Designing A Tangible Rhythmic Interface for Digital Drum Talk

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ABSTRACT

I propose a tangible user interface and communication protocol for computer mediated rhythm-based interaction for educational applications (music, language, mathematics). Thinking beyond the paradigm of keyboard-and-screen-based interfaces, this project is based on previous work on the *Drumball*. By converting rhythmic input into multimodal output, it creates an entangled ecosystem where the human body, digital musical instruments, and the Internet of Things intersect. Such a digital orality system could offer parents and practitioners a novel method for introducing children to literacy, STEAM skills and multimodal communication in the early years. I present design iterations of 1) a tangible rhythmic interface for digital drum talk inspired by the style of play of the Djembe, 2) a protocol for sending piezo sensor outputs over a custom PCB shield, which can be recognized across multiple platforms and web-based environments without additional customization; and 3) a suite of rhythm-based learning games using the *Alphariddims* multimodal symbol system based on the Morse code. I argue that such a culturally-grounded approach to music technology design provides a viable avenue for the preservation and revitalization of the vibrant, yet intangible, cultural heritage and traditions of the African talking drum cultural systems.

Author Keywords

Early literacy, drummology, talking drum, controller, microcontroller, rhythm-based web audio interaction

1. INTRODUCTION

Drummology is the field of research committed to the study of all social institutions connected to African talking drums. The etymology of the term 'drummology' can be traced to the words: 'drum', an English word for a percussion (musical) instrument that does not apply with complete success to the African instruments, which distinguish themselves by virtue of their communicative (linguistic) function; and 'logos', a Greek word that signifies the study or science of something. "From there, one can distinguish the drummophony, that is to say, the translation of what is said on the drums, and drummography, the text [in written form] of which the drum rhythm is the origin" [1]. By studying rhythms and cultural practices of African societies from the pre-colonial period, drummology provides the foundation for a scientific treatment of drum language.

A talking drum is not only a musical instrument, but also a communication technology that has been used for centuries to transmit information at a distance through drum language. Although our present notion of language comes from the era of the dominance of speech and writing, drum language fulfills many of the functions of speech in a specially styled manner, that is informed by percussion instruments and rhythm. As a mode of communication, drum languages rely extensively on the use of metaphors and rhythmic codes played on the talking drums [2][3][4]. More recently, researchers in education, sociology and psychology have discussed "how the talking drum has been a viable cultural voice for many West and Central African cultures in the acquisition of literacy" [5] and can serve as a counterpart to school curricula to shape the way young people participate in the nation [6].

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Still, a myriad of forces operating through the imperialism of Western power, language and technology have had causal effects on the erosion and near disappearance of many cultural traditions and practices worldwide, and the African talking drums are no exception. Whereas drums were altogether banned in the United States during the era of slavery [7], their role as widespread communication instruments have been eroded by new information and communication technologies. Ong noted the fact that "the movement from orality in the West to the modern technological world took some 6,000 years" and that "the transit from orality through writing and print to electronic communication in Africa is taking place, not over 6,000 years, but in two or three generations, and for many even less time" [8]; these comments raise important concerns linked to the entanglements of societies, cultures and technological adoption.

In this paper, we embrace a different approach to drummology, one where digital technology empowers the communicative function of the drum, instead of hindering it. We present a new in-progress drum-like interface, that is inspired by the West African Djembe drum and is designed to work in combination with culturally grounded, multimodal learning applications. The *Drumball* interface serves as an example of how music technology can entangle multiple domains—from historical African drumming practices to contemporary digital interaction and education. This is accomplished by using a drum-like hardware interface to control interactive music, language and rhytm-based game applications. The aim of the project is to improve the multi-literacy skills of children in the early years (3-6), by means of practices that are deeply rooted in old traditions, yet depart from Western pedagogical standards. To this end, the proposed redesign is meant to replace the initial prototype and enhance the level of embodiment experienced by young learners and their parents in the future Urban Griots Playground family workshops, later described.

2. LITERATURE REVIEW

While it is commonly acknowledged that children learn best when they are active, the standard approach to early childhood schooling tends to favor a passive mode of learning focused on the decoding and encoding of print, often overlooking one of the first (and perhaps most important) steps, which is motivation [9]. Furthermore, when literacy-supporting technology is found in most school classrooms, it often resides in a standard keypad-display styled computer interface, which makes it difficult for children to involve their voice and body in play. This prevalent cultural and standardized pedagogical feature of Western schooling tends to restrict physical movement and favor learning impassively. This fails to include as an integral part of the literacy practices those musical repertoires, sonic cultures, and embodied practices responsive to many children who come from backgrounds where voice-, rhythm- and movement-linked activities are the norm. In this section, we link our work to others' in the field with similar concerns, but a different focus, framework or approach.

