

Chapter 15

Moving Beyond the Singular: A Deconstruction of Educational Opportunity in Science Through the Lens of Multiples in an Era Marked by Globalization and Neoliberalism



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Abstract In this chapter, I challenge the functionalist view of informal science education and instead, through “a lens of multiples,” attend to youths’ diverse forms of meaning making of science and self in science; and how these processes are charged by and grounded in placemaking (entanglement of feelings with materials, bodies, and multiple ways of knowing, being, and becoming in STEM). I do so through two case studies, first, a video production project in *ArtScience*, a club that is part of a Saturday school that reaches out to elementary school level children and families with histories of recent immigration; and second, a joint video project about a girls-only afterschool program by now young women of color who no longer participate in that program. I show how the two projects took for granted the heterogeneity of forms of engagement with science and identities as insiders to science and thereby became critical sites of critique and transformation of informal science education and visions of who can do and be in science, mediated in part also by the researcher who as a collaborator contributed to that transformation. As such, the chapter challenges visions of colored youth as disposable through a discourse on multiples.

Keywords Youth · Learning · Identity · Mobility · Informal Science · Video Production · Heterogeneity · Critical Science Literacy

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In 2009, the National Research Council in its report about informal science learning put forth the argument that “informal environments can have a significant impact on science learning outcomes for individuals from non-dominant groups who are historically underrepresented in science” (Bell, Lewenstein, Shouse, & Feder, 2009, p. 301). Supported by research at the time, it spurred the development of design studies in informal science across a vast array of settings, assumed by researchers and communities who still struggle today to offer clear evidence in support of that kind of a functionalist argument. While the direct impact of the informal science field on youths’ interest in science and pursuit of science careers is difficult to measure, its implicit objective of documenting “non-dominant students’ mastery of dominant forms” is what needs critique. That lens to learning and identity work in science further perpetuates a narrow vision of what science learning implies and who can do science. It leaves unexplored the potential of informal educational settings in transforming “historical inequities and political structures that substantively shape learning” (Bang & Vossoughi, 2016, p. 175). It neither addresses nor questions deep assumptions about who can become an insider to science and scientist, and what we recognize and value as science. It leaves unquestioned assimilative narratives of participation in science.

In this chapter, I challenge that functionalist vision and its focus on the singular. Having pursued research on science literacy development in an array of informal settings in underserved communities for many years, I show instead what “a lens of multiples” can reveal about emergent learning opportunities in informal science practices owned by youth in an era marked by globalization and neoliberalism. Grounded in sociocultural-historical theory, I document expansive and transformative learning and identity work, which in the end takes me often away from science to other places and discourses that constitute the social futures of the youth I have worked with. It naturally also leads to questions about “how race and power operate in learning settings, especially as they may relate to privilege and marginalization” (Nasir & de Roystone, 2013, p. 266). Essentially, I re-engage with the study of creative ways of becoming, interpreting, and learning that Vygotsky had so much to say about and which the commodification of education has so eloquently marginalized or erased altogether. Re-engagement with creative learning also makes possible an unpacking of socio-material practices “analyzing agency ‘non-anthropocentrically, as a situated process in which material culture is entangled’” (Knappett & Malfouris, 2008, p. xii, cited in McKenzie & Bieler, 2016, p. 14). It makes possible the documenting of “situated or practical experiences” that function as “pedagogical pivot points in enabling critical learning and social change” for learners often forgotten about in the current market driven education system (McKenzie & Bieler, 2016, p. 16).

It also calls for a focus on the affective dimensions of informal learning and, in particular, placemaking and belonging, key dimensions for understanding learning and identity work in science in informal and formal settings (Ehret & Hollett, 2016). I assume that youths’ affective life is tied up with learning and becoming in science in complex ways. I also wonder how youth mobilize “feelings” or “our emotional relations to others and our emotional reactions to events—for constructive purposes” (Ehret & Hollett, 2016, p. 252).

