From Digital Divide to Digital Discovery: Re-thinking Online Learning and Interactions in Marginalized Communities

Lay-Wah Carolina Ching-Chiang[1,3](✉) , Juan Manuel Fernández-Cárdenas[1,3] ,
Nicole Lotz[2,3] , Noé Abraham González-Nieto[2,3] , Mark Gaved[2,3] ,
Derek Jones[1,3] , Alejandra Díaz de León[1,3] , and Rafael Machado[4,3]

[1] Tecnologico de Monterrey, Monterrey, México
Lay.ching@tec.mx
[2] The Open University, Milton Keynes, UK
[3] Universidad Autónoma Metropolitana, Mexico City,, México
[4] Insitu, Monterrey, México

Abstract. The digital divide presented between the Global South and North has been exacerbated due to the Covid-19 pandemic causing unequal access to technologies in education, public services, and healthcare. Through an exploratory study in the northeastern region of Mexico, a marginalized community used a hyperlocal network to engage in creative Science, Technology, Engineering, Arts and Mathematics (STEAM) activities. The study uses a qualitative methodology with a reflective approach, informed by sociocultural and dialogic concepts. Data collection primarily involved semi-structured interviews, observations, focus groups, and collection of artifacts. The findings present a rich framework of sociocultural factors and capital knowledge from the community. From the study emerged participants' meanings in three categories: i) the use of offline mobile learning, ii) the educational practices in the non-formal context, and iii) the dialogic opportunities created among participants. From this non-formal context of education experience emerged creative lessons in innovation, agency from the learners, and genuine involvement from the participants.

Keywords: Digital divide · Marginalized communities · Dialogic learning

1 Introduction

The Covid-19 pandemic has caused a lockdown of the entire world, resulting in a global scramble to learn and master new forms of interactions at work and school, within families, across communities, and beyond national boundaries. In the field of education, learning opportunities have been reduced by the pandemic because moving education to a predominantly online modality implies reliable and affordable access to the Internet and electronic devices. Despite the assumption that the world could have been ready for

distance and online interactions thanks to widespread usage of information and communication technologies (ICTs), the reality is that the pandemic made visible the challenges that many low-income communities face, in terms of education, public services and healthcare, that were broadened due to unequal access to ICT. These challenges demonstrated a clear divide between the Global North and Global South [1], greatly impacting educational systems and opportunities, especially for traditionally marginalized communities in the South. Furthermore, individuals have not yet developed the digital and future competencies to develop their own identities in a digitally connected world [2, 3] because access to digital technologies is not the only condition for contributing to distance learning, but also the ability to use and appropriate them [4].

In the specific case of Mexico, official data provided from the National Institute of Statistics and Geography [5] in the most recent National Survey on Availability and Use of Information Technologies in Households (ENDUTIH) highlighted the disparity in access to ICT: 55.7% of Mexican households do not have computers and of these, 55.3% attributed this to the lack of economic resources. Moreover, only 56.4% of the households reported a connection to the Internet. Unequal access to ICT has impacted the continuity of education during the pandemic. In marginalized areas, very few students have a permanent Internet connection and devices to attend online classes. During the pandemic confinement, students in marginalized areas are faced with (1) complete drop out of schooling, or (2) having poorer quality education in a formal learning setting. The government's distance education strategy has been to implement a television program series called "Aprende en casa" ["Learning at home"] for primary and secondary schools, which has been a strategy that aimed to cover the majority of the Mexican population, as 92.5% of the population reported having at least one television [5]. In these educational procedures, "teachers assign homework and other learning activities and receive evidence of activities conducted at home" [6] aided using digital and established technologies, such as Internet connections (Learning Management Systems, Email, text messaging, Videoconference, etc.) or phone calls. Nevertheless, 30% of the teachers have reported not having additional contact with their students [7].

Joining an online class has meant that students need to complete their homework in physical notebooks and use their limited Internet access to send schoolwork through applications like Facebook or WhatsApp. The lack of access to technology has widened educational disparities and hindered development opportunities for people in marginalized communities [8]. It is under these circumstances that the Hyperlocal Learning Network La Campana-Altamira was born. The leading research question is: How informal learning opportunities in social settings and using offline networked and mobile ICT engage a marginalized community in authentic educational practices during the pandemic?

'Hyperlocal La Campana-Altamira' has used Raspberry Pis, credit card sized computers that run on open-source software and can create neighborhood digital networks independent of the global Internet, as hubs for local community networking and learning during the Covid-19 pandemic. The project, based on a social justice agenda, aimed to create more equitable access to informal STEAM learning through creative making

activities facilitated by low-cost offline ICT. In a prior project, the co-creation of a community FabLab in a local high school[1], a plurality of pathways to learn through informal opportunities had been established and lessons were learned by all participants from the community and from the higher education institutions involved [3, 9]. The development of relevant skills and the motivation to learn needed to be maintained during the pandemic when the FabLab community was closed in March 2020. In the long term, a series of interventions took place aiming at narrowing the digital divide gap and providing quality education and socio-economic development opportunities in the community. Using hyperlocal learning networks and hands-on creative making kits in a marginalized community setting in Monterrey, a northeastern city of Mexico, was a reaction to the further marginalization during the pandemic, but it also aimed to test the potential for alternative ways of constructing inclusive and creative learning environments for the future.

2 Introduction

2.1 STEAM Education

STEAM stands for Science, Technology, Engineering, Arts, and Mathematics. Its pedagogic approaches support the creative integration of skills and knowledge from those disciplines in project-based inquiry, often, at least in face-to-face settings, through social dialogic engagement with others. STEAM education is a concept that derives from the global North and hence needs critical consideration. STEAM education is influenced by a complex interplay of local and global forces [10]. The global economy is still held up by some as a panacea for inequality but is simultaneously shown to be propagating as many inequalities as it is solving. STEAM education might be similarly contradictory, being seen as a universal driving force for international development, but also accentuating social and cultural inequalities. In other words, even if education is a powerful tool to restructure the existing social order, this is only true if educational practices develop a critical consciousness in students by inviting them to bring their personal understandings of their own learning experiences [11]. In this respect, project-based STEAM activities may allow learners to incorporate and critically evaluate scientific and artistic knowledge in everyday life through the lens of local skills derived from their lived experiences [12]. We also suggest that this approach is a 'constructive alliance' between epistemologies of the Global North and Global South, aiming for a decolonised education [13].