2.1 Early Literacy Interventions

In the field of early literacy, alphabetic knowledge is defined as the ability to name, distinguish shapes, write, and identify the sounds of the alphabet, and is considered the best predictor of children's later reading and spelling abilities [10][11][12]. Existing work indicates that literacy interventions during the "Golden Age" of child development (3-6) [13], may be particularly effective in preventing future obstacles, as preschool and kindergarten students with poor knowledge of

alphabet and vocabulary are more likely to struggle with formal literacy instruction, fall behind and be classified as having reading disabilities [14][15][16]. For these reasons, alphabet knowledge constitutes a critical learning milestone for young children, and facilitating its development has become a primary objective of pre-school instruction and intervention. Being largely anchored in a Western conception of literacy, primarily restricted to reading and writing, the conventional approach to early literacy intervention has limited the integration of non-Western cultural systems of knowledge that may be beneficial to students. In particular, many researchers argue that expanding the conception of literacy to include forms of understanding and language that is culturally relevant will allow for higher engagement of Black and Brown students [17][18][19]. Research shows African Drumming provides an opportunity for expanding literacy [20][21] and math [22] skills through a combination of the semantic and syntactic structures, how they develop executive functioning skills, connect to cultural roots and values, and also through social communication in a manner that is engaging and fun.

2.2 Drum-based Interventions

Drumming is rapidly becoming recognized and utilized as a medium for personal growth and development, for the enhancement of community feeling and for physiological and psychological healing [23][24]. Bittman's evidence-based studies of adults [25] and adolescents [26] confirm the biopsychosocial efficacy of group drumming school-based programs, and other researchers have suggested that the introduction of drumming within the social context of schools can "significantly improve a spectrum of behavioral problems in children [27]. In particular, "African drumming has been shown to offer numerous psychological benefits by encouraging social interaction, building skills that can make a meaningful contribution to society and by promoting a sense of competency in participants [28]; by facilitating self-expression, non-verbal communication and improved physical, emotional and mental health [29]; and by providing an opportunity to creatively channel negative emotions such as anger and frustration [30]. Emerging from this type of research are numerous approaches to integrate drumming in schools, founded largely upon behavioral theories of change, placing little emphasis on literacy development, nor considering recent paradigm shifts within cognitive science and music cognition research ushered in by the embodied approach [31]. While understanding the efficacy of drumming on positive socio-emotional and behavioral change is important, what may be equally important for early childhood practitioners, education researchers and ed tech designers is to design and examine situations to learn about the hidden power of the drum as a legitimate communication system. As drum language is very much based on verbal language, one cannot understand how it works without understanding the linguistic structures that it builds on. For digital natives, the need is to show them the application of rhythm as a universal mode of communication via any medium, not just in the context of African drum and dance classes, as beneficial as those are.

2.3 Embodied Learning & Applied Psychology

Embodied learning is an emerging field fueled by educational technology innovation that has not been thoroughly researched yet, but which holds great potential in terms of student engagement. The basic idea behind embodied learning is that students who fully use their bodies to learn are more engaged in the lesson than they would be simply sitting at a desk or computer. [32] It emphasizes the role of the body in cognition, advocating for learning experiences that integrate physical movement and interaction. Rooted in naturalized epistemologies, this approach values learners' sensory, motor, and cultural histories [33]. Embodied pedagogies have demonstrated promise in improving memory, expressive vocabulary, motor coordination, and foreign language learning in early childhood [34][35].

Cassell (2001) emphasized the potential of off-screen, voice-activated technologies to support emergent literacy [36]. Systems like *StoryMat* and *TellTale* enabled children to tell and structure stories using tangible, auditory tools, encouraging sequencing and early writing behaviors without relying on keyboards or screens. The Jam-O-Drum Interactive Music System developed at Interval Research Corporation where "up to six simultaneous players are able to participate in a collaborative approach to musical improvisation" also provided an inspiring direction in that "the system embraces both the novice and musically trained participants by taking advantage of their intuitive abilities and social interaction skills." The system furthermore demonstrated educational applications by virtue of its call and response module that would inspire "follow the leader" behavior through the orchestration of rhythmic and visual patterns and integrate "the community drum circle as a metaphor to guide the form and content" of this work [37].

