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# Online Making-Based Learning at Scale: Towards Equity in STEM Learning

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**Abstract:** Making, grounded in theories of constructionism, offers learners the opportunity to construct their own knowledge through constructing personally meaningful artifacts, thus making them interested and committed to the process of their own learning. However, making-based learning is challenging to implement owing to the limitations of materials and well-qualified teachers. Online learning is a way for marginalized learners, who often do not have access to quality educational resources such as well-qualified teachers and learning materials, to access well-qualified teachers. With the growth of synchronous e-learning, learners now have opportunities to interact with their teachers and obtain immediate feedback, a process known to be productive for learning. In this paper, we report on a large-scale making-based online intervention whose design leverages the potential of online learning and cheap, easily accessible materials to create a science, technology, engineering and math (STEM) learning pathway for girls from marginalized communities by engaging them in STEM practices. Using evidence from observations and interviews we evaluate the effectiveness of the intervention in creating these learning pathways. We find that while the intervention increases learner interest in STEM practices, thus initiating a pathway to deepening participation, the language used in the intervention, technology, material and teacher factors can become barriers that have the potential to constrain this pathway and further marginalize the students. We discuss implications and potential solutions to these challenges.

**Keywords:** online learning, making-based learning, cultural learning pathways, marginalization, equity and access

## 1. Introduction

Learning scientists have long argued that educational experiences should be personally meaningful and authentic to learners (Dewey, 1916; Papert, 1980). Research shows that learners have certain resources that can be activated during learning (Hammer et al., 2005) and that this activation happens during learning experiences that involve making and inquiring with physical and virtual materials, and center learners' agency and their cultural resources (di Sessa, 2000; Papert, 1980). This is because such experiences keep learners interested and in their zone of competence, so they remain committed to the process (di Sessa, 2000), persist on difficult tasks and learn from failure. Making with physical and virtual materials also brings intuitive knowledge to the fore, providing a way to ground the formal knowledge and thinking that is to come later and prepare learners for future learning (Bransford & Schwartz, 1999). Making is also a way to challenge deficit mindsets and support marginalized learners (Vossoughi & Bevan, 2014). However, effective making-based learning requires resources, facilitators and communities (Litts, 2015), which then makes it less accessible to marginalized learners. How can we then democratize making-based learning for marginalized learners?

With mobile devices, software and internet connectivity becoming cheaper and permeating into highly remote areas, synchronous online learning has been democratized (Dhawan, 2020; He et al., 2020). High quality interactive learning resources such as videos,

simulations and trained teachers can be simultaneously made accessible to large numbers of learners at a fraction of the cost of physical learning environments, with research showing that the perception of online learning and its outcomes are similar to those of in-person learning in several situations (Chirikov et al., 2020; He et al. 2020). In addition, online learning has advantages such as personalized and self-paced learning (Dhawan, 2020). Thus, online learning can be a way to provide marginalized learners access to high quality education (for instance, Chib et al., 2019). However, research has also shown that depending on their use, educational technology tools and online learning have the potential to accentuate the digital divide, leaving marginalized learners even more vulnerable (for instance, Bhatia et al., 2024; Ochieng & Ngware, 2023). Research shows that students from lower income families are often left without guidance regarding how to use the many online resources for learning and thus end up underutilizing them (Bhatia et al., 2024). Therefore, it is crucial to design online interventions to ensure that they overcome and not accentuate marginalization.

In this work, we report on the first year of a multi-year after school intervention titled *Curiosity Program*, aimed to spark curiosity and scientific temperament amongst the learners. It makes the use of online medium and cheap, readily available material to democratize making-based learning and create a STEM learning pathway for marginalized girls. The study was conducted using participant observation and semi-structured interviews of teachers and students. Through the lens of cultural learning pathways (Bell et al., 2012), we explore the following research questions: How was the intervention experienced by the learners? What were the barriers and enablers to the conjectured learning pathway? What shifts were observed in participants along those learning pathways? We begin by discussing the cultural learning pathways framework.

