

COMMUNITY MATH STORIES: INFORMAL ADULT EDUCATORS EXPLORING MATHEMATICS IDENTITY THROUGH DIGITAL MATHEMATICS STORYTELLING

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During the COVID-19 pandemic, many urban schools relied on community centers with existing computer labs and high-speed internet that could provide in-person support for a small number of children engaging in online learning. Using a digital storytelling approach, this research report analyzes the mathematics identities of 14 informal adult educators. Situating the stories shared through Critical Race Theory counternarratives, this study enables participants to ground their narratives within their own spaces of power—to tell and forge their own digital mathematics story. Because informal adult educators are not family members nor school-based educators, they often are invisible variables in conceptualizing a child’s mathematics learning. This research seeks to elicit their mathematics stories and understand how to enactment digital mathematics storytelling through listening to how the community positions and visions math.

Keywords: Equity, Inclusion, and Diversity; Design Experiments; Informal Education; Technology

Perspectives

The Shift in Education during COVID-19

During the COVID-19 pandemic, many urban emergent school districts¹ in the United States of America, already dealing with racial and socioeconomic segregation, had to switch to a completely remote model of learning, meaning that children were expected to engage in all their school interactions online (TODOS, 2020). This forced adoption of virtual and online learning exasperated already stark divides in technology access, requiring children to have access to high-speed internet, a stable tablet or computer, and a regular work space just to attend school. This was an almost impossible ask of families and communities who have historically been marginalized in multiple ways, resulting in many of the largest urban and urban emergent school districts in the U.S.A. reporting that as many as 70% of their students were not attending online schools (Christakis et al., 2020).

One community-based approach that rose to address the needs of families struggling to support their children’s education is the Learning Extension Center (LEC), community centers with existing computer labs and high-speed internet that could provide in-person support for a small number of children engaging in online learning. These LECs are partnerships between the school district and “community, faith based, and other public sites that provide physical space within the facility to allow workstations for students. The purpose of the LECs is to provide educational and social-emotional support to Columbus City School students in a safe

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environment and welcoming environment during our prolonged period of virtual learning” (*Columbus City Schools 2020-21 Reopening Archive / Learning Extension Centers*, 2020).

These types of partnership sprang up in urban emergent communities across the country (Greenberg et al., 2020), filling in the gaps in technology access by providing a meeting space for a child to use a sanitized computer, an adult educator who provided nominal technology and instructional support, snacks and meals, and a feeling of community for children. While these LECs were not able to, nor designed to, replicate the affordances of a school classroom, they did provide a necessary space for children in urban emergent communities to continue their school-based learning during the COVID-19 pandemic. The LECs, thereby, became a place where masked children could attend in order to connect with other children, complete online school lessons, and work with an informal adult educator. For many, the LECs played a crucial role in supporting urban emergent families and communities.

Informal Adult Educators

The LECs are staffed by informal adult educators, usually community members dedicated to supporting children, but who are not formally trained or certified teachers. These informal adult educators bring many backgrounds with them. Some might be college students studying to eventually become teachers, local sports coaches who regularly work with community youth, or community members whose other employment was disrupted by the COVID-19 pandemic. Because these informal adult educators are not formally prepared teachers, they often bring more mainstream perspectives to mathematics learning. For instance, informal adult educators may express anxieties and fears about mathematics based on prior experiences. Additionally, informal adult educators may also have limited experiences with inquiry-oriented mathematics pedagogy and therefore position mathematics learning as heavily procedural and focusing on memorization because of their own experiences. Finally, while informal adult educators might be comfortable with using technology in their own lives, they often may have limited experiences with instructional technology (e.g., Google Classroom, Flipgrid).

Informal adult educators are rarely studied within the mathematics education research, partially because their limited role often exists entirely outside of the classroom. However, due to COVID-19 pandemic, informal adult educators now found themselves as the only *adults* outside of a child’s household that were regularly physically working with children. Informal adult educators were no longer positioned as supplementary workers or after-school helpers. Due to community-based restructuring of our nation’s schools during the COVID-19 pandemic, new roles and possibilities involving the nature of informal adult educators and their impact on children’s mathematical learning became apparent. And therefore, as the informal adult educators’ roles in urban emergent communities grew, the question we as mathematics education researchers ask is: How do informal adult educators narrate and conceptualize their own relationship to math—their own mathematics identities?