These projects inspired the application of drumming and oral traditions into early literacy practices, especially in culturally responsive ways. Technologies that embed rhythm and drum language in their design frameworks offer new opportunities for children to "read" rhythm as text and "write" with their full bodies and hands—bridging sound, movement, and meaning across disciplines. By exploring embodied rhythmic communication, students can assert their tacit and cultural knowledge as they learn about rhythm patterns of letters, names, words, sentences, numbers and shapes. By enabling young learners to express cultural and linguistic knowledge through embodied rhythmic communication, parents and educators can open a multimodal pathway for literacy development, numeracy, and creative expression grounded in oral traditions.

3. Drumball-Alphariddims System Overview

The *Drumball-Alphariddims* is a digital orality hypermedia system and tangible interface that acts as a transducer of finger-tap and hand-stroke patterns into digital audiovisual output. The system has two components: a tangible user interface connected to a laptop or mobile device running a software application that serves as a multi-user player game environment accessible in both stand-alone mode and in-tandem with a physical drum controller. The system was play tested in a few different informal cultural settings to both iterate the concept itself and to give some direction on what some of the most viable ways might be to implement the instrument in the actual workshop intervention.

This section provides an overview of the system, including details about the tangible interface, rhythmic encoding scheme, interaction paradigm and software environment.

3.1 Design Metaphor

The integration of the cultural framework of African drumming in the system's design is based on 3 sensors as an analogy to the tone-slap-base drumming principles and techniques of the *djembe*, an hourglass-shaped drum originally from Mali (Fig. 1).

Figure 1 - Hand-playing technique consists of slap-tone-base strike combinations, modeled after the djembe drumming principles

The hardware component includes 3 parts: 1) a physical layer (fabric cover, laser cut or 3-D printed shell) with 2) sensors embedded in the surface (conductive pads or piezo microphones) to trigger hand/finger taps which are received by 3) a laptop or mobile device, connected from outside via USB to control the application. A circuit board (MakeyMakey, Bela or Arduino) connected to the sensors provides presence of touch or intensity value information. Each pad sensor is connected to a particular

input which tells whether the user's strike is a bass, tone or a slap. The rhythmic input is then processed in Javascript (P5.js, React) or C# (Unity) and the output response served via the audio speaker and visual display of the connected device. The size of this embodiment is approximately that of a child-sized djembe.

Figure 2 – a) Initial Arduino-based *Drumball* prototype made of custom fabric with conductive pads as input sensors overlayed over a physical djembe; b) Second embodiment of Drumball-Alphariddims prototype using the MakeyMakey (San Diego, 2019); c) Second *Drumball* prototype tangible interface embodiment internal components

In this context, there are several digital drum talk encodings (Figure 3) which represent the various modes of the call-and-response interaction paradigm. These rhythmic encodings are based on specific strike or gesture combinations associated to drum sounds, alphabet letters, word syllables, numbers or angles, thus allowing users to compose rhythms, spell words, verbalize phrases, perform arithmetic operations or draw geometric shapes solely via rhythm, using 3 visual-sound symbols (. – x; tone, slap and bass). At the time of the inaugural UGP study, the encoding scheme employed was the *AlphaRiddim* code, which is based on the Morse code, whereby each letter has a unique sequence of dit (·) and dah (-) signs, which I refer to as tone and slap. By normalizing each Morse code through the addition of bass (x) symbols, the resulting code connects literacy with numeracy and music as the action of producing a letter is generated from a rhythm of exactly 4 beats. Figure 3a shows the *AlphaRiddim* pattern for each alphabet letter currently recognized by the system.

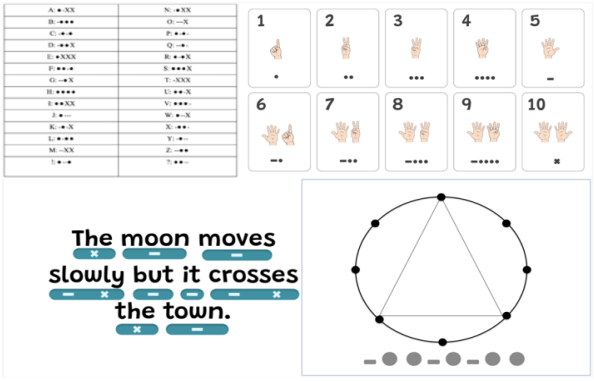

Figure 3. *Digital drum talk encodings: AlphaRiddim (top left), Numeriddim (top right), Syllariddim (bottom left) and Georiddim (bottom right) – Drum Sound Notation [Tone: ●; Slap: -, Bass: X]*

3.2 Design Iterations

The communication between the hardware interface and the receiver application went through several iterations, starting with a Makey Makey circuit board (Figures 2b and 4a) with alligator clips connected to each of the 3 drum pads/contact switches made of conductive fabric/tape, thus providing presence of touch and intensity value information. Under this initial scheme, each sensor pad is connected to a particular input emulating a keystroke ('a', 'f', 's') which tells whether the user's strike is a bass, tone or a slap. A pattern recognition algorithm programmed in the software application matches the rhythmic input from the tangible interface against the digital corpus and returns the corresponding item as output (text-to-speech generated by the computer or sounds played back from pre-recorded audio files).