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[1] The fabrication laboratory (FabLab) was installed in 2019 in Monterrey, Mexico, to promote the 'maker' culture involving an agenda of cognitive and social justice through the implementation of a "platform for the democratization of educational practices through the inclusion of participants from different settings, countries and ages, collaborating in the achievement of common goals, while stimulating creative thinking, and strengthening the bonding with participants and their needs" (González-Nieto, et al., 2020, p. 1535).

In several countries, the engagement with STEAM subjects in schools and other non-formal settings has led to its integration into educational policies [14, 15]. Huge emphasis has been placed on the development of STEAM skills for their significance in economic growth and has thus encouraged the development of research in this area in the last decade, particularly focusing on the development of human capital. In North-Eastern Mexico, where Monterrey is located, major social and economic issues are related to, and underpinned by, low engagement with STEAM education. Expanding engagement and emphasis on STEAM would be critical if we are to see improvements in the quality of work for marginalized groups and communities. Consequently, the longer-term benefits of this project aim to generate open spaces for educational innovation to improve social conditions in vulnerable communities.

Monterrey is the largest city of the state of Nuevo León in the North of Mexico and the second largest city in the country. The metropolitan area of Monterrey holds 93% of the population of the entire region (around 5 million people) with 97 men per 100 women. Despite industrial development, Monterrey presents a high number of people in conditions of poverty (19%) and extreme poverty (1.3%). Mexico's rates of daily pay are low; both Mexico and Nuevo León present low gross salaries for the population, averaging a weekly pay of only £70. These are the reasons why we are looking at this intervention in Monterrey through a lens of social justice and decoloniality in the *Global South.*

2.2   Global South

The term *Global South* has been employed by policy makers and academics who have used it to embed multiple meanings and evoke different ideologies. While authors like Dados and Connell [16] consider the *Global South,* a transnational space encompassing Africa, Asia, Latin America, and Oceania, other authors like Esler [17] have used the term interchangeably with *Third World.* Both conceptions have shown limitations. The *Global South* as a geographic space assumes the entire south of the globe as a single region. However, the cases of China, Russia, India, Brazil and Mexico give us lights that counterfeit those assumptions. We cannot assume that the global south is a single region. In the second interpretation of the *Global South,* as interchangeable with the term *Third World*, the limitation is that it portrays racial, religious, political, economic and historical views. In a genealogy construction, the Latin American historian Palomino [18] points out that the terms suggest two different ideas: one being a political affirmation and the other as an expert assessment of a problem.

Thus, a proposal for the term *Global South* in Latin America requires consideration of its colonial history, neo-imperialism, social change and economic development. In that regard, Mahler [19] points to the use of the *Global South* to address spaces and people negatively impacted by capitalist globalization. This broader conception responds to the limitations of *geographic space* and *third world* interpretations for Latin America. Here, the *Global South* term emphasizes the geo-political marker of inequality as well as the impact of globalization in the community. The research in this paper makes use of this

conception of the *Global South* to point out precisely the impact of capitalist globalization for a marginalized community in Monterrey in which the study was carried out. Before the pandemic, this community was already characterized by inequality and difficulties in accessing quality science and technological education and related resources.

2.3 Sociocultural Perspective

The concept of the *Global South* term calls for the study to consider a sociocultural perspective in which a dialogic and decolonial approach are fundamental to make the study *for and from* the Latin American context. The empirical work carried out through the Hyperlocal Learning Network La Campana-Altamira - which we refer to in the text by its abbreviated form, 'Hyperlocal', is informed by a **sociocultural perspective** in which the construction of knowledge is mediated by cultural factors which are appropriated and mastered by participants in communities of practice [20–23]. Cultural artifacts, language, and social institutions are tools that can produce cognitive change [24] and transformative learning [25]. In that sense, following a sociocultural perspective, this study emphasizes the understanding of how participants engaged in the design and making of activities. It is the experience and interactions with sociocultural tools provided which became the focus for learning.

Moreover, in this sociocultural perspective, **the dialogic approach** [26–29] becomes fundamental for participants to examine their circumstances of oppression, and relationships among them and with technology. Under this dialogic perspective it is relevant to give a voice to the participants to understand how they are building knowledge, rather than just assimilating instructions and information. Hyperlocal aimed to provide an opportunity to use technology as a catalyst for participants to reflect on their lived history through dialogic and creative scenarios that bloomed with the development of STEAM activities. Similar studies [3, 30] in informal contexts of education have supported the impact of dialogic learning through such enrichment programs, which offer opportunities to explore and study arts and sciences coupled with occasions for emotional development and historization. Freire [26] proposes that the individual becomes conscious of their world and is positioned to have a critical view of their own circumstances, thanks to their relationship with others. Learners become inquirers and builders of their own knowledge and become able to liberate themselves from oppressive 'banking' educational systems, and as a result they redesign and transform the tools according to their circumstances. Very importantly, learners also realize that they become more capable and creative than they originally considered.