Finally, I build on the call by Kress (2012), to engage deeply, and possibly in new ways, with “signs of learning” in our times of complexity and mobility. It takes me beyond a focus on the multimodal and multisensory in learning and identity work toward the unpacking of “agency evident in semiotic work” and hence, a new reading of affordances and possibilities (Kress, 2012, p. 129). I attend to the affective life and underlife of informal educational settings, and in what ways the coming together through social relations over time leads to the emergence of learning opportunities that matter, driven by deep emotions and shared affect, and tied to placemaking and belonging in ways empowering and potentially supportive of transformation and change at multiple levels, resulting in voice and agency (Ehret & Hollett, 2016). Given my work with immigrant youth, I also ground the work in the vast literature on transnational youth and youth circulations, implying travel both real and imagined among cultures and languages that we take as a rich toolkit and constitutive of who they are and are becoming (Lamarre, 2013). As such, I position the youth I work with as agents of their learning and identity in science and distance myself from neoliberalism’s vision of youth as disposable (Giroux, 2012).

I begin the chapter with a brief overview of the theoretical framework and a selective literature review of the use of video production in science education. I then present case 1, the making of a video project in Art-Science, a club we ran for 2 years within a Saturday school organized by a community organization reaching out to immigrant families. Case 2 offers an analysis of a joint-video production among a group of six young women about *Les Scientifines*, an afterschool science program for girls only that they all participated in. In the conclusion, I return to the challenge raised by Bang and Vossoughi (2016), namely how to design for learning and identity in science in ways supportive of “sustainable and transformative change” deeply committed to and open to multiples.

15.1 Theoretical Framework

In line with a theoretical grounding in sociocultural-historical theory, it is assumed that learning opportunities emerge from interactions among youth and materials in place. Hence, learning is understood as a process of making meaning through doing, talking, and becoming in action and place (Wells, 1999). The latter offers affordances for certain forms of learning and becoming that, once appropriated by participants, result in multiple learning outcomes and as such can be understood as expansive (i.e., as building on prior forms of knowing, doing, and becoming) and transformative (i.e., resulting in new agentic ways of knowing, doing, and being) (Vygotsky, 2004). Meaning making and becoming in place are also understood as intertwined with the affective in that through interaction in place, participants develop social and material attachments to such programs, activities, and each other. As noted by Ehret and Hollett (2016), “the affective intensities of bodies moving, feeling, and generating social connections to each other, to place, and to the common goals of change-making” (p. 250) are key for understanding informal learning environments’ multiple contributions to youths’ lived experiences and future selves.

Meaning making and identity work emerges from and is grounded in placemaking, entailing the “active engagement of human beings with the places they inhabit” (Fettes & Judson, 2010, p. 124). As well said by Duff (2010), “to experience place is to be *affected by place*” (p. 881).

Placemaking is also an anchor for youths’ identity development (i.e., assumed identity) and identity work (i.e., the making of new identities). It is through youths’ participation and contribution to a community of practice and its affective force that youth can assume their identity in place while simultaneously forge new identities from place. If youth experience places in positive and empowering ways, engagement results in agency and voice and new imagined possible selves. Yet, affect like identity do not reside “in individual places or individual bodies but rather in the dynamic and relational interaction of places and bodies” (Duff, 2010, p. 886). Building on the work of Holland, Lachicotte, Skinner, and Cain (1998), I take identity work to imply an interplay of figured worlds (i.e., realms of interpretations of STEM and self in STEM), positional identities (i.e., how the system and others position the youth in STEM or in the world), the authoring of selves (i.e., how youth think of themselves in light of the former), and the making of worlds (i.e., the creation of new meanings and selves through this dynamic and ongoing process). The two case studies offer insights into the dynamic between meaning making and identity work in STEM and beyond.