In the next implementation with a Bela board (Figure 4b), I experimented with *isochronous control*, which is the use of audio to transport control signals, an approach previously explored in the context of digital musical instrument design [38]. In this case, the index of the piezo pad being struck by the player is encoded as the amplitude of an analog voltage pulse. Upon detection of a strike, the Bela sketch outputs the pulse through one of its analog outputs, which is connected to the audio input of the receiver device through an audio cable. When the pulse is received, the information is decoded and the *Alphariddims* application can play the sound file associated with the specific pad/strike (i.e., bass, tone, slap), as well as progress the logic of the software application.

The current implementation (Figure 4c) employs a mix of both previous iterations by way of an Arduino UNO with a custom PCB shield (Figure 4d) designed in Fritzing and outfitted with inputs and resistors to handle 3 piezo sensors. The basic coding principle is to monitor the analog port for each and when the value rises above a certain threshold, to send a character encoding the piezo that was triggered ('a' for bass, 'f' for tone, 's' for slap). This new prototype bears a shape and feel that enhances the passive haptic experience that a drum-like device offers. In particular, the overall metaphor was revised to better reflect the playing technique of the *djembe*, by replacing a generic touch-activated system with one more percussion-based.

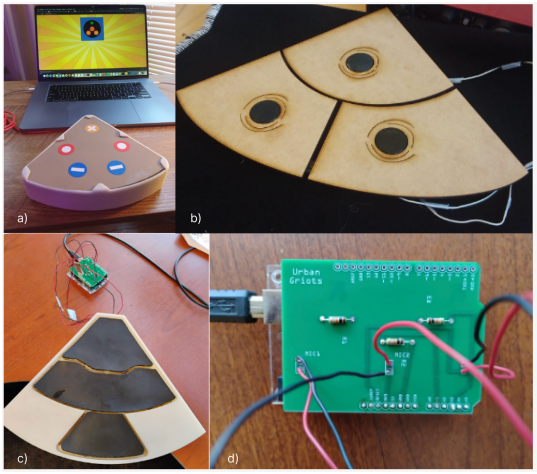

Figure 4 – a) and b) Intermediate prototype embodiments with MakeyMakey and Bela, respectively; c) Current prototype embodiment with d) Custom Arduino PCB shield designed to streamline the analog communication protocol using piezo mics.

3.3 Software Environment

The *Alphariddims* game is prototyped as both a Processing/P5.js (Javascript) and Unity (C#) app for interacting through digital drum talk via the browser on a laptop/desktop computer or as an app installed on a phone or tablet. The software is designed to operate in a call-and-response cycle, serving a dynamic corpus of multimodal language objects (letters, words, proverbs, icons, shapes) that children can interact with by means of the tangible interface. This is a rich multi-modal environment designed to provide real-time audiovisual feedback in response to users' rhythmic input patterns on the *Drumball* device. The object of the game is to explore the rhythms of various corpus items. In its mechanics, the algorithm detects the rhythmic input, retrieves its associated number, letter, word, shape or proverb and returns the response item. In its stand-alone mobile app version, the *Drumpad* (Figure 5) is the main area of interaction for the user as it imitates an actual djembe drum which at its most basic level of play offers the three sounds tone (.), slap (–) and bass (x).

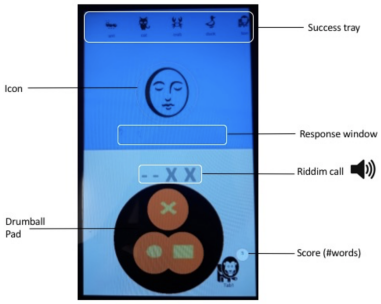

Figure 5. User interface of the *Alphariddims* mobile game app. The Drumball pad is the main area of interaction for mobile.

The intention was to ground the user interaction model in a manner inspired by the call-and-response framework of drum language communication, i.e.: the system makes a call (a letter represented by its *AlphaRiddim* code, which is also sounded), players read, listen and respond to the call, an algorithm compares the user input pattern to the call pattern and validates. Players can select the current sign by using the *Drumball Pad* feature of the graphical interface; alternatively, they can use the *Drumball* hardware interface. The possibility of using a physical controller is meant to increase the quantity and the complexity of back-and-forth children experience (alone or in the company of others), while exploring the relationships between spoken, written and drummed representations of words as onlookers on the periphery can use a regular drum, or even their own physical body. If correct, the letter corresponding to the code is displayed and sounded. If incorrect, a sound effect prompts the user to 'Try Again'. Once the word is successfully completed, the entire word is sounded, and its label and icon move to the success tray at the top of the window, while the next corpus item is served up.