Community and Family Mathematics vs. School Mathematics

These informal adult educators, suddenly tasked with supporting students as they engaged in learning traditional school mathematics, hoped to find ways to explore their own mathematical knowledge in juxtaposition the mathematics they were seeing in online and hybrid learning models they were supporting their children with. One approach to address this issue to connect out-of-school mathematics with in-school mathematics is through recognizing the mathematics knowledge shared in community spaces (Aguirre et al., 2013). For instance, when someone shares about the daily mathematics checks they do to make sure that each of their animals is fed, juggling the feeding schedules of lizards who eat every other day, fish that eat multiple times a

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day, and birds that eat every day, the mathematics of finding common factors emerges. Mathematics that exists within the community is often dismissed as not “real” mathematics because family and community mathematics often operates socially, involving storytelling and group problem solving, while school mathematics is often positioned as internal knowledge measured individually (D’Ambrosio, 1985; González et al., 2001; Powell & Frankenstein, 1997).

Mathematics Identity

Mathematics identity, often only explored as a students’ mathematical identity or as a mathematics teachers’ identity, has been shown to be positional, performative, and socially constructed (Esmonde & Langer-Osuna, 2013; Holland et al., 1998; Martin, 2000; Wenger, 1998). For teachers, mathematics identity involves the negotiating of one’s provisional self with regard to various sociopolitical positions taken when teaching mathematics (e.g., sexuality, ethnicity, and economic status) (de Freitas, 2008a, 2008b). Additionally, mathematics teacher identity can involve the position a mathematics teacher takes to either confront or reify the oppressive practices within traditional mathematics teaching and learning (Gutiérrez, 2013; Herbel-Eisenmann et al., 2013). Mathematics teacher identity, therefore can “consists of knowledge and lived experiences, interweaving to inform teaching views, dispositions, and practices to help children learn mathematics.” (Aguirre et al., 2013, p. 27).

Intersectionality, a lens with roots in Critical Race Theory, Feminist Theory, and Poststructuralism, focuses on examining the intersection of various social spaces of oppression (Crenshaw, 1991). Research examining issues of equity and identity can sometimes position social identities as static variables (Darragh, 2016), leading to generalizations that erase voices and position all members of a category as similar. An intersectionality approach allows participants to present the nuances within their various social identities, showing ways in which they are individually unique and human (Leyva, 2017). Each of these social identities carries with it some artifact of oppression and opportunity. An intersectionality approach, therefore, examines the stories where these multiple social identities overlap. The stories revolve around lived experiences, not second-hand evaluations or judgments (Solorzano & Bernal, 2001), valuing the varying narratives that the adults tell about their backgrounds, pedagogies, beliefs, and positions (Walshaw, 2013).

Work that conceptualizes identities from a *Critical Race Theory* perspective, and *LatCrit* specifically, draws attention to the multiple layers of subordination based upon race, class, gender, language, immigration status, accent, and phenotype experienced by Latinx communities (Delgado Bernal, 2002; Johnson & Martinez, 1998; Lopez, 1997; Solorzano & Bernal, 2001). This *LatCrit* perspective draws a cultural connection between participants’ stories and the cultural construct of *testimonios*—first-person narratives one tells about one’s self to others (Gutiérrez, 2013). These narratives often reveal accounts of systemic oppression hidden from more structural modes of inquiry (Yosso et al., 2009). Mathematics identity therefore, from a *LatCrit* perspective, can be understood as these specific narratives that directly expose or confront oppression (Solórzano & Yosso, 2002; Zavala, 2014).

An intersectionality and *LatCrit* approach moves away from characterizing identity as a categorical adjective or noun; instead identity becomes a verb, something in-flux, being made and remade, as a sociopolitical act. Identity through storytelling is agentive—an emancipatory act in which adults construct counter narratives that confront and claim power within the oppressive worlds they live in (Aguirre et al., 2013; Gutiérrez, 2013). Since identity involves the telling of one’s stories (Sfard & Prusak, 2005), the counter narratives themselves become a theoretical,

methodological, and pedagogical means of understanding a mathematics identity (Solorzano & Bernal, 2001).

