrong" and prompted them to both acknowledge their own embodied and affective experiences of writing and making science as well as those of the youth participants. By drawing attention to the different vantage points from which readers approach texts, the classroom teachers and the poetry educators demonstrated how to think critically about a text's impact on different audiences. Unfortunately, however, the scientists' viewpoints and reactions were largely missing from some of these conversations, leaving young people unable to access important feedback about what the scientists themselves might appreciate or critique. Ultimately, the protocol could not solve the problem of retreat and avoidance. While valuable, the intervention was enacted late—perhaps too late—during the partnership and programming. As such, *Remix, Remake, Curate* did not fully leverage the impacts of crash encounters as a catalyst for the critical work of reasoning around how wild science-fiction fantasies are not so far removed from the foreseeable future and its formidable realities.

Implications and Suggestions for Facilitating Vibrant Science Literacy Programming

Reframing science literacy through the metaphor of crash encounters places particular emphasis on the reciprocal transformations that occur when bodies of knowledge, discourse, and organic and inorganic materials collide. Such a dynamic notion of literacy works to empower learners to move across contexts, disciplines, cultures, media, and modes. In addition, a crash encounter framework can help scholars and practitioners follow learners and composers across those modes, even when the disciplinary and cultural territory is unfamiliar and uncomfortable. At the same time, it's important to keep in mind, and to prompt scholars and practitioners to consider, the risk inherent in metaphors that encourage impact and collision. Just as the world's largest particle collider, the Large Hadron Collider, creates high-energy radiation-emitting particles and the potential for small-scale nuclear damage, literacy colliders like *Remix, Remake, Curate* can create incidental impairment, particularly in the form of cognitive dissonance and conflict retreat, as is demonstrated in the examples of *50 ft. Shark* and *Eagorilla and Other Mashups*. Practitioners engaging in such crash encounters should prepare for unintended consequences of such destabilizing labor and develop contingency plans for engaging its fallout. To leverage crashing as a catalyst for more critical interdisciplinary literacy, practitioners in the sciences and the humanities might learn to follow youth composers on these collision courses and develop their capacity to facilitate sustained conversations regarding the relations of power that are embedded in the texts they create.

Recent scholarship in the field of literacy studies posits that mobility is a more important concept for understanding literacy development as learners are perpetually moving through a variety of online and offline media, knowledge domains, as well as formal and informal learning contexts. Literacy learners are also moving with a diversity of people, languages, objects, and ideologies and are carried and directed by multivalent affective currents that structure meaning beyond rational and linguistic domains (Compton-Lilly; Stornaiuolo et al.; West-Puckett). This article builds on theories of movement by attending to the crash encounters that are inevitable in such busy literacy learners' lives. Through these encounters, learners impact and are impacted by a host of others. As a result of these impacts, learners remix and remake themselves, creating new ways of knowing, doing, and being. When learners are allowed and encouraged to pursue such crash encounters, their experiences also have the potential to act back on the disciplines—*if* we are willing to re-examine and rethink what counts as poetry or what counts as science.

As demonstrated, there is great promise in interdisciplinary, open, online programming such as *Remix, Remake, Curate* to prompt more dynamic, flexible, and vibrant approaches to science literacy; however, certain changes to program design and delivery may be useful to promote and leverage crash encounters and foster more critical engagement with the tools, processes, and values of scientific inquiry. First, program developers and educators need time to create sustainable partnerships across institutional and disciplinary contexts. While two years may seem like an ample duration to build and plan programming, *Remix, Remake, Curate* facilitators were pressed to develop both new curricula and open-source digital platforms to deliver the curricula within the timeframe. As a result, the interpersonal work of negotiating roles, articulating commitments, discussing communication preferences, and making space for frequent debriefing and processing of experience was given too little attention. For example, facilitation teams were never prompted to discuss what to do when teammates retreat or disassociate and could have benefitted from concrete strategies to call collaborators back into these difficult public conversations. In undertaking this interpersonal work, program developers and facilitators should expect multivalent affective orientations to composing through difference, and they should acknowledge, appreciate, and discuss those emotional responses straightforwardly. The goal of discussion is not to smooth over difference or reframe negative valences. As I demonstrated with the anxieties around youth composing that led to the creation of protocols, negative feelings can prompt important work. Honest conversations can help educators become more attentive to how affect is essential to literacy work for both teachers and learners. Having these conversations and producing accords, like that of the response protocol described in the last section, might prove more effective if positioned earlier rather than later in the partnership development.