15.2 Joint Video Productions with Youth in and About Science

Any human act that gives rise to something new is referred to as a creative act, regardless of whether what is created is a physical object or some mental or emotional construct that lives within the person who created it and is known only to him. (Vygotsky, 2004, p. 7)

To facilitate creative forms of engagement with science, we engaged youth in video productions. Building on the work of Furman and Calabrese Barton (2006), we were curious in what ways video can become a means for youth to tell stories about science and reconfigure their relationship with science and “to communicate on their own terms” (p. 670) their understandings of science. Since we worked with youth with histories of immigration, video also seemed a promising tool to express understandings of science and selves in science in multiple ways other than through language alone and essentially engage youth in the creative use of media (de Block & Buckingham, 2007). In prior work (Gonsalves, Rahm, & Carvalho, 2013), we used video to engage in joint-questioning about science in the lives of girls and their peers in an afterschool program. The girls we worked with opted to interview others about science and its role in their lives, and then produced a rich story about figured worlds of science of urban youth. The production process led to rich discussions about science and what counts as science in different settings, and how these multiple ways of understanding science constituted their identity as learners of science. It also led to discussions about the manner engagement with science is marked by

social status, power, and gender. While the produced video made evident youths' funds of knowledge and everyday practices of science, the girls discounted it as not being about "real science."

In these studies, video production became a means to speak back to dominant visions of science and stereotypical images of doers of science (Luttrell, 2010). Video production supported "hybrid, unsanctioned literacy practices" and encouraged youth to pursue multimodal representations of science and their positioning in science with a critical gaze (Rogers, Winters, LaMonde, & Perry, 2010). Video production also implied deep questioning of their role and place in science and engagement in a critical reading of science, a reading that could then become transformative and agentic, leading to new ideas about how to promote more equitable engagement and futures in science. An interest in these kinds of processes and goals drove our projects, and the use of video led to a focus on the following: First, youths' meaning making of science (the construction of new science knowledge in light of their past ways of knowing and understanding) and self in science (how they perceived themselves in relation to STEM); and second, how these processes were charged by and grounded in placemaking (entanglement of feelings with materials and bodies and multiple ways of knowing, being, and becoming in STEM). Case 1 speaks more closely about challenges second language learners experience in education, whereas Case 2 attends more closely to the being and becoming in STEM over time of young women of color.

15.3 Case 1. Video Productions in *ArtScience*: Stories About Language, Meaning Making, and Becoming in Science

15.3.1 Context

ArtScience was embedded in a community program, *Aspiration*, reaching out to immigrant families. In the context of their Saturday tutoring program that they run in collaboration with six elementary schools within an ethnically diverse underserved community in Montreal, we co-designed *ArtScience*, a science club we ran for 2 years from 2009 to 2011. Its goal was to create a space for student interest-driven science activities, animated in part by a science major, a graduate student in education, and myself. The design of the club was inspired by a previous work that explored the effects of "doing science" on language minority students' learning and becoming (Rosebery, Warren, & Conant, 1992). Inquiry science was understood as a tool for language and STEM literacy development. We worked with two groups of 14 youth, aged between 8 and 12 years, primarily from the Philippines, Sri Lanka, Bangladesh, Morocco, China, and the Caribbean. All activities were recorded on video given our goal to document with them student-owned engagement with science and a science practice responsive to their needs (Vossoughi & Escudé, 2016).

15.3.2 Emergent Learning Opportunities, Affordances, and Transformation


French was the language of instruction in *ArtScience*, as mandated by the community organization and the language charter of Quebec which declared French as the official language of Quebec in 1977. However, most youth in *ArtScience* struggled academically due to that language charter and the kind of language discontinuities they experienced between their home and school. Most youth who participated in the club were at ease in English, had oral fluency in their native language, but struggled with French. They were still developing strategies to manage the “language obstacle course” they faced daily (Lamarre, 2013). In the club, we encouraged students to mobilize their entire language repertoire. Hence, they switched forth and back constantly between English, French, and native languages, when working in their teams, while whole group dialogue mediated by us was typically conducted in French. I focus on a video production of three youth, Vasu (11 years old), his brother Viskar (9 years old), and Sami (11 years old). They were born in Canada to parents from Sri Lanka and spoke primarily Tamil and English at home and with each other, and French at school. Viskar was sent to the program by his teacher to work on sentence structures and reading, Vasu to work on his attention and to develop effective working strategies, while Sami was described by his teacher as very hardworking yet in need of more opportunities to engage with others in French. Together, they pursued a video about volcanoes as shown in the timeline in Fig. 15.1. Their




Fig. 15.1 Visual depiction of the storyline of the video

video entailed some video footage of a simulation of an eruption of a volcano with images, sound, and strolling text, and periods of talk by each one of them looking directly into the camera, conveying some scientific information and terminology about the kinds of volcanos that exist and forms of eruptions. Sami responded to the question about how long an eruption might last, while Vasu offered a list of the scientific terms of the different volcano types, and Viskar explained what type of volcano they had constructed for the simulation.