Similarly, under the umbrella of a **decolonial perspective** in technology and education, the historization process provided by the dialogic perspective frames this study. Decoloniality and decolonial thinking highlights the pluriverse of systems of knowledge and thought beyond the colonial framework [31]. In that sense, decolonial thinking implies engaging in educational and technological practices that think outside of the categories, hierarchies, and antagonist binary categories of coloniality (individual vs. community, society vs. nature, immanence vs. transcendence) to think more relationally. De Sousa Santos [32] proposes the concept of 'epistemologies of the South' to understand the transformation occurring in our societies, realizing that theories have been based and developed on the experiences from only the side of the North. Therefore, in

the knowledge frameworks of education and technology, the study invites participants to challenge themselves to think about who gets to use a tool or service, and to which extent. Moreover, De Sousa Santos [1] claims that this pandemic era can be used as an opportunity to deconstruct the oppression of socioeconomic ways of living linked to capitalism, colonialism, and patriarchy, thus becoming more appreciative of the plurality of lifestyles that can be more relational, sustainable, and caring of others and that are already a way of living in rural, marginalized, and indigenous communities in the *Global South.* De Sousa Santos invites all of us to realize that it is possible to live a different life, and for that, a starting point is to appreciate diversity and multiculturalism, and to be creative in proposing new socioeconomic activities that can be more respectful of each other.

Similarly, the sociocultural and dialogic perspectives offered through the experience of STEAM activities opens the floor to a dialogic space, which can also be an opportunity to realize the potential and capacities one has as a person, as a member of a community, and of a living world with a nature to protect and care. Therefore, the dialogic engagement in which participants, the project team, and community partners were involved, incorporates aspects of reality into the shared sense of identity [33]. Thus, we were aiming to understand dialogic spaces to identify the value participants have for transforming their own circumstances together.

3 Methodology

3.1 Context and Participants

La Campana-Altamira are two neighbouring hills in Monterrey, Mexico, and have traditionally been an urban marginalized area. The first projects to populate the hills aimed at creating housing for public teachers, but corruption cases hindered development, and semi-constructed buildings were left unfinished. As a result of the abandonment of the houses, the hills were later populated mainly by internal migrants from San Luis Potosí, Oaxaca, and Chiapas, who were looking for economic opportunities in Monterrey. The resulting settlements lack urbanization planning, which negatively impacts the socioeconomic opportunities of their inhabitants, for example due to difficult access up and down the steep inclines.

Since 2013, Tecnologico de Monterrey, a higher education institution neighbouring the La Campana-Altamira district, has implemented social program initiatives in the area through Distrito Tec, an urban regeneration initiative promoted by this university. Distrito Tec leads the Campana-Altamira Initiative which looks to engage the community in six lines of action: Social Security and Peace, Social Inclusion, Urban Inclusion, Economic Inclusion, Education, Housing, and Health. Distrito Tec incorporates private and public institutions including CEMEX, Monterrey municipality, and Nuevo Leon state government to implement the Campana-Altamira initiative.

In the line of Education, Distrito Tec supported the creation of the 'Fab Lab Campana-Altamira' [3, 9] because it fit the overall strategy of creating opportunities to provide access to quality STEAM education to the community. This was led by researchers who are now part of the Hyperlocal project. For Distrito Tec, these projects are seeds that support the overall initiative. In that line, the Hyperlocal project accomplished two

purposes for them. First, with the pandemic, it was challenging to maintain projects and ways to reach out to community members due to the lockdown regulations and lack of access to ICT devices. It was also difficult for the community to reconnect with fellow learners and to maintain a sense of shared learning from the safety of their homes, especially because the community's priority was the need for basic sustenance. Second, this opened a relationship with the people at the top of the hill. These participants are usually left out of projects because of the difficulty of access. The topology of the district meant that the people at the top of the hill were the most forgotten during the pandemic. The idea of education continuity attracted participants who lacked access to resources from the bottom of the hill.

Hyperlocal was proposed by an international intervention team, including three researchers from the Open University (UK), three from Tecnologico de Monterrey, one from UAM Cuajimalpa, one from In Situ, and supported by one researcher from La Campana Altamira Initiative from Distrito Tec, our implementation partner. Distrito Tec helped us contact the community at the top of the hills by accompanying us to visit and talk to them about the project of STEAM activities from their homes. Their experience with social design projects guided us, and they emphasized the importance of avoiding an interventionist approach but rather, the value of taking a more participatory approach, ensuring we listened to the community and recognised the capital and knowledge resources they could bring to the project.

Thus, ideas from and for them emerged from their side during the project. For example, it was the community participants who decided where we could hold the meetings, and who organized the catering for the end of project celebratory event.

The overarching aim was to continue to engage La Campana Altamira community members in informal, creative, maker-based learning in a social setting during the pandemic to continue developing relevant skills and sustain the motivation to learn and change. We also wanted to test an 'offline' (not connected to the internet) networked social and mobile learning approach with the community. This approach was corroborated by the community leaders we consulted with and supported by informal feedback and observations from other interventions with the community, as well as during the planning of this intervention. The academic and social initiative teams also intended to test the scope of bringing maker education into family homes, rather than the families' coming into a community makerspace, with the aim to reach a broader audience.

Eleven families participated in the Hyperlocal project. Table 1 lists the anonymized names of the adults and children (aged 5–15) who expressed their desire and consented formally to their participation in the project. Later, during the interview process, the research team realized that there were more family members who had become engaged with the project, such as husbands, cousins, and friends. For research ethics reasons, we did not engage directly with these additional 'peripheral participants' but gathered insights into their perspectives through participants who had formally given their consent.

Table 1. Participants from the Hyperlocal project

Family ID	Adults	Children (age)
F1	Martha	Yolanda (12), Pepe (10)
F2	Ivanna	Noah (15), Francesca (6)
F3	Lucía	Aracely (11), Edgar (10)
F4	Isolda	Josefina (11), Ari (7)
F5	Noelle	Lola (12), Marco (9), Miriam (6)
F6	Katy	Amanda (11)
F7	Lily	Brad (5)
F8	Victoria	Juan (9)
F9	Salomé	Gloria (13), Yarezi (12), Emilia (6)
F10	Lime	Alondra (13)
F11	Danuska	Irene (11)

The project was also carried out with the participation of a project team consisting of 8 researchers and 12 undergraduate students from Tecnologico de Monterrey who supported the design, implementation, and celebration phases of the project.