Storytelling

The most active way to explore mathematical identities involves storytelling. When members of urban emergent communities tell narratives about their out-of-school mathematical experiences, they position themselves and their communities as mathematical (Aguirre et al., 2013; Love, 2014). Given the popularity of video and image-sharing platforms like TikTok, YouTube, and Instagram for sharing personal stories (Auxier et al., 2020; Rideout, 2017), there is a strong case for utilizing these emerging digital literacies to connect out-of-school mathematics to in-school mathematics (Ozpinar et al., 2017) for exploring mathematics identity. In this study, we explore Digital Mathematics Storytelling (DMST), a mechanism for using videos, photographs, and audio to craft and share mathematically-rich narratives from communities, to potentially connect out-of-school mathematics with in-school mathematics in informal education settings and explore identity.

Activity Theory

Cultural-historical activity theory (CHAT) positions learning as occurring when individuals participate in culturally organized activities that are constituted by six essential entities: human subjects (individuals or groups), objects (artifacts and motivations), instruments, rules, community, and division of labor (Engestr m, 1987). This activity system can be depicted as an “activity triangle” (see Figure 1) that is useful in examining and interpreting artifact-based interactions in social learning contexts.

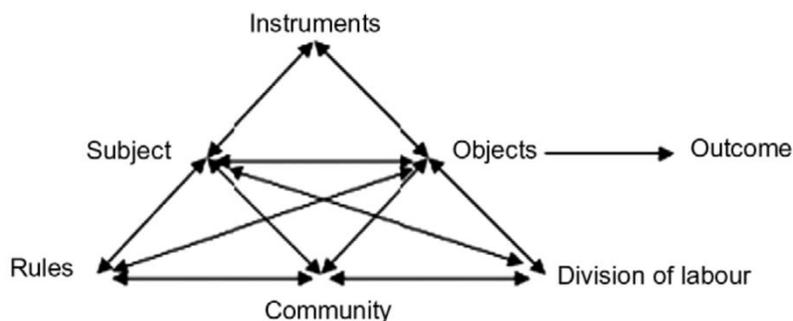


Figure 1. The structure of a human activity system in CHAT. (Engestr m, 1987, P.78)

CHAT attempts to explain the distributed and situated nature of knowing in human activities mediated by artifacts and culture (Engestr m, 1987). When achieving objects in an activity, subjects not merely produce outcomes but also produce or reproduce themselves (Wenger, 1998). It is this dialectic relation between subject and object that prompts the transformations of learners’ identities and their learning community.

Digital mathematics storytelling can be situated as a CHAT-oriented learning activity that involves informal adult educators (subjects) using digital technologies (instruments) to create mathematically-rich personal narratives (objects) in the online storytelling circles (community). Through participating in a digital mathematics storytelling experience, adult educators’ craft and hear each other’s narratives around mathematics, impacting their evolving mathematics identities.

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Objectives

This research study focuses on 3 objectives: (1) To develop a protocol for Digital Mathematics Storytelling through Participant Design Research in partnership with adult educators who work in urban emergent community centers, (2) To listen to the stories that informal adult educators tell when given the opportunity to create Digital Mathematics Stories to understand their narrative-based mathematics identity, and (3) To explore the impact of Digital Mathematics Storytelling on their mathematics knowledge, digital literacies, and feelings of connection with the communities they serve. Simply put, this research report analyzes the role of adult informal adult educators within two community learning extension centers during the COVID-19 pandemic. Through the lens of mathematics identity through storytelling from a Critical Race Theory Counternarrative perspective, we explore a framework of mathematics identity specifically involving informal adult educators who work within marginalized urban emergent communities.

Research Modes of Inquiry

Researching Identity

Studying something as personal and complex as identity, particularly when working with communities that are often oppressed and marginalized, requires research strategies and tactics that avoid deficit colonizing perspectives (Patel, 2016). This requires eliciting narratives, and recognizing that these narratives are the participants' identities (Sfard & Prusak, 2005), thereby avoiding unnecessary evaluation and judgment from the researcher. This narrative-biographical approach to studying identity also enables participants to ground their narratives within their own spaces of power—simply, participants tell their own story (Kelchtermans, 1993).