As shown, their video production was multimodal, weaving together images, movie clips, presentations assumed by them, text, and sound, attesting to much creative joint work. Taking a closer look at their work, I was struck by the energy and time the team put into the recording of their voices. Each one of them had a handwritten note of scientific information that they had copied from the web and reformulated somewhat with the help of the instructor who encouraged them to use their own words. The team struggled appropriating the scientific terms and pronunciation. The recording called for concentration and patience, but at the same time, was supported by respectful relationships among youth and the instructor as shown below:

Talk	Image	Activity
<p><i>Sami: An eruption lasts one to six months in 10% of all cases of volcanic eruptions, six months to an year in 12% and 5-10 years in 2%, less than 10 minutes in 10% of all cases</i></p>		<p>Sami is reading his note that he placed on the right side of the screen. We can see his face being recorded in the middle, and his finger on the keyboard, controlling the beginning and the end of the recording.</p>
<p><i>Sami: Yeah, done, finished!</i></p>		<p>Calling out loud with a big smile</p>
<p><i>Ray: Wait, no, it cut the last ten percent, Sami, can you redo, sorry...</i></p>		<p>Instructor checks recording and notes that the beginning was cut off</p>
<p><i>Sami: What?</i></p>		
<p><i>Ray: Yes, see here...</i></p>		
<p><i>Sami: I do not hear a thing...</i></p>		
<p><i>Ray: We miss the five...</i></p>		

Talk	Image	Activity
<i>Sami: Oh no, not again...</i>		Third trial. Straight back signals level of concentration by Sami

Ray encouraged Sami to try one more time. The peers of Sami stepped back and practiced their portion of the talk, giving him the space needed to begin the recording anew. Video self-recordings are challenging, but even more so for second language speakers whose accents and struggles with pronunciations are readily evident in such recordings. Listening to oneself on video can also be emotionally charging. Yet, the team did not shy away from trying it. Other groups resorted to the inclusion of written text only. This team essentially experienced and lived “the gift of confidence” that Mahn and John-Steiner (2002) discussed, in that they knew that it was safe to try. The instructor’s insistence on redoing it and getting it right made evident the high expectations he had of them yet also confidence that they could succeed. These kinds of affectively charged moments led to the development of a sense of belonging to *ArtScience*. Essentially, play with language in this manner constituted placemaking (Lamarre, 2013). It implied teamwork and solidarity among the youth, as the following excerpt makes evident:

Talk	Image	Activity
<i>Sami: One, two, three, go!</i>		Sami is standing behind Vasu.
<i>Vasu reads: There are six types of volcanos, the fissure, the shield, the dome, the ash-cinder, the composite, and the caldera</i>		Ray, standing on his right, holds the paper. Vasu in the middle reads the script and records himself.

Note above and also in Fig. 15.2 (left) how the team worked together with Vasu looking on while Ray and Sami held up the poster board with the questions they had developed, thereby also ensuring an artistically interesting background. They all supported Viskar’s recording who was nervous about recording and doing it well. Following the recording, the team sat together with Ray to check the video for accuracy and potential glitches as shown in Fig. 15.2 to the right.



Fig. 15.2 Affectively charged moments recording (left) and reviewing their video clip (right)

What was at stake is evident from their facial expressions. They were anxiously watching the recorded clip together with the instructor on the left. Notable are the signs of relief on the right, once they judged their video a success. It makes evident their emergent and yet still developing identity as speakers of science but also masters of technology and French. The video project gave them the opportunity to author selves as “being able” to engage with science in French, their third language. In essence, they were on their way toward “finding a voice, or controlling a new discourse” (Rosebery et al., 1992, p. 92) to which they had little access to elsewhere.