3.2 Tools

To trial the planned approach of using STEAM to engage families during lockdown, the research team designed a craft kit with the materials to engage in established STEAM learning activities. The kit, to be issued to each family, contained materials such as fabric, markers, sewing kits, tape, ruler, papers, glycerin, molds, scented essential oil, among others as seen in Fig. 1. As a result of the successful prior interventions with engagement of some of the community members in creative maker-based learning in a community FabLab, the academic team members proposed four creative activities (Decoder, Draw-bot, Soap making and face mask) that could be carried out at the families' homes to re-engage them in informal learning during the pandemic. All these creative making activities were previously used successfully in the community FabLab and were known to create fun and dialogic engagement and social learning opportunities suitable across different age ranges. In a design education setting, creative making activities develop a sense of agency over what is made and encourage reflection on the purpose of the making and the maker [34–36] particularly when such activity is authentic in, or to, some context [37]. Furthermore, creative learning at a distance benefit from social comparison and collaboration amongst the learners [38]. The Open University provided the funding to purchase the necessary materials and technologies to enable the participants to engage in such learning opportunities, while respecting pandemic lockdown and social distancing regulations.

Fig. 1. Craft Kit for the families

To enable sharing of family activities and to encourage sharing locally, Hyperlocal sought to test the viability of hyperlocal digital networks operating independently of the internet. The project employed a digital platform, MAZI [www.MAZIzone.eu], an open-source software toolset running on Wi-Fi capable small low-cost computers, Raspberry Pis. The MAZI networking software facilitates sharing in community settings, enabling devices such as smartphones, tablets, and laptops to access a common hub and share resources with each other, via Wi-Fi. This hyperlocal network supports dialogic learning approaches by building a networked learning space. Participants can contribute to and receive information from the network furthering opportunities of peer learning. Peer learning is underpinned by dialogic opportunities that arise from interaction around artifacts created and shared online [38]. The hyperlocal network tools enable the community to share their own knowledge and learning locally without a reliance on external network connectivity (internet access). The advantage of this 'offline networked learning' approach [39] is the decoupling of access to knowledge from the socio-technical and economic conditions of the participants.

The MAZI digital platform is available with a set of standard configurations, and the research team customized these to offer Hyperlocal participants three components: *Aprende, Comparte, and Comparte más* (Learn, Share and Share More) as seen in Fig. 2. In the *Aprende* section, families could access preloaded educational videos and guides, in *Comparte* the functionality allowed them to upload pictures and make comments, and in the last section they were able to upload videos and other types of files. Conceptually, the research team wanted to offer (a) the opportunity to access guidance, (b) to start conversations with each around their activity outputs and (c) to engage in extended sharing activities, including videos. The conversational tool (the open-source program "Guestbook" had been designed for the exchange of images and short messages), so to enable video sharing within the limitations of this pilot, the team activated a file sharing program (NextCloud) as *Comparte más.* Each hub offered instructions for four initial creative learning activities for the entire family at their homes. The videos and guides supported making a message decoding device; face masks; soap and a drawing robot.
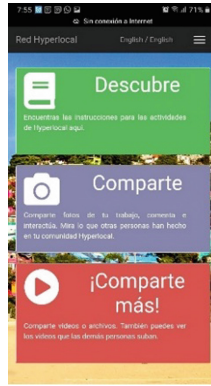
Fig. 2. MAZI Platform as seen by participants

3.3   Phases of the Intervention

The intervention with the families consisted of three phases: planning, implementation, and celebration.

The *planning phase* with the families started with a series of conversations about the project proposal, and how to implement it within the community. This involved the calling and selection of participants who were willing to be part of the project, and for this action, the Distrito Tec insider knowledge of the community was particularly important. A technical test was carried out to find out the most appropriate homes to place the Raspberry Pis, trialing various locations that would give the best hyperlocal network coverage, considering the short Wi-Fi range (approximately 20 m) of the Pis, and the topography of the hills. After the testing, the team decided to deploy five Pis, seen in Fig. 3. By proximity, at least two families were able to access one Raspberry Pi. However, other members of the nearby hubs could visit and comment on families' contributions and upload their own responses.
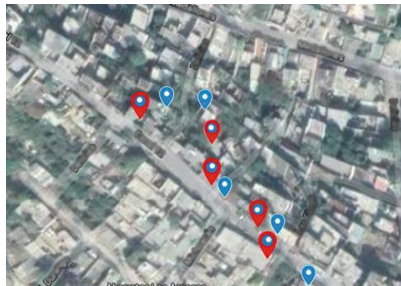

Fig. 3. Approximate location of participants. The blue dots represent the participants, and the red dots represent the Raspberry Pis locations. (Color figure online)

For the *implementation phase*, the research team visited the families to give them a craft kit and the smartphone for the project. Each family was given a craft kit with the

materials to engage in established STEAM learning activities. Families were also given a smartphone and sim card to access and engage with the hyperlocal network through the Raspberry Pis running the MAZI digital platform. Families were supported during the intervention with a team of academics leading the study and undergraduate students who were doing their community service program. The academics leading the team made weekly visits in which they presented the craft kits, deployed the Pis, and solved technical issues that could not be solved remotely. The undergraduate students' roles included contacting the families by phone calls weekly as a follow-up to understand the progress of activities, and to channel technical difficulties.

For example, during the first week of this phase, families reported that they could not upload pictures to the MAZI platform. As a result, the team designed a step-by-step procedure on how to upload the pictures that were handed to participants. The second week, the families reported the same issue, so a team was deployed. In that technical visit the team realized that there was an issue with software configuration: the maximum file size to be uploaded was set to a small default size. This had become a limitation because the phones were taking pictures with a larger default size. The team tried to decrease the quality resolution in the smartphone camera, but it did not work. During the third week, the team was able to change the setting in the Raspberry Pis.