## 2. Theoretical Framework

The cultural learning pathways framework theorizes how learning happens, both cognitively and culturally, over long stretches of time, across diverse social contexts, and subject to the value systems operating in social groups (Bell et al., 2012). According to the framework, learning occurs when learners participate in personally meaningful activities *"that are temporally extended, spatially variable, and culturally diverse with respect to value systems and social practices."* It explains how participation in sociomaterial practices develops, and is developed by learners' evolving abilities and identities. Specifically, learning starts with interests, which initiates learning pathways and leads to deepening participation when situational interest is stabilized. Learning pathways also result from personal or shared concerns, both of which lead to goal-oriented learning and identification of more interests and concerns. Subsequently, learners start participating in social practices in coordinated ways, further deepening their participation in established or evolving practices. Participation is shaped by diverse structures that govern a social practice; for instance, the perceptions of a learner's ability can impact the access they obtain to learning opportunities, or the difference in the structures of a practice (for instance, math) from one context to another can affect learner participation (Bell et al., 2012). Further, as learning is a fundamentally social process, developing social relationships is a necessary part of the learning process, both as a means and an outcome. Finally, developing stable identities or becoming is a crucial outcome of situated learning (Lave & Wenger, 1991) and identification with a domain happens through sustained participation in its practices (for e.g., science or engineering).

The cultural learning pathways framework posits that learning occurs *"across contexts in the midst of connected constellations of situated events."* (Bell et al., 2012). Learning is seen as a series of multimodal, discursive actions influenced by situational circumstances, reflecting learners' commitments, concerns, and identities. These actions are shaped by learners' social positions, which connect cultural narratives to individuals within specific events. This positioning can relate to social identities, expertise, or perceived roles. Learning is also influenced by the social and material contexts of places, especially in STEM fields, because they use specific materials (such as instruments and chemicals) in specific places (such as labs and clean rooms) in particular ways instilled with political, epistemic and social

power. These contexts are not neutral, but shape and are shaped by human activity. Individuals often construct sociomaterial arrangements to support learning, and places set specific expectations for participation. Institutional constraints can either enable or restrict opportunities for action, thus defining the *"scopes of possibilities"* for participants (Bell et al., 2012; Bricker and Bell, 2014; Nasir et al., 2020) and influencing their learning experiences.

In this work, we adopt learning pathways as both a design and an analytical framework. In terms of design, with the goal of promoting equity in STEM learning, the intervention is designed as a constellation of situated events that creates scopes of possibilities for students to engage in STEM practices aligning with and developing their interests and concerns, along with deepening participation, building of social relationships and fostering STEM identities. Correspondingly, we analyze our data through the learning pathways framework to understand to what extent our intervention enabled or inhibited students' experience of, and the shifts if any, along the conjectured learning pathway.

## 3. The Intervention: *Curiosity Program*

The intervention is called *Curiosity Program* and is designed for the "Kasturba Gandhi Balika Vidyalayas" or KGBVs, residential schools that offer free education, boarding, and lodging to female students across India. 75% of the seats are reserved for students from the Scheduled Caste (SC), Scheduled Tribes (ST) and Other Backward Classes (OBC), officially designated by the Indian constitution to be historically underserved communities with low socio-economic status. Seats are also reserved for wards of single parents, migrant laborers, or below poverty line parents, drop out students, and children with disabilities. This is a multi-year online making-based intervention currently running in multiple states of India including Gujarat and Uttar Pradesh, targeting students of 6th to 8th grades. In this work, we focus on one[1] Indian state only, where 170 schools have been part of the intervention for seven months. However, the state government has asked the 9th and 11th grade students to also participate. The state government officials carefully monitor the participation of the schools and wardens (in-charge of the overall management of each school) through attendance forms, social media groups and regular meetings to hear the wardens' concerns.