The excerpts above also make evident what it takes to support students’ transformation of feelings in ways supportive of constructive purposes (Ehret & Hollett, 2016). Initially, the level of stress was high, with some teams abandoning the idea of videotaping themselves. By persisting and taking up the challenge to film oneself in this manner, however, these teams developed an affinity that mediated placemaking and belonging in *ArtScience*. In many ways, the case makes evident “how identities are formed (improvised) in the flow of historically, socially, culturally and materially shaped lives” (Rogers et al., 2010, p. 300). Improvisation and risk-taking constituted in important ways the participants’ engagement in the activity. The challenges video production implied in this context (e.g., mastery of technology, mastery of science content, language), and the kind of embodied learning it supported, also led to the “thickening” of relationships. As such, learning was more than a cognitive act. Instead, as Linds et al. (2015) describe it, “learning is felt” and “is a sensation” (p. 6). Those kinds of feelings and sensations then led to empowering images of selves and possible future selves—as youth who *can* achieve and be successful. And it is that kind of identity work which challenged the functional imperative typically associated with informal science clubs. The club was not about STEM per se. In fact, the club barely had them engage with and think scientifically through the video project. Yet, it certainly opened up a small part of the world of science to them. In that process, heterogeneity was valued in terms of the languages youth could use to talk science, in terms of the format the video production could take, and the kind of multimodal modes they were encouraged to leverage to convey meaning (Rosebery, Ogonowski, DiSchino, & Warren, 2010). Hence, the project empowered youth to come to see themselves in new ways, as youth who can succeed despite their complex histories of immigration and struggles with language, two dimensions still too often seen as barriers rather than strengths for meaning making and identity work in science and beyond.

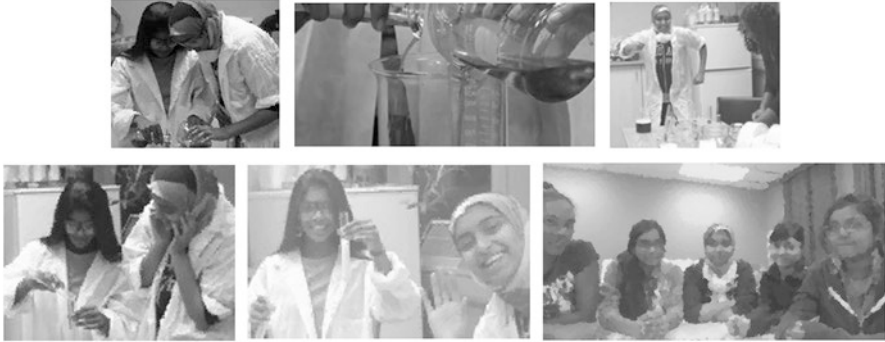


Fig. 15.3 A timeline of the introduction

15.4 Case 2. What the Joint-Creation and Sharing of a Documentary About a Girls' Afterschool Science Program Reveals About Being and Becoming in Science

15.4.1 Context

Les Scientifines is an afterschool science program in Montreal, serving girls from two elementary and one high school in its community. They offer hands-on science activities, the opportunity to pursue science fair projects, and a science newsletter activity. The video production project I report here took place in the winter of 2013 and is an extension of a previous 2-year video ethnography of the afterschool program and its scientific newsletter activity that took place from 2009 to 2011. My research assistant and myself worked with six girls, some of whom were no longer with the program given their age and having moved on to college. We met six times to produce a video about the program for an international science conference. The six participating girls then had a chance to share their video production and exchange with youth from other informal science programs at an international science education meeting via video conference. The six girls had complex immigration histories. Their parents came from Bangladesh, Trinidad, St Lucie, and Sri Lanka. Five of the six girls were born in Canada. All of them had traveled back to their home country for family gatherings and were tightly connected with the families and culture of their country of origin, often dialoguing with family members through the Internet.