The *celebration phase* consisted of the team and the families planning a day to share the results of the four activities the families had engaged with and sharing a meal together. The Hyperlocal team printed photos of the project for displaying during the celebration. The families took charge of getting tables, chairs and supplying the food. During this celebration day, the children presented their projects and were given a diploma for participating. Each child had a picture taken with the diploma and then a group picture (See Fig. 4). After that, a focus group interview was carried out with the mothers. Then, the mothers served food they had cooked: tacos, three colour jelly and fruits.

Fig. 4. Celebration day

3.4   Reflective Approach

As outlined before, reflection is an important component for the Hyperlocal project, the contextualization of this reflection is as important as the content of the reflections. In

particular, the application of the theoretical lenses of horizontal dialogic spaces [3] were integral to our reflection process. These reflections were informed by the data collected from the participants' engagements during the Hyperlocal intervention. We used a critical stance informed by Freire and contemporary dialogic theory revised above these lines.

Data collection came from semi structured interviews, field notes, a focus group and the MAZI Platform as detailed in Table 2.

Table 2. Data collected

Instrument	Amount	Description
Semi structured interviews - Set 1	11	Done at the beginning of the project to create rapport with participants
Semi structured interviews - Set 2	26	Done during the project to do a follow up about the four activities that the participants were making
Focus group	1	Done at the end of the project for the participants to share their experience with the activities, the raspberry Pi and issues they face with the project
Fieldnotes	6	Done from the first visit to share about the project with participants until the celebratory event at the end of the project
Raspberry Pis (MAZI platform)	5	The information (photos, videos and comments) that was collected from the 5 Raspberry Pis

Using a qualitative approach [40, 41] the data was coded inductively, and grouped to form categories which help to provide an answer to the research question of this paper: *How can informal learning opportunities in social settings and using offline networked and mobile ICT reflectively engage a marginalized community in authentic educational practices during the pandemic, and what change processes can be observed in this community*?

This research question was answered following an emic perspective. Pike [42] proposed a distinction between phonemic and phonetics, which has been taken up by social scientists interested in highlighting the personal and situated adjustments and interpretations that an agent makes of culture. This is a contemporary approach in anthropology [43, 44] which privileges an *emic* perspective where participants interpret social interactions and practices in their own terms versus a more normalized and imposed view of culture (an *etic* perspective).

The international research team held weekly reflective online discussions between 2020 and 2021, initially to plan the design of the study and later to discuss the categorization of the data for evaluation of the intervention. Notes were taken and this resulted in a collaborative 86-page record. Through these reflections we attempted to uncover any

processes of social change in the participants who engaged in the Hyperlocal network, including the intervention team.

4 Findings

Three main themes emerged inductively from the data analysis: i) the use of offline networked mobile learning, ii) the educational practices in the non-formal context, and iii) the dialogic opportunities. Within these themes the participants' emic perspective was documented in categories and is presented below.

4.1 The Use of Offline Networked Mobile Learning

The first theme, the use of offline networked mobile learning, is related to how participants used the Raspberry Pis, MAZI platform, and smartphone to engage in the learning activities. The use of offline networked mobile learning as described in Tables 3 and 4 offers a general view of the participants' interactions with the technology.
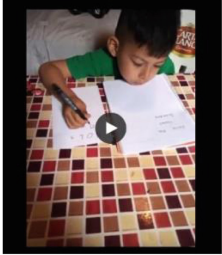
Table 3. Data in the Raspberry Pis

Raspberry Pi	Families	Photos	Comments	Videos
R1	F1-F2	1	0	1
R2	F9-F10-F11	1	0	0
R3	F5-F6	0	0	0
R4	F7-F8	10	0	4
R5	F3-F4	31	4	4

Table 3 summarizes the data that the families uploaded into the *Comparte and Comparte más* sections of the MAZI organized by Raspberry Pi. The table shows which families accessed each Raspberry Pi and the number of photos, comments, and videos they uploaded. The Raspberry with the most content was number 5 from families 3 and 4. The content with less uploads was "comments", and the one with the most was "photos".

Table 4 has sample content uploaded by participants to the MAZI. From the 43 photos uploaded, only in one of them do adults appear, but in the background. Of the four comments, one is a greeting and the other three are related to creative activities (soap making).

Category 1: Engagement with Technology. Participants found the use of offline networked mobile learning easy, which propelled the thinking of the future uses of technology. The use of the Raspberry Pi to access information allowed participants to explore possibilities that transcended their own prior experiences with technology and offered wider perspectives of how it might be used in the future. The use of this offline network in

Table 4. Samples of content uploaded to the MAZI

Photos	Comments	Videos

Hyperlocal triggered their thinking about the possibilities of this technology for formal education. Transcript 1 is a conversation between a researcher, and two participants, a mother, and her daughter, about the use of the Raspberry Pi.

Transcript 1. The use of the offline network mobile learning for formal education

Luna: What did you learn from the use of technology in your life? Did it leave you any experience having used the Raspberry or the cell phone? How was your experience watching the videos from the Raspberry?

Josefina: From the Raspberry it was quite easy to use and connect.

Luna: What will be easier to watch the videos from the Raspberry or from YouTube?

Josefina: With the device, it is more direct and nothing more.

Salomé: Well, it was fast, you go in and see the video that you wanted to see.

Luna: If your teacher brought you the class videos in the Raspberry, would you use it?

Salomé: Definitely, it will be easier. In that way, it is all there easier to access and watch.

In this transcript, the participants reflect on the ease of accessing videos from the offline network (Raspberry Pi and MAZI) compared to the online networks (cellphone, internet) they may already use. Salomé mentions how the device was fast and helped in the development of the activities. Here it is important to consider that the topography of the participants at the top of the hill was problematic, and limited access to fast and reliable global Internet connections, making the use of an offline device a faster alternative. Moreover, when Luna questioned Salomé about the use of the Raspberry for a formal education, Salomé answered that she would use it and that it would be easier.