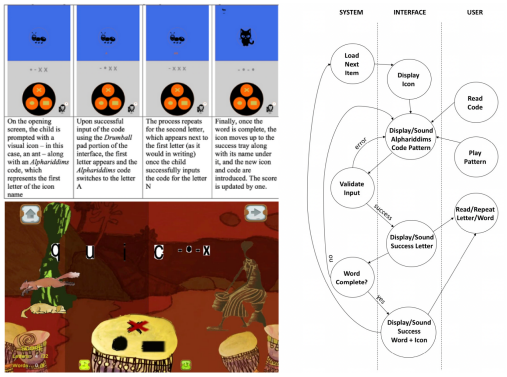

Figure 6. a) Sequence of a player spelling the word 'Ant' in the initial Alphariddims mobile app game (P5.js version); b) Second version of the Alphariddims game prototype focused on spelling the pangram "quick brown fox jumps over the lazy dog" (Unity) and c) state diagram of the game algorithm showing internal dynamic

The introduction of alphabetic letters and visual icons in this context is a must-have for the system considering its broader pedagogical objective, i.e. to serve as a rhythmic device for children with the motor ability to tap ambidextrously and no prior knowledge of writing to explore language through a non-screen-and-keyboard-based interface akin to those found on desktop, laptops, tablets and mobile phones. Children can learn by tackling words and phrases of varying length, corresponding to game levels, allowing them to progress, as they're ready. Thus, a single learner (or group of learners) could use the system to explore the rhythmic signature of letters, words and even phrases of varying length (e.g. appellations, metaphors or proverbs).

The combination of these software and hardware tools makes the tool appropriate for different settings, ages and skill levels and has the potential to benefit early literacy learning, by facilitating solo, dyadic or group embodied multimodal interactions. This is noteworthy because, when literacy supporting technology is found in the classroom, it typically resides in a laptop or desktop computer where an individual child is placed in front of a screen and a keyboard. This makes it difficult both for children to collaborate, and for them to involve their full bodies and senses in learning and play.

4. The Urban Griots Playground (UGP) Study

The proposed technologies were designed to be part of the Urban Griot Playground (UGP) study investigating how leveraging cultural systems can lead to a transformation of praxis in PreK-3 education through systematic integration of cultural tools and embodied practices into the learning ecology. Given the material and time-related obstacles to designing and testing enough prototypes of the hardware interface that was robust enough to withstand the hands of a 3- to 6-year-old, the decision was made to use the app-based version of the interaction that could be installed on mobile phones or tablets for families to use.

4.1 What is UGP?

The Urban Griot Playground workshop model builds from the aforementioned theoretical and design spaces to propose a dynamic technocultural ecology that engages children, parents and teachers to create and share together through voice, rhythm and movement activities. The goal of the culturally grounded, hybrid curriculum (face-to-face and online) is to guide children through the apprenticeship of the art of the griot by navigating various learning and social contexts that require the mastery of both rhythmic, linguistic, mathematic and digital skills. This music-based embodied literacy intervention (MBELI) approach is designed to be responsive to the (Pre-) Kindergarten Literacy and Music/Dance standards. A review of the Visual and Performing Arts Content Standards for California Public Schools adopted by the California State Board of Education reflected the knowledge areas and skills for the curriculum to align with (Artistic Perception; Creative Expression; Historical-Cultural context; Aesthetic Valuing; Connections, Relationships and Applications).

4.2 Participants and Setting

The focal participants for this study were the families who attended the UGP workshops offered weekly over the course of four weeks. While participants varied in cultural, racial and ethnic background, all were English-speakers or English as a Second Language learners. The focal participants were 5 child-parent dyads or triad who attended all sessions and completed all data collection instruments. The 5 children were between 2 and a half and 6 years old and were enrolled in the program by their mothers who accompanied them and remained present for each session.

The inaugural UGP study took place once a week for four weeks at a Performing Arts Cultural Center (PACC) located in Siskiyou County (Northern California). The Urban Griots Playground was the first family workshop series of its kind offered at the center, which came after several trials runs in Bay Area venues including cultural arts centers, childcare facilities, and preschools. Participants have access to the Alphariddims interactive digital game online, further extend children's learning journey to the home with at home activities to reinforce the skills they picked up in the workshop, and deepen their understanding. In light of this, parental engagement at home is key. An analytics dashboard is integrated within the game for parents to monitor and understand their child's learning experiences more deeply.