Second, program developers should work with partners to bring youth composers into the planning, development, and delivery of programming. In hindsight, an excellent use of grant funds would have been to provide stipends for youth mentors to work with each facilitation team. Science centers may have junior docents or camp counselors, and participating schools may have poetry and robotics clubs from which to recruit youth mentors. Such a move to fully integrate young people in planning and development would help to center their experiences, interests, aims, and motivations in open science education initiatives. As anyone who teaches peer review knows, youth, too, can benefit from learning to give meaningful feedback to difficult texts. If youth facilitators had been involved in negotiating the response protocol, the protocol may have been more effective in prompting critical conversations.

Finally, if the goal of science literacy is to prepare young people to effectively address critical global issues such as biological conservation, health disparities, and viral pandemics—both locally and globally—perhaps we might start with these real-world problems instead of the "problem" of science literacy. The *Remix, Remake,* *Curate* programming foregrounded composing interdisciplinary texts instead of composing solutions through interdisciplinary processes and frames. In contrast, youth composers and facilitators might collaboratively identify problems, issues, and concerns that are at the forefront of their own anxieties, interests, and passions and build programming that engages others in sustained cross-cultural and cross-disciplinary inquiry. Instead of linear programming that mimics the ways students march through curricula in formal education settings, facilitators should consider offering writing and making units that run concurrently for a longer duration and ask participants to self-select a particular group that focuses on a local or global issue that they investigate using the tools and techniques of science and poetry. Research that explores the impacts of free-choice and motivation in science learning supports this intervention (Falk; Falk et al.; Miller). Falk et al. note that a broad approach to science literacy does not consider the specific experiences, questions, and personal interests that motivate people to learn science across their lifetime. They also note that when investigating science literacy among professional scientists, few have a deep knowledge of science outside of their area of expertise. This is not a deficit for professional scientists or the science learner, they argue; it is simply the consequence of living and learning in an information age in which "…access to content- and context-specific information is readily available" (464). Promoting free-choice and supporting science making and communicating that are more personally motivated could still provide space for collisions of the *50 ft. Shark* and *Eagorilla* kind; however, more time would allow facilitators to better make sense of the fallout and drive students toward more critical thinking and composing.

By taking up these suggestions, program developers can support literacy practitioners in relaxing resistance to matter and objects and encourage partners in the sciences to do the same regarding discourse. This means we must embrace the impact of crash encounters, rather than seeing science and humanities as two different lenses, if we are to grasp what that snotty blob of DNA is as well as what it means for the future of our world. Thus, we should not just *look at* but also *listen to* and *feel* the material and embodied world of science composing, approaching critical questions about both *matter* and *mattering* (Barad 3). While I'm certainly not advocating here that scholars dispense with rigorous, discipline-specific methods of investigation and knowledge-making, I am suggesting that we understand those methods differently when we see them diffracted through other disciplinary ways of knowing, doing, and being. What's more, through cultural and disciplinary intra-activity, we can approach a new space of science + literacy that acts back on each discipline and transgresses boundaries that restrict integrated meaning-making. These transgressions can enable educators to sponsor more dynamic and meaningful science literacy initiatives and cultivate lifelong learners who engage science as life-enriching and life-sustaining quotidian practice.

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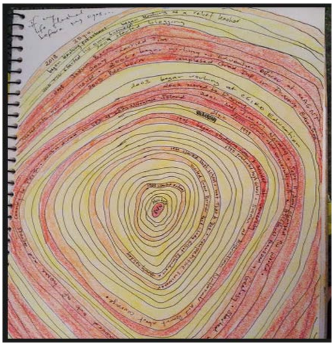
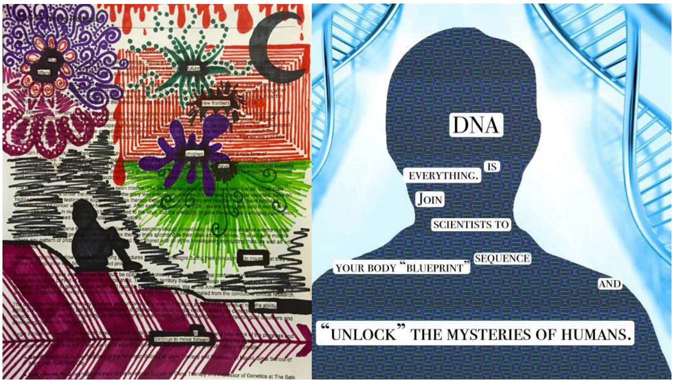
Appendix A

Science Media Examples



Student poem about tree growth and time.