*Figure 1.* Some examples of student work

The features of the intervention align with the cultural learning pathways framework. Students from all schools join biweekly sessions on Zoom or YouTube, and do activities requiring STEM practices (Figure 1), led by a facilitator and supported by their teacher, using readily available material (for e.g. straw, paper, flour and string). The facilitator sends out a list of required material before each session. We conjectured that these sessions, positioning learners as doing STEM when they use everyday materials in their own classrooms to make toys or activities, discuss and write about them, would become a series of situated events offering possibilities for action. Each session, beginning with a hook (for instance, a story or a surprising toy or activity) is designed to trigger learners' interests, which we conjecture would

[1] To maintain anonymity and ethical standards, we have not mentioned the name of the schools and state and supported government websites. The authors will provide them, if asked and required.

eventually lead to deepening participation and subsequently evolve to stabilizing situational interest. The hook is followed by the recap of the previous session, a discussion of the homework and spotlighting the students who have done the homework well as a way to recognize and motivate them. After this, the facilitator moves to the making activity followed by the explanation of the concepts. To ensure that everyone is participating in the activity, the facilitator asks questions during the session at regular intervals that schools respond through Zoom polls and in the chat. These questions, often based on observing the activities, also further interest and foster social interaction. The session is wrapped up after addressing student queries, which further supports building relationships between the facilitators, and the teachers and students. For instance, in the session titled 'Science of Sound,' the hook was listening to different types of sound around them. The making activity involved making a straw whistle, followed by explaining the concept of pitch by cutting the length of the straw, leading to different sounds. From simple to complex, the facilitator made other toys, such as a string telephone and explained vibrations, sound waves, pitch, frequency and related concepts.

## 4. Methodology

Focusing on the first year, the research goals of our study were to explore the barriers and enablers in the intervention for the creation of a STEM learning pathway for the students, and the initial shifts along the learning pathway. We do so by examining how the designed features of the program instantiate on the ground, what challenges teachers and students face during the program and the changes in the learners thus far. To understand how the online sessions are conducted and comprehended by the participants, digital ethnography (Jensen et al., 2022) was done. We attended all the live sessions from January to March on Zoom and YouTube. To have a deeper understanding of how the sessions are experienced by the students, we visited three KGBVs, and attended sessions from there. We did participant observations and prepared field notes after coming back from the field. To get a nuanced understanding of the problems faced by the students, we interviewed them. A semi-structured interview guide was prepared and 30 students studying between 6th to 8th grades, with an exception of one student from 9th grade, were randomly sampled. The study was approved by the Institutional Ethics Committee (IEC) of our institute and interviews were recorded with permission of the participants. Verbal assent was taken from students and consent from their respective wardens before beginning data collection.

To understand the experiences of teachers, we interviewed 10 teachers who participated in a three day in-person teacher training workshop in March as part of the intervention. The teachers belong to varied disciplines like science, math, language, and physical education. A separate semi-structured interview guide was prepared for them and teachers volunteered to participate. The interviews were recorded with the permission of the participants. All the interviews (students & teachers) were primarily conducted in the language similar to the Medium of Instruction for the sessions while the participants were allowed to switch to the state language, if they felt more comfortable. Notes were taken for the participants who did not wish to be recorded. The quotes used in the paper have been translated to English to the best of the knowledge of both authors. To maintain confidentiality and anonymity of the participants, pseudonyms are used throughout.

After the data collection, the interviews were transcribed verbatim and thematic analysis was done to analyze the data. After the transcription, one researcher (the first author of the paper) carefully examined and coded the data using an inductive approach. The key recurring themes related to our research goals and theoretical framework were identified by both the authors and an initial codebook was developed. Through a two-cycle coding process undergoing several iterations, the key themes were then refined through discussion between the two researchers until there was complete agreement regarding the themes, and we then together wrote the descriptions of the themes. There are multiple sub-themes and arguments within a theme to enhance the richness of the findings and provide a more nuanced argument.