Through repetition and application of skills newly learned in the workshops to the home environment, parents enhance their child's overall learning journey.

4.3 Workshop Structure & Learning Goals

The workshop series comprises of four modules, each session last about 90 minutes (or less) and is divided into three parts:

- Circle – Communicate: A time for relationship-building through group activities and interpersonal communication
- E-Learning – Create: Stimulating children's multiple literacies using technology-based tasks and multimodal production.
- Practice – Celebrate: Engaging in drama and improvisation to create performance pieces that embody children's identities.

Children in the workshop complete various multimodal meaning production tasks (verbal, visual, kinesthetic and digital) centered on using the *AlphaRiddim* symbol system. The core of the procedure is to employ the natural social organization of the group as division of labor (child-parent dyads) and create a set of tasks (or quests) to be completed and shared out by each child-parent pair. During the tasks, all the participants were provided with drums or tablets to drum up letters and words as a way of exploring the alphabet letter names and their sounds, after first embodying the patterns with their own bodies. The codes were also printed and handed out to every participant, who were encouraged to practice with them from home in between sessions, at least one time. This framing opened the possibilities for any young child and family who participates in the intervention to have benefits that could be documented and analyzed, as each workshop session is focused on a different domain, integrating literacy and STEAM learning objectives.

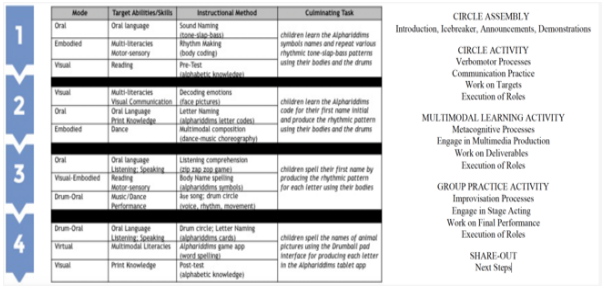

Figure 7. Study procedures (quests) aligned to Preschool Early Literacy & Performance standards

4.4 Data Collection and Analysis Methods

Data collection (including entry and exit interviews) spanned a 6-week period, divided into 3 Phases. Data included a parent online survey on child multimodal skills inventory, a 30-min entry and exit phone interview of parents about children's music and literacy habits at-home, participant observation during the workshops, audio-video recordings and focus group discussions, and a pre- and post-test of alphabetic knowledge to examine the research questions on the *impacts of culturally-grounded, embodied learning environments and activities mediated by the Urban Griots approach to multimodal experiences on children's development of literacy and socio-emotional skills.* During Phase II - The Four Workshops, the pre-test was administered to all children (on the first day), and selected audio/video portions of their performances on each task recorded, while observing the parent-child interactions attentively. The post-test and focus group were completed during the final workshop. In Phase III, exit interviews were conducted with the focal parents who had participated in all four workshops of the study to better understand the nature of their experiences with the *Urban Griot Playground*'s learning ecology (activity, tools, resources).

For the analysis, I draw on multimodality and Cultural-Historical Activity Theory (CHAT) to examine the affordances of integrating multimodal call-and-response strategies facilitated by the *Drumball-Alphariddims* system on children's early literacy experiences, and how children and their parents engage in literacy practices within an embodied learning ecology by exploring the relationships between embodied literacy learning experiences (or environments), and children's cognitive and socio-emotional growth, through a CHAT lens. In the UGP's context of multimodal literacy activity, the object-oriented action of practicing new literacy and socio-emotional skills was most influenced by a network of three interrelated factors in the UGP activity system: cultural tools (tool), embodied learning practices (division of labor) and social participation (community), as shown in Figure 8 below.

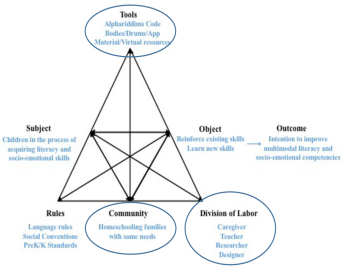

Figure 8. ***The UGP focal activity system elements***

5. RESULTS AND FINDINGS

Through this preliminary study, it was found that the workshop's embodied learning ecology and approach to literacy via rhythm-mediated multimodal learning activities and social games had a stimulating impact on children's literacy behaviors, active social participation and understanding of emotions in relation to visual icons and oral proverbs. However, the sample size was too small and the change in pre- and post-tests too modest to validate the efficacy of the method for teaching literacy via a multimodal symbol system. Still, the findings highlight the potential of rhythm-mediated family-based activities in fostering children's early literacy behaviors and socio-emotional skills as a means of promoting school readiness. Indeed, the intervention was found to be most effective for those focal children whose parents were most concerned for, in terms of early literacy and/or socioemotional development, although some of the children were too young to understand the intervention, given the complexity of the multimodal use of the symbol system which requires more translations than standard reading.