15.4.2 A Lens of Multiples, Science, and Being in Science

The joint video production about *Les Scientifines* is an interesting mix of multiple discourses. The video begins with the program logo and a read aloud by one girl of an introduction in English as follows:

Les Scientifines is a non-profit organization founded in 1987. Its goal is to promote science and develop life skills in young girls. They hold different free activities every day afterschool from the journalism workshop to the science fair.

After the logo, two girls enact “doing science” in stereotypical ways by mobilizing powerful markers of science. It begins with the mixing of colors in beakers, pursued by two of the girls who are wearing lab coats and eye protection. The two girls mix two colors (red and blue). One color is in an Erlenmeyer flask, whereas the other liquid is in a beaker. Then both the colors are mixed in a bigger-sized beaker in front of the camera. While mixing happens, the camera briefly zooms in on the mixing and the emergent color “brown” and then backs out and closes in on the two girls who are engaged in the doing of science, and who show much excitement about their accomplished experiment. Achyntia jumps up in the air, while Saliha then takes the lead in mixing vinegar with baking soda in a test tube, resulting in a bubbling substance that then spills out of the small test tube, followed by expressions of excitement and waving by Achyntia, marking the end of that staged performance. Figure 15.3 offers a timeline of that introduction:

The rest of the movie shows the girls sitting in front of the camera (See Fig. 15.3, image on the lower right), first introducing themselves, and then presenting the program. They basically respond to staged questions by the research assistant and offer prepared answers, a script they co-created and practiced. As with the youth in *ArtScience*, the taping of their staged dialogue was a challenge and implied many trials to get it right. Unlike the other group, the girls were fluent in English and French, leading them to introduce the program in English given the audience they were targeting (science educators at an international conference), while the informal dialogue that followed was pursued in French, and later translated, and subtitles added. The girls exhibited flexible multilingualism in that they moved among languages constantly in their informal talk but knew when boundaries between languages mattered (Lamarre, 2013).

Yet, the documentary about the program was about “things thicker than words” (Rogers & Schofield, 2005). It was about a program that most of the girls considered as their second home and that helped them develop aspirations for their future by identifying and being encouraged by other women who were successful and by engaging in meaningful science activities with others who shared an interest in becoming educated:

One of the goals of the program is to get girls interested in science, since science, at least traditionally, was not for women. Pursuing a career in the sciences was also not something women thought about traditionally. So, giving girls the taste for science so they can pursue their futures in or beyond science is important. And the women working in the program, and all the invited guest speakers are all good role models for the girls in the program. The participating girls can be inspired by them and become like them. It gives all of us a taste to learn more about science, to be curious, to ask questions, to become better adults... for me, *Les Scientifines* is an inspiration. [Alana, Group interview, 2010]

Participation in the program supported the development of “a science affinity-identity” (Adams, Gupta, & Cotumaccio, 2014, p. 15)—in that the girls learned about science but also contributed to science by becoming the next generation of role models as women in science, and as women pursuing nontraditional careers in the sciences—goals the program was designed for. Yet, that vision was not as readily articulated and apparent in their video, where they presented themselves primarily as youth living in an underserved community and in need of a safe place to go after school, and as needing additional educational opportunities of high quality. Take for instance the first part of the dialogue that followed the introduction in the documentary:

Audrey:	Personally, what did you get out of Les Scientifines?
Sari:	Mmh, doing better academically, for instance, in French, the writing. That’s it, it also improved our understanding, or for doing research, if they gave us a project at school, where we had to do research, we knew from Les Scientifines how to do it and also knew about some scientifically sound websites that we could then consult.
Achyntia:	Me, here, me, here, what I like at Les Scientifines is the fact that I feel safe here, ‘seriously’ (to emphasize she mixed English ‘seriously’ into her French) I feel really at ease and safe here (giggling)
Alana:	It’s also, it’s also for the parents, they know that you go some place serious after school, a safe space, and that you are not about to just hang out in the street.
Achyntia:	Yes, exactly!
Alana: <i>Later</i>	So it’s really good for the parents also. You feel like being at home here