## 5. Findings and Discussion

### *5.1 Overview of each session as viewed from the field*

During our visit, we found that a bell rang 10 minutes before the session, as a call for the students to assemble in the computer room. The warden or the computer teacher, either through her personal email account or school's official account, joins the session using her mobile phone, laptop or tablet and then connects it with a smart TV, or a projector. Along with a few students, they distribute the material amongst all the students. The students sit on a big mat either in groups or rows and watch the session. Many schools leave the meeting before it ends, while some stay to interact with the facilitator about the session, homework, and ask the facilitators to visit their schools. As an example, we attended the session on paper puppet making from a hostel and noticed that the girls made the puppets, and also interacted with the facilitator. As soon as the session was over around 5 pm, the girls picked up their notebooks and rushed to their dormitories to wash their clothes, while only a few students stayed behind to submit the homework.

### *5.2 Barriers and Enablers to the learning pathway*

When we watched the session online, everything seemed to be going smoothly even though we noticed small problems related to language, internet and materials during the session. However, observations and the interviews gave an in-depth view of the reality experienced by our participants, who experience multiple challenges while attending the online sessions.

#### *5.2.1 Internet and electricity*

The wardens conveyed that they face internet problems on a regular basis, also substantiated by the fact that only 50-60 participants turn on their videos on Zoom. During a session we observed that the internet connectivity was lost and the warden had to use her personal mobile hotspot to continue the meeting. Commenting on the issue of internet connectivity in her interview, Divya, an assistant warden, mentioned that *"because our KGBV is located in a remote area, network connectivity is a huge problem. On the day of the session, we (teachers and the students) have to walk around one and a half kilometers for better network and we sit in an open ground to attend the live session."* They are compelled to join the session on their mobile phones which makes it difficult for the students to comprehend, hindering their overall participation and interaction with the facilitator. After the session gets over, teachers download the session from YouTube and repeat it after a day or two. Another assistant warden, Suman shared the network and electricity issues they face while running a school in a tribal dominated remote area. Echoing the same concern, Harshi, a computer teacher, mentioned *"at times, when there is a long power cut we are not able to get the printouts needed for the activity."* In such a case, either few students do the activity and others watch them or everybody watches the session, and they have to download and repeat the session later, similar to what Divya reported. The internet here is an enabler as it provides a platform to introduce STEM making activities to marginalized students and connecting them with a skilled cohort of facilitators. However, the lack of stable, high-speed internet and electricity becomes a structural constraint (Nasir et al., 2020) threatening to further marginalize already marginalized learners.

#### *5.2.2 Material*

The sessions involve extensive engagement with the material that is largely readily available to our participants. The goal was to make the practice of STEM, which often makes use of specialized materials in specific places, more accessible to our participants by using everyday material, thus decreasing the social and political power imbued within them (Bell et al., 2012). However, many teachers talked about the inaccessibility of some of the material. Roshni, a warden, mentioned that *"as the hostels are situated in an isolated area, transportation*

*becomes a problem, many times, certain things are not easily available and we have to go an extra mile to purchase them."* Harshi, while making a similar claim, narrated the incident when they could not find a small round magnet in their region, required for the session on DC motors and they ended up taking out a magnet from a speaker. Though the effort indicates an interest in participation, given that such an effort is not very sustainable, it becomes another barrier threatening the learning pathway (Nasir et al., 2020).

Another challenge related to the material was that certain materials were culturally and geographically inappropriate. Suman mentioned that as her school is situated in a remote area, she could not find bendy straws and kebab sticks because, *"the material the facilitators are asking us to bring should be at least known to the stationary shop owners."* Commenting on the requirement of red cabbage for the session on acids and bases, she said, *"Generally red cabbage is available in the city, but there even cabbage is not a part of the regular diet. Then where will we get red cabbage? Green cabbage is barely available since it does not grow there."* She reiterated the same for the session on math using vegetables that requires many vegetables that then go to waste. Given that learning is intertwined with sociomaterial practices (Bell et al., 2012), an inability to participate in these practices is an enactment of marginalization brought on by the structural constraints imposed by materials that are aligned with the dominant culture and therefore unavailable to certain learners (Nasir et al., 2020).