Pre-/Post-Test Results: The curriculum proved engaging and feasible, with two children (Sam and Arfia) improving letter recognition by 6 and 4 letters, respectively. Olem and Cam showed no change, having already mastered the alphabet. The complexity of the *Alphariddims* symbol-to-gesture mapping proved challenging for some, but call-and-response routines and embodied interactions maintained high engagement.

Session Observations: All children engaged in the body, drum, and digital activities, with varying levels of ease. The structure fostered agency, listening skills, and expression. Social games helped children connect movement, sound, and meaning, laying a foundation for symbol-based literacy.

Figure 9. a) Olem joining Machi in the *BodyRiddim* name spelling activity b) Participants drumming in a circle c) Olem & Olivest; d) Alcanat, Cam & Arfia, using the app

5.1 Finding 1 - Stimulating literacy behaviors using a visual symbol system deployed through multimodal means

Throughout the UGP sessions, it was found that the workshop model had a motivating and stimulating impact on children's literacy behaviors and their active social participation and understanding of language, communication and emotional literacy in relation to visual icons and sonic objects (drum tones, rhythms). It was observed that all the focal children displayed visible enthusiasm and enjoyment of embodied literacy learning by representing syllables or letters as rhythms performed on their bodies. Through the recognition of the *Alphariddims* visual symbol patterns as movement sequences representing alphabet letters from Workshops 1 and 2, the children were able to compose (with the help of their parents) body rhythms that effectively "spelled out" their first name. All of the focal children were able to engage in letter recognition and gain a sense of enjoyment/motivation from the digital task consisting in the spelling of animal/object names For children who did yet not possess the cognitive and fine-grained embodied skills necessary to write with a pen, the *Alphariddims* app helped them develop a basic understanding of writing as the manipulation of visual symbols through sensory-motor interaction in order to encode meaning using a restricted set of signs.

5.2 Finding 2 - *Cultivating key social participation dispositions*

A key aspect of the UGP pedagogical approach was to engage the children's verbal and motor skills in dyadic or circle activities centered on how rhythms and symbols can be functional in interpersonal and group situations in and beyond the physical world. In this regard, an important organizational structure was to conduct each session in a circle format, which provided everyone (children and parents) an equal footing for participation, using the center of the circle as a space for individual performances to be shared with the whole group.

5.3 Finding 3 - Providing means for parents to encourage and evaluate children's literacy learning

In addition to cultivating children's key social participation/literacy behaviors, the UGP also provided parents (as mediators integral to the workshop facilitation) with an opportunity to develop their own ability of using embodied play, music and digital tools to support and encourage children's development of multimodal literacy and social participation skills, as well as their understanding of emotions. All focal parents reported that the pre-test was their first opportunity to present alphabet letters to their child in a sequence ordered differently than the typical alphabet song.

5.4 *Finding 4 - Expanding possibilities of digital literacy activity through cultural awareness*

As the focus group revealed, while most parents found the cultural and social aspects of the curriculum to be effective for children of this age, they also felt that in its multimodal literacy aspects, the curriculum was a bit too advanced for the children's level. Practical suggestions were also made on how to improve the workshop facilitation and presentation of information in ways that would resonate more with how children at this age acquire and organize information. Some of the instances that were mentioned in response to my question *on the ways that any of the workshop curriculum came up at home at all* were spontaneous activity initiated by the children themselves (like Cam and Arfia playing with the *Alphariddims* card deck before dinner), and sometimes leading the parent (like Machi breaking into the *Axé* song and eventually getting his father, who never sings, to join). Some parents said they felt their child could potentially benefit from the workshop some time down the line, with consistent practice. This theme of *consistency* which emerged from the focus group discussion has led the research team into the exploration of the *GriotQuest* at-home learning kit specifically designed to foster embodied literacy and STEAM (Science, Technology, Engineering, Arts, and Mathematics) skills and mobilize the workshop curriculum across various early childhood educational settings. This is beyond the scope of the current paper as it constitutes the focus of ongoing research.

5.6 *Limitations*

Although the preliminary study results were promising, the findings suggested that a more robust tangible interface allowing for an authentic drumming-like musical experience could lead to more success, by allowing children to rely on their existing sensorimotor skills (honed from drumming practice) without cognitive reflection, and shift their attentional focus to the higher dimensions of the multimodal activities of the *Alphariddims* game app. Although the original design was simple and intuitive, the major technical limitations found at the time pertained to responsiveness, robustness and mobility. To address these limitations, my research lab has been designing a new prototype of the system with a shape, feel and responsiveness that enhances the embodied experience that rhythmic interaction offers.