The dialogue positions the actors and the program in an underserved community which might not be safe for hanging out on the street. The program offers safety to girls who need it given how busy their parents are. In doing so, the program helps the girls’ parents to “feel good” despite the fact that they cannot offer their children an education in a safer neighborhood. It positions the girls and their families as in need of programs that help them manage their lives and integration in an educational system that is new to them. Interestingly, the girls themselves contributed to the maintenance of such a discourse given the manner they presented the program, science, and themselves in the documentary. At the same time, the program supported the emergence of a collective identity and “a sense of group membership with like-minded peers” (Adams et al., 2014, p. 16), in that it was a safe space to show interest in science and in becoming somebody.

Later, when they were asked to find one word to describe *Les Scientifines*, they referred to it as “fun” while others added, “you do things you would not do otherwise outside of school” or another, “we have access to experiences that are really interesting.” That discourse hints at the value of making such quality programs accessible to girls in underserved communities. Simultaneously, it makes evident some of the many contradictions that marked the girls’ everyday lives, such as not having access to quality education as youth growing up in an underserved community or being shameful about their community and sense of self, as became apparent through informal talk during a work session:

To say the truth, it is only recently that I realized that *Les Scientifines* is a program that aims to support youth in underserved communities. And I lived through a period when I was ashamed to be from that community. At my current high school, there are girls from many different neighborhoods from Montreal, and most are not poor, and so it was really embarrassing for me to admit that I came from this neighborhood. Yet, now, I can say that I am from an underserved community and it is what made me become who I am now, and I am very proud about who I have become.. and thanks also to having participated in *Les Scientifines*, I realized that I do not have to be ashamed about living in an underserved community, it is just a fact, and it actually helped me to become better, more open-minded, and better able to understand others who are ashamed about their place of origin. [Mohini, Informal conversation, 2013]

In the end, through the video production, opportunities emerged to work through some of those contradictions by naming contradictions and the positionings they implied of them, and build on each other’s experiences. As such, the program was about much more than science, the initial depiction of it up-front in their video.

15.4.3 Storying of Selves, Selves in Science, and Science

Through five editing sessions, some parts of the script were cut out or readjusted, other episodes were filmed a second time or readjusted, a time-consuming and not always trivial process inherent to video editing as shown in Fig. 5. Hence, that tedious yet collaborative effort over a couple of weeks not only led to a video production, but also supported the girls’ reflections about selves, selves in science, and science (Gonsalves et al., 2013). As shown in the brief exchange below, it led to the development of deep affinities given the affectively charged work the video production process implied, and placemaking in ways we described in case 1.

Talk	Image	Activity
Achyntia: Ah, c'est laid (<i>Agh, it's awful</i>)		Watching video clip together and deciding how to edit it.

The storying of selves through the making of the documentary and the video production was tied up in complex ways with the kinds of resources and tools youth had at their disposition. Yet, the documentary also became both, “a window to the world” the girls lived in (see quote before by Mohini) and a “window to identity.” The latter is evident in the following dialogue where some of the girls position themselves as science savvy and doers of science (see also Fig. 15.3):

Achyntia:	And there is the newsletter too, where you write articles.
Alana:	That's it, you do your research.
Achyntia:	That's it!
Alana:	And as you say, you go to many websites and find information, it helps you become critical, to know when something is credible.
Achyntia:	That's when I decided to become a writer, because of the article I wrote.
Sari:	Yes, its like this, you read, and when you do the research on internet, you improve your capacity to make a summary in your own words, you do the research, you use synonyms and other words.
Alana:	You learn to popularize science.
Sari:	It's popularizing science and all, that makes your whole life simpler, when you do oral presentations, when you do research, you no longer just copy things.

Essentially, the program supported the development of an identity as a writer and communicator of science. It enlarged their figured worlds of science and sense in science, leading to the authoring of new selves and worlds not always aligned with the manner the system positioned them. Through the program activities, the girls were essentially offered opportunities to “try on” and play with other types of identities that then positioned them as insiders to science, at least momentarily. It is in this manner that the program offered opportunities for meaning making in science and the storying of selves, selves in science, and an introduction to the multiple discourses of science.