### *5.2.3 Language*

The sessions are conducted in one of the official languages of India with a few terms borrowed from the state language. Our findings from schools located close to the state capital, where both languages are quite prevalent in use, revealed that the students were able to comprehend the 'other Indian language' than their state language, while the ones who faced difficulties were assisted by their wardens or teachers. Few students suggested that the session be conducted in the state language while others were comfortable with either language. Some wardens also preferred the sessions to be conducted in state language. However, interviews with the teachers and wardens from the tribal dominated areas, highlighted contradictory trends regarding the language preferences. Suman, an assistant warden, positions the language barrier as the biggest challenge, as 100% students in her school speak their native tribal language and do not understand the language of instruction or even state language. She mentioned that even if the sessions are conducted in state language, the issue will remain unresolved.

On the contrary, Divya, also an assistant warden said, *"if the sessions happen in state language, it will not be beneficial for them, as the students are not proficient in it. But the girls can understand the language of instruction, because they watch television; they may not be able to speak fluently but can comprehend everything."* Divya's school also has 100% students belonging to the tribal group and they speak their native tribal language. In our interview with Harshi, a teacher from the local tribal community herself, we obtained personal insights into student experiences. She mentioned that she speaks her native tribal language while at home and that all the students in her school belong to different tribal groups and so, while they understand state language and language of instruction their proficiency is not very high.

These findings suggest that our initial assumption that the *other* Indian language as the medium of instruction would not harm the students, is not supported. Similarly, using state language may have similar implications. Considering that the program is running across the state and almost 15% of its population is tribal dominated, use of a dominant language by our intervention, which represents power, becomes a structural constraint that could escalate the marginalization of the tribal communities (Esmonde, 2016; Nasir et al., 2020).

### *5.2.4 Position of the teacher*

Our findings highlight the dual nature of teachers being both a subject and an object of the human-education interaction (An & Oliver, 2021) in the intervention while attending and facilitating the session at the school. The teacher listened to the facilitator during the session

and tried to learn along with the students as they were not trained in making-based learning. In such cases, the teacher becomes a learner, hence becoming a subject of the facilitator along with the other students. On the other hand, after becoming familiar with the activity, the teacher becomes an object during the tutorial sessions. Secondly, the teacher acts as a mediator connecting the facilitator and the students. All the students who were interviewed mentioned that they seek help from their warden if they face any difficulty in comprehending a session or concept. K, a 7th grade student mentioned, *"I generally do not face any problem during the session but if I cannot understand anything, I seek the warden's help."* Apart from this, the teacher also translates the jargon into state language or in their local language. During a session on biodiversity, we observed that the teachers were telling the colloquial names of birds and animals to the students for better comprehension.

Our observations revealed that the teacher mediates student activity by controlling the technology and material, and their physical position by changing the seating arrangement in the class. For instance, when necessary, the teacher forms groups rather than doing the activity individually. As mentioned by one of the teachers, Reena, *"at times when it's expensive to purchase the instrument (material) from outside or if it is unavailable, then we form groups of 5 and distribute it amongst the students."* For the activities done in groups, the teacher assigns group leaders who generally do most of the making. Thus, the teacher regulates access to the material by giving control to certain students. Similarly, we noticed an interesting seating arrangement during one of our visits. The 11th grade students make a big circle in the center while other students surround them. They form groups and the 11th grade students lead them. As a result, other students have limited opportunities to participate in the STEM practices and situate their interests during the session. We observed that the warden joined one of the groups and actively participated with them, while the students sitting at the back were either watching others, or writing in their notebooks. The overall arrangement of the students suggested a strict hierarchy that barred the participation of the junior students. In addition, despite the making being done by the 11th grade students, the warden chose a 7th grade student to present their work to the facilitator. As we interviewed her, we found that the girl was the top performer in her class and was hence favored for such events.