Category 2: Catalyst for Reconnecting. The use of offline networked mobile learning was a tool to propel sharing. Participants encountered a limitation with the use of the Raspberry Pi to share information in the *Comparte and Comparte más section* because

the photo sharing tool was initially set to only allow 2 Mb photos, which was the default setting. This became problematic because the default size of an image taken by the mobile phone provided was bigger than 2 Mb. However, instead of not sharing their making activities with others, participants pursued workarounds to satisfy their desire to socially share the result of making with their neighbors and relatives using ICTs. Isolda told the team "*My daughter sent it [a photo of the decoder creation] to her cousin through WhatsApp, so they were sharing ideas on how to improve the model*" and Lily said "*Before the pandemic I used to meet with Lucía outside and talk while washing clothes. During Hyperlocal, I met her to talk about the project and share what we were doing and how to solve the technology issues" (Field Note 3*). In both examples, we can see that technology served as a catalyst to reconnect with other participants as it served as a new (local) platform that was available to people of this community. Therefore, they found a new place in which they can share not only their results but also the process they established to complete the making activities.

4.2 The Educational Practices in the Non-formal Context During the Pandemic

Hyperlocal was developed in the framework of a non-formal educational context during the juncture of the Covid-19 pandemic. During the implementation of the project, families had been confined for 13 months and the children had only had intermittent opportunities to access quality formal education. Hyperlocal was a non-formal opportunity to engage families in educational opportunities. The dynamics of that framework are expressed in the following categories:

Category 3: Motivations. Participants had different motivations to join the program, such as: mothers or grandmothers looking for an educational experience for children; upgrading knowledge; and spending time together. For instance, during an observation, Lucía (a mother) shared that she wanted her children to be part of Hyperlocal because she had previous experiences with opportunities offered by Tecnológico de Monterrey and Distrito Tec such as sports and painting programs. So, she expected Hyperlocal to also help her children in their educational experience. Similarly, For Ivanna, a grandmother, there is a willingness that her granddaughter "*could improve her knowledge with what she is currently learning in school" (Interview-Initial).* Finally, Katty, another mother, mentioned "*My neighbor told me. My girl likes to do arts & crafts and she says is friends with the other girl. I wanted her to get along with my girl more because sometimes she is really withdrawn, and I'd like to have more time with her (Field Note 4)".*

In these three cases, adults are willing that their offspring are part of this project as a way to deepen their learning. They are motivated by seeking to achieve more opportunities within and beyond the community, and by learning about technology, making activities, and gaining competencies that are going to be useful for their everyday lives in the present and future stages.

Category 4: Taking Roles. Families had to agree which specific roles each member would take to complete the activities. From the interviews inquiring about who did what in the process, it was seen that roles were decided based on abilities, safety issues, and

knowledge. For instance, in an interview with Victoria and her son Juan (see Transcript 2), she described how those factors became relevant to decide who took charge of which part of the process.

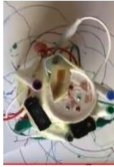**Transcript 2.** Step by step making of the activities

Luna: Good. Let's start the interview with Victoria and Juan. Well, first, thank you again for allowing me to do this interview. Could you explain to me how you did each of the activities?

Victoria: I think with the face mask we started by cutting the fabric. We made some types of patterns with some leaves and from there we were guided ourselves to cut them. We cut them and sew them. It was there where I taught Juan how to sew. He was very enthusiastic to learn how to do it. He wanted to learn. With the soaps, it was almost all done by Juan. I hardly helped him. I only helped him to melt the soap in the oven because it was hot for him to carry. He emptied them in the mold and put the figurines. He also took care of the rest, the colors, the scents and everything. Next, was the decoder. In that one I helped him because of the scissors. It was more dangerous because you were supposed to cut the cardboard. So, I cut the circles and the messages. He just put it all together. Finally, with the robot, he did it all by himself. But I just helped him glue the battery holder and the motor.

Similarly, the actual abilities and previous knowledge of family members were relevant to the making process of the activities. Even though the fathers did not sign up for Hyperlocal, they participated. When interviewing the families, 6 of them mentioned that dads helped in the drawbot project. Their role was fundamental in helping the families understand how the drawbot works; this can be linked to the fact that 6 families mentioned that the husband works in construction jobs. Additionally, age also became a factor to decide who would take care of the technology. In most families, children took the leading role in using the phone and accessing the MAZI platform. However, in the case of Lily, she took control of the use of the phone because Brad was five years old, and he was rather actively involved and engaged in the making process of the activities.

Category 5: Creativity. The project had four activities with tutorial videos made by the undergraduate students. In Table 5, the first line shows figures of the proposed products from the activities, and in the second one a sample of the products that the families produced, as well as the total quantity created. The products show a lot of personalization and additions to make them look different from what the tutorial videos suggested, showing the families' likes, and innovative ways to execute the activities. The decoder was in most cases coloured and had drawings on it. The face mask was personalized by adding characters or jewels. For example, Juan added Spiderman cuts from an old sock he had, while Aracely used jewels to write "Tik Tok" on her facemask. The soaps had stickers and rings among other objects and colours. Josefina said that she used rings thinking that at the end of the use of the soaps, her sisters could have a prize for washing their hands. The drawbots were decorated and personalized, and the cables were put inside the cups, so they did not show on the outside.

Table 5. Activities proposed vs actual results

	Decoder	Face Mask	Soap	Drawbot
Pro-po-sed				
Ac-tual re-sult s				
	11	45	100	11

Lily commented that she hopes that her child learns to do things by himself. Martha's family mentioned the positivity that comes with engaging in creative activities: *"it opens our heads more, we play, we entertain ourselves as a family. We get a little distracted and we are not thinking negative things (Field Note 5)"*.

As evidenced with the photographs and testimonies, families made an appropriation of the activities by adding novel items and materials that were available in the local community. Furthermore, the creativity shown in this category enhanced the agency and decision-making process of the community to promote a meaningful learning experience through the collaboration with others.

Category 6: Capable of Doing More. Families' members realized that they were more capable of doing things that they believed they could previously do. In Transcript 3, Victoria was amazed by what her son, Juan, did. She could not believe that Juan had used the motor of the drawbot to move to his toys: a car and an airplane.