15.5 Discussion

15.5.1 *Critical Science Literacy and the Case for Multiples*

What do we mean by critical STEM literacy? And how do the two cases speak to critical science literacy? In what ways do the two cases transcend power differences between researchers and youth, between what counts as science in mainstream and what may count in an informal setting? In what ways do they contribute to the refiguring of who can become somebody in science?

As suggested in the report by the National Research Council (Bell et al., 2009), informal science programs may play a particularly important role in offering especially youth in underserved communities with opportunities to critically reflect upon their relationship with science and build the confidence needed to come to see themselves as insiders to science. The two cases certainly suggest that video production became a tool to engage with science into them meaningful and new ways, leading to rich reflections about science and who can be an insider to science. In doing so, the video production projects also challenged the singular view of what science is, what form participation in science takes, and what an identity as an insider to science looks like. The projects took for granted the heterogeneity of forms of engagement with science and identities as insiders to science. Those diverse forms and practices were not seen as a problem in need of fixing, but instead, as fundamental to learning and as a richness to mobilize (Rosebery et al., 1992; Rosebery et al., 2010).

It is in this way that the case studies are about multiples. They were told in ways to highlight different notions of doing science and being in science. The visual ethnography and participatory video projects were a means for “working with things, objects and artefacts” (Mitchell, 2011, p. 37). The process of co-production was also a powerful means to support youth’s placemaking and develop a sense of belonging. These affective dimensions are essential features of a practice supportive of student-powered learning and transformative forms of participation and identity work in science. Both programs and emergent practices supported students’ engagement in learning in ways they valued and could come to own. The two practices also encouraged critical reflections about that learning and identity work. The joint creation of videos led the teams to engage in deep reflections about themselves as learners, as learners of science, and also about their future selves in and beyond science. The projects helped youth refigure who they are and who they thought of becoming. The study of youths’ editing choices and processes of co-creation also make transparent youths’ bids for recognition of selves and programs in ways aligned with imagined images and discourses of STEM that ensure public recognition (Halverson, 2010). Essentially, they can be read as “trying on” identities in STEM and as such are about local agency and voice. They also orient the participating youth toward “new” or “different” social futures and aspirations for which they initially did not feel entitled to or knew about.

Counter-stories as those offered in this chapter are essentially about relationships between non-dominant youths' everyday experiences and discourse practices and "the everyday practices of professional disciplines" (Rosebery et al., 2010, p. 324). And as shown here, these everyday practices "can be mobilized productively in learning and teaching" (ibid). For instance, had we insisted on the use of French only in *ArtScience*, as mandated by the current language policies in Quebec, we would have compromised youths' participation. By valuing the tool kits and language repertoires they brought to the program, we literally multiplied opportunities for learning. It made the teams take up the challenge to tape their science talk, even if it took them multiple trials and was emotionally taxing. Clearly, the narrow vision of language development and learning and current language policy in place needs to be revised (Lamarre, 2013). As is, that policy undermines the complexity of current language practices of multilingual youth in Montreal, and their skills at navigating a vast array of educational practices that all have different stakes attached to them in terms of the language that needs to be spoken, and in terms of the kind of knowledge that counts. Attending to that multiplicity and youths' incredible navigation skills of such a complex and politically charged educational landscape can only help us move forward toward a more inclusive and empowering system of education. It would offer rich insights into what STEM as practices of critical literacies could imply and how we may design for it in a vast range of educational practices together.

In sum, the stories in this chapter make evident that we need new ways to study learning and identity work in STEM, that we need to reposition programs as those described here as sites of critique and transformations, and our own position as researchers from collaborators to co-constructors of such change-making over time. We need longitudinal studies with youth and programs to develop the kind of affinity and emotional safety that is needed to work together on voice, agency, transformations, and new social futures. As researchers, we also need to move *with* youth and be open to scale making with them while contributing to it—the latter makes our work naturally political and steeped in practice with them. It might also move us away from STEM as we know it toward an appreciation of multiples, and most important, beyond a discourse of youth as disposable.

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