Community-based Participatory Design Research

The community-based participatory design research methodology builds upon design-based research by positioning all participants as integral to the designing of research goals (Bang & Vossoughi, 2016). The first objective of this research project involved developing a model digital mathematics storytelling protocol for the informal adult educators to adapt and use with the children at their LEC. From there, feedback from participants shaped the refinement and modification of the protocol for use with other students in the local community. Within the workshop itself, informal adult educators had the opportunity to question and reshape the research team's plans, while also engaging in an iterative process of telling, refining, sharing and imagining to refine their own digital math stories.

Participants.

This project involved 14 adult educators across two community LECs who work directly with over 100 K-8 children in an urban emergent community. Of the 14 adult educators, all 14 identified as a Black or a Latinx person of color, and had lived in or had substantial roots to the communities they worked in.

The Data Collection Phases

The data collection took place over four phases, with at least one week passing between each phase. In the first session, the participants engaged in a workshop to explore their own feelings towards mathematics and to brainstorm the ways mathematics exists in their lives. Between the first and second session, participants created a draft video in which they shared the ways math might exist in their lives. In the second session, the participants engaged in a facilitated reflective protocol called the Storycircle, in which each participant shared their initial story, received feedback from their peers, and thought out loud about how to refine their mathematics story

(Lambert, 2013). Between the second and the third session, the participants worked on crafting their Digital Mathematics Stories, a 3-5-minute video in which they shared a story about mathematics and how it related to them. These videos focused not on a mathematics problem, but on the ways that mathematics occurs in a story that only the participant could tell. In the third session, the participants presented their finished Digital Mathematics Stories and also give feedback and commentary to their peers' stories. After this "screening" session, each informal adult educator engaged in a 1-on-1 interview with one of the authors to discuss how this process connected to their mathematics identity, how it affected the way they helped their children with mathematics in the LEC, and how they might alter the protocol to for their own community.

Measurement/Instrumentation

We focus on three measures in this report.

Digital Math Stories. The informal adult educators created, workshopped, and refined their own short videos stories. Both the draft and the final stories were analyzed.

Weekly Comments. The adult educators also added significant online comments, feedback, and questions to shared, online documents during and after every weekly session and also in the chat feature within the online conferencing platform. These comments and questions involved questions to the research team, feedback to the other informal adult educators, and advice or even further stories and anecdotes about implementing Digital Math Storytelling in their LEC.

Interviews. After the informal adult educators finished their workshops, they each engaged in a 1-on-1 interview to discuss the effect of this experience, how they thought about implementing digital storytelling in their own work at the LEC, and how this experience affected their feelings of connectedness to the community.

Analysis

In order to analyze this data, the research team used constant comparison analysis (Corbin & Strauss, 2008) and narrative inquiry (Clandinin & Connelly, 2000) to compare data from the informal adult educators' digital stories and their written comments during workshops in order to understand the changing aspects of the educators' mathematics identities (Aguirre, et al., 2013; Langer Osuna & Nasir, 2016) and their ability to employ digital tools to meet their needs as storytellers, educators, and mathematical actors. In the analysis, we focused specifically on connecting the ways that the informal adult educators (1) expressed their sense of agency and comfort with mathematics; (2) imagined the process of engaging children in telling their math stories; and (3) gave one another feedback on the stories they shared. The written contributions were analyzed alongside the digital video stories that adult educators created.

Results

Informal Adult Educators' Mathematics Identity

Generally, each informal adult educator expressed trepidation about mathematics in their initial story, revealing fears and anxieties about mathematics based on their own experiences in school. These stories focused on feeling "dumb" or "stupid" in their mathematics class, racial and gender stereotyped reinforced by educators and other adults in the community, and a focus on school mathematics as being about following directions and preparing for tests. Overall, we found that the first sessions of working with the informal adult educators required listening to stories of frustration coupled with empathy for the violent and oppressive mathematics experiences that most of the informal mathematics educators had experienced.