Transcript 3. Capable of doing more

Victoria: He really liked the soaps, and the robot was what he really liked the most.

Luna: Great!

Victoria: In fact, with the robot's little motor he was putting it in an airplane and a car so that it can move.

Luna: And did it turn?

Victoria: Yes, they moved. I told him to take them off because he did that before the celebration event. I told him to take them off because he was going to show the robot.

People from the community felt comfortable by adding materials or changing some of the original instructions of the activities. They knew that their own knowledge, experience, and materials could enhance the making process to produce a better result that was more relevant for their local conditions and possibilities. With these ideas in mind, people solved problems and felt that they could participate with a more active role by doing more. This category shows how this sense of agency was built through the development of the project in a communitarian and collaborative context.

4.3   The Dialogic Opportunities Created Among Participants

Families created dialogic opportunities through the making of the decoder, mask, soap, and robot, the use of the Raspberry Pi, and their decision-making process.

Category 7: Facing Hardship Together.   Historicity focuses on the reflection process in which participants and the project team are able to name their world and verbalize their circumstances. The historization of participants' circumstances was shown through generative themes, topics that were relevant for them. Lucía's historization, as seen in Transcript 4, of socio-economic hardship allows her to point to what really matters - education of her children - and through this she makes connections to future possibilities:

Transcript 4. Historicizing the importance of education

As my father used to say, the only inheritance I can leave to my children is education. In addition, it is very didactic for them, they learn a lot. They were most excited about the soap, but not when they saw those dinosaur molds because they did not like it for a girl. Imagine, if I want to sell it but only for boys. So, I told my daughter that if we see the same ones downtown [molds], we will buy them.

In Transcript 5 (Interview Lucía, Pos 150–153) the dialogue reveals generative themes for Lucía as she continues historization of how she came to live where she is and how she figured out building and equipping her house through 'tandas'[2].

Transcript 5. Generative themes

Lucía: My house is about a block and a half away. I used to live with my mother. When I was pregnant, I didn't want to be with him. While my whole pregnancy lasted, I was with my mom. He sent money and everything he could. After our son

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[2] This word refers to an informal saving method in which people provide money to a common pool with friends or colleagues. This pool, then, is rotated among the members of the "tanda" to receive the entire money given by all the members of the group. Tandas also serve as a short-term loan, as people can receive big amounts of money in a short period of time (Fundary, 2018, retrieved from https://medium.com/@fundary/tandas-and-the-informal-economy-of-mexico-4f3c80c1c7ce).

*was two months old, I moved in with him. I have been living here for 5 years. Here
is my room and that's it, we built it upstairs.*

Luna: *How was that entire process?*

Lucía: *Well, I told you about the pregnancy: I spent it there with my mom and
after our son was two months I came. The truth is that when I came here, well,
I had nothing. He didn't have a bedroom' door. We had a bed, but as I told you:
I was regretting having left my mom's house, to having said yes. Little by little. I
started buying the stove, the fridge and having to cook myself apart. We already
built up and down, I have the kitchen here and upstairs we use it for the room. We
struggled for what he worked for, but then the good thing is that in challenging
times the tandas helped us. We use tandas because there are no loans for us and
I don't like them, I feel like I'm going to pay more. So, among all of us, my mom
does tandas of 500 or 300 pesos and with my siblings join them; I have one sister
and two brothers, my dad, my brother-in-law, one, my sister-in-law. We put the
numbers together and raffle the numbers. When the tanda is done, it is no longer
necessary to ask for a loan.*

In this transcript the generative themes are tightly related to things that matter to Lucía
in daily life: relationships, housing and finance. She reflects about how her pregnancy
somehow led her to live with her husband. However, economic difficulties have been
presented to build and equip the house. For that reason, they have used 'tandas' which
are a way to finance themselves. All the participants in a tanda give a specific amount of
money each month and one get all the pot in the month depending on the number they
got. So, if the "tanda" was 100 pesos per month with 5 people, each month the tanda
would be 500 pesos. If Lucía got the number one, she would get the 500 pesos for the first
month, the next month she has to pay 100 pesos. The concern about economic sources
generated that later in the interview, she mentioned the possibility of selling the soaps
that she learned to make in Hyperlocal. Other generative themes that appeared in the
findings were schooling, women violence, abilities, gangs, and the Covid-19 pandemic.

Category 8: Projection of Future Possibilities. After the intervention, the families
had the opportunity to make reflections about their future and possibilities. As part
of that opportunity the families expressed their previous desires for the future before and
after the intervention. Their previous desires for the future revolved around their ambi-
tions for their children to have opportunities for a different job profession than what their
parents currently have. Transcript 6 (Interview Salomé, Pos 269–286) is a conversation
with a mom and her two daughters and exemplifies their professional aspirations.

Transcript 6. Reflect about the future

Leticia: *What do you want for your daughters in the future?*

Salomé: *All the good things that can happen to them.*

Leticia: *And what do you want for your future?*

Yarezi: Lawyer.

Leticia: What do you like about being a lawyer?

Gloria: *if you don't know anything*

Salomé: Let her talk

Leticia: Come on. Yes, tell us, tell us.

Salomé: I'm going to check the beans. [She leaves]

Yarezi: I want to be a lawyer because there are many things you have to do, that is. As well as defend, as well as many cases of. I mean, so to speak. How? As well as. Defend people, people.

Leticia: Who would you like to defend?

Yarezi: No, well I would like to defend the ladies who are beaten by their husbands

Leticia: And you?

Gloria: Well, I want to be a doctor.

Leticia: What type of doctor

Yarezi: veterinarian

Gloria: No, a doctor to help people.

In the conversation, Yarezi and Gloria expressed their desire to become a lawyer and a doctor. These two are different professions from what their parents do. Their father works in construction and their mom, Salomé, is a housewife. Their mother got married when she was 18 years old, only finishing middle school. Her father insisted she didn't need high school because she only needed to get married. The reasons given by the girls to choose their profession hint at social problems found in this context such as domestic violence, and gangs that they also comment on in their historization process.