No similar seating arrangement was observed in other schools we visited. Many teachers reported that the students have the choice to sit wherever they want to, depending on how early or late they arrive in the room. Mostly students sat according to their grades in ascending order that largely coincides with their heights as well. In other cases, the students are arranged as per their class in separate rows. This seemingly did not follow a hierarchical structure but did segregate students according to the level of formal education. Often, students who score well academically are favored by the teachers to sit in the front. However, some students revealed that sometimes a student is asked to sit in the front row so that they learn better and actively participate in the activity. *"The teacher said if the weak student will sit at the back, then how will she learn? The weak students are asked to sit in the front so that they learn. If you (facilitator) are explaining on the screen, the weak student who is sitting at the back will start talking, then how will she learn? If she will sit in the front, the teacher will ask her to pay attention to the activity, she will do and so she will learn"* said S, 6th grade student.

The evidence above demonstrates that the teacher plays a significant role in the students' experience of the intervention and consequently their learning pathways. Through providing access to the technology and material, they are enabling the students to attend and participate in the sociomaterial practices of STEM. They help them in understanding difficult concepts and words as well. On the other hand, their strict regulation of the technology, material and favoring certain students hinders the participation of many during the activity and in the intervention at large. Thus, the teacher by controlling access to the technology and the material transforms the conditions of learning, expanding the scopes of possibilities for some learners while narrowing them for others. Further we notice how by changing the physical position of the learner, they change the learners positioning (Bell et al., 2012). Concretely, by moving a learner to a front, they position them either as a 'good' student whose voice is worth sharing with the facilitator or as someone who can learn by participating actively in the front.

### *5.3 Shifts along the learning pathway: changes in students*

Our findings above highlight the barriers and enablers experienced by the students and teachers, and suggest that the intervention could potentially (re)enact marginalization in varying ways and scales. However, we also found some positive shifts among the students, that suggests movement along the conjectured learning pathway. Many students connect science with making or inventing things, and report that *"science is important to learn as it will help us to create something new in future, if we want."* Below we elaborate on some other changes observed in the students.

#### *5.3.1 Curiosity*

Students reported more interest in learning through activities as compared to the traditional methods. The sessions have sparked curiosity amongst the learners and teachers. *"Since the online sessions have started, I have begun questioning everything. Why does this happen?"* said K, a seventh-grade student. Dolly, English teacher and assistant warden mentioned- *"ever since the online sessions have started, I have been learning through the activities, the fear that I had since childhood of math and science have gone. Now I even motivate my students by sharing my experience."* Literature suggests that curiosity can trigger situational interest (Hidi & Renninger, 2019) and so this is a favorable movement along the learning pathway.

#### *5.3.2 Understanding*

While students enjoy participating in the making activities, they also improve understanding. *"Whatever we are learning now, I have a better 'grip' on that, whatever we learn, we understand,"* says H, a 6th grade student. Another student from 7th standard mentioned that *"before the intervention, when I used to learn it through books, I always doubted if it was right or not, but now as we do it through activity, I understand well and remember for a long time."* The evidence was supported by the teachers and wardens who mentioned that the girls show more interest in the making and remember things longer. This increased understanding is not only positive from the perspective of school learning outcomes, but can also motivate increased participation in STEM practices (Nasir et al., 2020).

#### *5.3.3 Connecting with school science*

Students could connect the content of the online sessions with their regular classes in school. As RA, 7th grade student mentioned, *"as we have studied the chapter on sound in the online classes, the same chapter was taught in the class, I performed the straw activity to explain pitch. The teacher was amazed and he asked me from where I have learned this, to which I replied that I have learned this in my online class."* The wardens also shared that *"the students participated in the science fair, they prepared models taught in the online classes."* Harshi, on being asked if she has observed any difference in her school tutorial classes since the beginning of the online sessions said, *"at times, the students already know the topic and concept as it has been covered in the online class, they ask us to rush through the chapter or opt for the methods or ways that has been taught in the online class."* This suggests aspects of life-wide learning (Bell et al., 2012) as students start to relate science practices across multiple locations.