Student blackout poems, made from informational texts about DNA.

Student insect painting, observed during from porch light science.

Student six-word poem coded in HTML using Mozilla Thimble

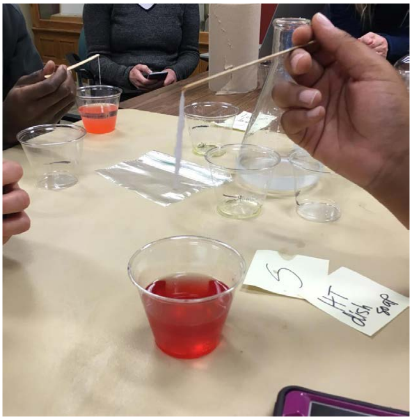
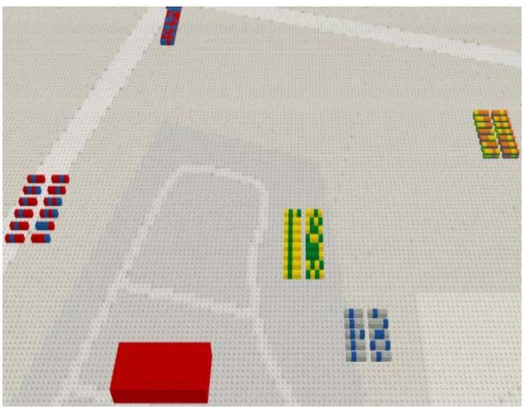


Photo of students extracting DNA.

Video of a youth participant singing about butterflies while playing the ukulele, available on YouTube at https://youtu.be/zSZ3tZE-1Jg.

Poetry how-to video created by a poet facilitator, available on YouTube at https://youtu.be/1pxvaT07uDk.



Screenshot of a digital landscape of student names coded in binary with digital Legos.

Appendix B

Facilitator Response Protocol

Noticing the science:
I notice…
You did _____ like a scientist. I know this because you____.
I see the science of _____ here.
I think it's interesting that you said _____. Do you have any ideas why that happened?
I like how you connected…
Have you thought about which systems...
I like how you've thought about the system of_____.
What else do you want to know?
Wow! That's an interesting observation, and I'm curious because I've never seen or heard of a __________ (do or look like or be as big as, etc.) ____________. They are typically more like _________.
Here's a good resource to learn more about…
Tell me more about your practices of (observation, documentation, experimentation, etc.)...

Noticing the poetry:
I noticed you used ___ like a poet. I really like ________ (these words or phrases or lines) because…
I see how you are using poetic (language, concepts, or practices) in these lines and wonder if…
Your use of ______ in the poem was really powerful. It made me think of or remember…
Your word choice in this line _______ was really accurate and precise. As a reader, that's important to me because…
Here's a good resource to learn more about…
Here's an example of a poem similar to yours that uses, discusses, demonstrates, etc….

Noticing dis/connections between science & poetry:
Both scientists and poets appreciate or use ____________. I like or am wondering about how you used ____________ to create this piece. Tell me more.

How might a scientist look at ___________ differently than a poet? What would the scientist focus more on here? How about the poet?

Appreciating creativity:
I like how you described ____ by doing/saying_______.
I like how you used (sensory details-sound, sight, touch, smell, taste) to describe ______.
You did a great job describing your feelings/actions/observations. I noticed______.
I like that you chose to represent your findings using a (voicethread, poem, graph drawing, etc). Tell me more about how you composed that…
That's such an interesting connection you made between...

Appreciating the content:
I like how you______.
You did a great job of________.
I like your____ because_______.

Encouraging deeper thought or extension:
Have you thought/or considered about ________?
Did you know that____?
What else do you want to know now?
I wonder____?
What did you have to learn about to (draw, write, compose, perform) this piece?

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