After the intervention, when asking participants about what they could do with the acquired knowledge, their desires for the future can be grouped in three subcategories: apply for business, more STEAM projects, to learn other things. Salomé exemplifies the desire to apply the knowledge they acquired for business: *"I was thinking of getting the soap to make bigger soaps to sell in my dad's shop. I told my dad I can make the soaps and sell them here. He said it's okay. We can put them in bags or in the same molds. We can charge 5 pesos for the big one. That would be less expensive than the cheapest in a shop." (Interview Salomé, Pos 226).*

The acquired knowledge by participants opened the horizon for participants to dream about other possibilities. In the "apply it for business" subcategory, the participant has made her marketing study, selected a place, thought about promotion and products thanks to the soap activity. In the second subcategory, the participant asks for other STEAM projects specifically to be taught to make antibacterial handwash which is connected to the pandemic. Through Hyperlocal, she has re-evaluated the circumstances in her life and sees the possibility of learning to deal with it. In the last subcategory, the participant proposes specific topics of interest for future workshops, for moms to discuss their concern on how children use mobile phones and how to tackle domestic violence. Participants were explicit in terms of the learning agenda they wanted to pursue in the following interventions.

5 Discussion

This study of a Hyperlocal Learning Network in La Campana Altamira exemplifies a digital transformation initiative *for and from* a local community. The community's engagement with STEAM educational activities in a non-formal networked learning context created a dialogic space that propelled participants' creativity and search for solutions, giving them a sense of agency. They developed pride and confidence, not just in being able to complete the tasks but in striving to personalize the designs created and in thinking about future possibilities these new skills and ideas could give them.

In the dialogic space created by individuals within a family and their immediate neighbours, the participants challenged their own goals and practices, and positioned themselves in the world. The main drivers of the learning network were mothers and their children. Mothers realized that the project became an opportunity for the children not to be bored, to create new friendships with the neighbour's child, to gain experience to develop their minds. The adults reflected their own educational aspirations with their children. There is a strong role of the mothers in the education of their children, giving them educational opportunities, so their children are not exposed to the same vulnerable labour markets, such as construction and house cleaning, that these adults have to rely on. Giving opportunities to voice their historicities is an important part for bringing about social change and transformation.

The exchange of traditional teaching-learning roles within families was a further important finding that this intervention brought to light. Cooperation among family members to complete the activities represented a space for them to work towards a common goal and negotiate roles. While in some families, mothers led the sewing process for the masks, with children being more engaged in uploading the content into the MAZI platform for recording and sharing, in other cases children took the teaching role in personalizing the masks and soaps.

Documenting the use of technology showed that the transformation was not only about adopting recent technologies, but rather about the appropriation and combination of other technologies and lived experiences in non-formal settings for educational purposes. For example, one participant used the social network service Tik-Tok to create the videos that they then uploaded to the Hyperlocal network. While social networking services were originally not considered a tool for formal learning by the community, informal dialogic spaces invited drawing on these alternative sources for creativity.

Participants compared their experience of using the Hyperlocal offline network to their use of online networks as being less distracting, focused and faster to access. We believe that understanding this mix and match approach to using offline and online ICTs is valuable in non-formal learning and community settings, which might be more difficult to facilitate in formal school settings [e.g. 45].

We assumed that the community had an interest in sharing the outputs and comments on the Hyperlocal hub. Technology is only used when it is convenient or advantageous to do so. A technical glitch during the setup of the Hyperlocal hubs meant that participants could not upload pictures with a higher resolution than 2 MB in the *Comparte* section, but the phone with which they took images produced images larger than 2 MB. This resulted in participants using workarounds, such as using *Comparte Mas* for images and video only, or sharing the pictures, videos, and comments through WhatsApp or sharing

them in person. They also used the street as a shared space for them in which they used it as an extended part of their homes, becoming an arena for dialogue to emerge between them. This arena also became an oasis of social interaction where they also engaged in community gatherings with food, drinks and (often unmasked) conversations around the pandemic confinement and how to creatively face everyday problems. Through these interactions they managed to relate to each other in respectful and cooperative ways to survive the lockdown. Introducing Hyperlocal, with the offline hub, mobile phones, and STEAM activities, became a catalyst for dialogue, and got the community members thinking about extending their personal opportunities. While the interest to 'share' could be observed, again, the community participants used a mixed approach to how they did that.

6 Conclusions

The Hyperlocal intervention has implications for academia and practice. Documenting the participants' experiences offers the opportunity to legitimize the richness of the dialogic space created in a non-formal educational context. It is expected that the family members, with the dialogic space created by this intervention, will continue to historicize their own circumstances, challenging their previous learning and future possibilities, so that they realize that they are more capable than what they initially thought. We hope that the results offer professionals who work with communities' advice on how to create such dialogic spaces. The researchers also positioned themselves as participants of the intervention and started to critically question their educational and research practices, and adopted a decolonial perspective, in which diverse ways of thinking were integrated in understanding the processes of change.

The lenses of dialogism and decolonization were useful for analysing the data collected and discussing the possibilities and challenges of this educational intervention. Dialogism, and in particular, its focus on historicizing, was a productive feature for participants to realize that their capabilities are larger than they initially thought, and that they can creatively design transformative trajectories of their own interest, as well as workarounds to the constraints of tools and activities. As a result, their sense of agency flourished allowing them to define an agenda to next pursue, and to propose their own themes for reflection and learning, such as the production of sanitizing gel and learning to do hairdressing, as ways to sell products and services in the future. This resonates with a decolonial perspective, in which participants reflect about defining their own lifestyles as legitimate within a *Global South* way of living. This project was a seed for reflection and for some more promising transformations that can be achieved by continuing the relationships established between community participants, scholars, and university students. This is a noble way to relate to each other, and to bond in the diversity of roles each participant performed.

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