#### *5.3.4 Language skills - writing and speaking*

Despite language barriers, certain changes were observed in language skills as well. H, 6th grade student mentioned that she has learned the technical terms in state language after the online sessions have started. On further probing she explained that *"the online sessions are conducted in another language, but when we (students) do not understand certain words, they (facilitator) speak in state language." Consequently*, she learned the technical state language

terms which she did not know in any language before. This contradiction is interesting; on one hand, the imposition of the language of instruction on state language speaking learners creates learning barriers as described in Section 5.2.3, while on the other hand the borrowed codes of state language by the facilitator grabs the learners' attention and highlights them as being significant to learn. This suggests the need for a critical examination into the role of multilingualism in the intervention (Flores and Garcia, 2020). In another interesting case, a student R, 6th grade, mentioned that *"from the online class she has learned how to write a notebook, how to maintain a notebook."* The students maintain a notebook to write about the online sessions – the activities and the underlying concepts - suggesting an increased participation in the science practice of documentation (Bricker and Bell, 2014).

## 6. Reflection and Conclusions

In this work we presented a study of *Curiosity Program,* an online making-based learning intervention aimed at creating a STEM learning pathway for girls of marginalized communities studying in KGBV residential schools in India. The KGBVs run in two modes, they are either 'schools with hostels', where the students live and study, taught by the same teachers who stay with them in their hostels. The other mode is 'hostel only' in which the warden, the full time and part time teachers serve as tutors, while the students go to the nearby government schools to study. Both settings create different learning pathways and here we reflect on these.

In both settings school science and math provides one set of situated events on the girls' learning pathway, while our intervention provides a different set of situated events through online sessions. In the case of 'hostel only,' the students have multiple interactions, such as with their teachers and wardens who serve as their tutors, girls who stay with them in their hostels, teachers and other students in their schools, and the facilitator who conducts the online session, which makes their learning pathway diverse and uncontrolled. As the school teachers are unaware of the online sessions, they have no opportunity to connect their lessons with the online sessions. As the number of students participating in the intervention is low, the school teacher might not be motivated to be aware of the online sessions. In such a scenario, without social support orchestrating the learning pathway and 'stitching together' situated events across places, students may experience the events as completely disjointed from each other, placing them on two, potentially parallel learning pathways – the online one with greater scopes of possibilities to take a STEM embracing stance, and the school one with lesser scope of such possibilities, similar to what was reported in Bell et al (2012). However, when two situated events seem to align, as was the case in the session on sound, we see an expansion of the scope of possibility in the school event, with the online making event supporting the student's STEM embracing stance in their school class. In 'schools with hostels,' the students learn STEM from the teachers who also stay with them. All the situated events along the STEM learning pathway are orchestrated by the same teachers, and as they reported, they borrow strategies from the online sessions to engage students in STEM practices in their school science and math classes. The students also ask to be engaged similarly in their school science and math classes, suggesting that such a scenario expands the scope of possibilities for students taking STEM embracing stances.

In conclusion, our preliminary study of the *Curiosity Program* showed the nuanced role that technology (i.e. the internet and material), teachers and language play in engendering the conjectured learning pathway, as they are experienced by learners as both structural constraints and supports depending on the actual implementation in each school (Nasir et al., 2020). This suggests the need for administrators, facilitators and teachers to work together to decrease differences in implementation to ensure that marginalization is not (re)enacted. Concretely, this means ensuring equal internet access and material supplies to all schools, teacher professional development regarding how to support making-based learning during the online sessions and afterwards, and a more careful consideration of language during the design and implementation of the online sessions. We are currently addressing these issues in our ongoing work.

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