However, in the short time between the initial and the final mathematics stories, many of the informal adult educators had quickly shifted in the way they positioned themselves towards

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mathematics. Based on the sharing of the stories, the feedback and the commentary of shared negative experience in mathematics, and the shepherding of the research team that mathematics is not about judgement or evaluation but about problem-solving and creativity, the informal adult educators generally showed major shifts in their stories.

For instance, one educator, who was also a college student, shared about how this experience gave her the confidence to sign up for a mathematics course, even though she had been avoiding taking mathematics courses throughout her matriculation. Another educator shared a story about how she felt engaged in the validating the mathematics she did each morning to calculate whether or not she had time to stop for a cup of coffee. And another student shared a story about connecting to the indigenous mathematics knowledge he was curious about in ways to mix specific herbs and plants together to create healthy teas and potions. Overall, the stories showcased the ways that the adult informal educators had found aspects of mathematics in their own lives, but more importantly were not able to recognize that they themselves were mathematically powerful.

The Types of Digital Math Stories

In analyzing the stories, we found that in terms of mathematics content, the stories could be categorized as either a *quantity-based mathematics story* (e.g., how much money do I have in my budget?) or a story involving a *basic arithmetic scenario* (e.g., how do I figure out how much food I need to feed my pets?). In terms of the context, we found that the stories fit within four specific types that each illuminated aspects of the storyteller's life: (1) Work or time management (e.g., how much time do I need to commute to work?), (2) Money or budget management (e.g., will I have enough money to pay for a *Disney+* subscription if I move to a different apartment?), (3) Hobbies or sports (e.g., how can I mathematize my improving basketball playing ability?), and (4) Caregiving (e.g., How do I create a system for taking care of my plants?).

Insight into Supporting Children's Emerging Mathematics Identities

The stories and the commentary surrounding the stories showed how the informal adult educators felt about their math self-efficacy (e.g., negative personal experiences with timed test), how they were starting to grow in their beliefs about mathematics learning (e.g., recognizing the need to listening to children's mathematical thinking), and their approach to enacting mathematics storytelling either through engaging children in a math problem or eliciting mathematical routines or stories directly from children. Additionally, the informal adult educators delved into discussions around the ways they would talk about and position mathematics, particularly paying attention to the mathematics terminology they used in their stories (e.g., tallying vs. counting; being clear about units). These emerging insights show that, while these informal adult educators had little formal mathematics teacher preparation, just going through this exercise engaged them in conversations that dominate most inquiry-oriented university-based mathematics methods courses.

Digital Literacies

Finally, the informal adult educators showed a wide-range of comfort in their "digital literacies" enacted as they created and crafted their videos. They often commented to each other about the "crispy"-ness of each other's videos, focusing on the attention-grabbing transitions and inviting visual techniques used in the videos. Yet, many of the comments also expressed frustration with the availability and usability of the video editing tools they had access to, focusing on what it even means to be "digitally literate." For instance, while we as a research group assumed from the initial conversations that the informal adult educators were well-versed

in creating videos for Instagram or TikTok, the commentary around the digital stories showed that many of the informal digital educators used this experience as an opportunity to create their first ever Instagram or TikTok video. We are still unpacking how this might challenge the definitions and forms of what it means to be “digitally literate”, that it is less about technical skill or familiarity, but more about opportunities to tell “your” story.

Discussion

While we are still analyzing the stories, the commentary, and the interviews for deeper insights, we will share that this experience of working with informal adult educators has helped us conceptualize the importance of engaging and listening to community members that impact our children’s mathematical learning. The informal adult educators live in a unique space; they are not family members nor are they school-based educators. They often are ignored in the conceptualization of the many variables affecting a child’s mathematics learning. Yet, community centers and the informal adult educators who work within them are integral members of the community, and their stories and enactments of mathematics has a significant impact onto how our children thereby position and see mathematics in their own world.

Note

¹ The term urban emergent signifies communities in large cities, but not as large as metropolitan areas such as New York or Los Angeles. These urban emergent communities, however, encounter the same scarcity of resources and historical issues of segregation (Milner, 2012).

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**CUENTOS MATEMÁTICOS EN COMUNIDAD: EDUCADORES INFORMALES
EXPLORANDO IDENTIDADES MATEMÁTICAS A TRAVÉS DE CONTAR CUENTOS
MATEMÁTICOS DIGITALES**

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