6. CONCLUSION

Designing technologies for culturally grounded embodied learning is a practical challenge. In particular, endeavors for improving STEAM learning outcomes are connected to the pressing need within the educational community to reimagine early learning environments. I believe that the potential in the embodied, linguistic, social and cultural affordances of a tangible rhythmic interface for digital drum talk to aid in this transformation is promising. In this paper, I presented exploratory work on educational applications of the *Drumball-Alphariddims*, a digital talking drum system used in the context of a music-based early literacy intervention. By analyzing the functional and technical components of this early prototype through the lens of educational and music technology research, I framed its main strengths and limitations. I then proposed a novel design approach, that is grounded in embodied interaction and is conceived to preserve cultural heritage, rather than reducing it. The design of the new prototype controller is simple and relatively inexpensive, yet it leverages advanced mapping techniques like gestures-over-audio [12] and *isochronous control* [13], to maximize portability and responsiveness. Although still in progress, the development of the Drumball is confirming the feasibility and the robustness of the targeted design, and its potential to implement an embodied metaphor [14] capable of supporting multiliteracy and multimodal learning.

7. ETHICAL STANDARDS

Given that the research involves children and parents, as part of the human subject study protocol, a child assent and parent permission form is required as part of the registration process to participate in the Urban Griot Playground workshops. The Child Assent is read to all families present during the first assembly,

leaving enough time for questions and discussion; and all participants must sign the informed consent, parent permission and media records release forms at the time of their arrival at the workshop site. These standard documents encompass all of the required information designed to help an individual make an informed decision about whether or not to participate in the workshops.

8. REFERENCES

[1] Niangoran-Bouah, G., & Ahouo, L. R. (2003). Le langage des tambours. Africultures, (3), 51–51.

[2] Nketia, J. K. (1968). Our drums and drummers. Ghana Publishing House.

[3] Carrington, J. F. (1969). Talking drums of Africa. Greenwood.

[4] Finnegan, R. (1970). Oral literature in Africa. Oxford University Press.

[5] Gaines, J. H. (1996). The Talking Drum: Moving Towarda Psychology of Literacy Transformation. Journal of Black Psychology, 22(2), 202–222.

[6] Coe, C. (2005). Dilemmas of culture in African schools: Youth, nationalism, and the transformation of knowledge. University of Chicago Press.

[7] Zhao, H. (2018). No Drums Allowed: Afro Rhythm Mutations in North America.(Medium.com, Ed.). Retrieved from https://leohezhao.medium.com/no-drums-allowedafro-rhythm-mutations-in-north-america-8230a5a663c0

[8] Ong, W. J. (1977). African talking drums and oral noetics. New Literary History, 8(3), 411–429.

[9] Mahiri, J. & Maniates, H. (2013). The tough part: Getting first graders engaged in reading. Th Reading Teacher, 67(4), 255–263. doi:10.1002/trtr.2013.67.issue-4

[10] Hammill, DD. (2004). What we know about correlates of reading. Exceptional Children. 2004;70(4):453–468.

[11] Scarborough, H.S. (1998). Early identification of children at risk for reading disabilities.

[12] Schatschneider, C., Fletcher, J.M., Francis, D.J., Carlson, C.D. & Foorman, B.R. (2004). Kindergarten prediction of reading skills: A longitudinal comparative analysis. Journal of Educational Psychology. 96(2):265–282. doi:10.1037/0022-0663.96.2.265.

[13] Untung, S.H. (2023) The Gold Age of Childhood: Maximizing Education Efforts for Optimal Development

[14] Gallagher, A., Frith, U. & Snowling, M.J. (2000) Precursors of literacy delay among children at genetic risk of dyslexia. Journal of Child Psychology and Psychiatry. 41(2):203-213.

[15] O'Connor R.E. & Jenkins J.R. (1999). Prediction of reading disabilities in kindergarten and first grade. Scientific Studies of Reading. ;3(2):159–197. doi:10.1207/s1532799xssr0302_4.

[16] Torppa, M, Poikkeus, A.M., Laakso, M.L., Eklund, K. & Lyytinen, H. (2006). Predicting delayed letter knowledge development and its relation to grade 1 reading achievement among children with and without familial risk for dyslexia. In Developmental Psychology. 2006 Nov; 42(6):1128-1142.

[17] Lee, C. D. (2001). Is October Brown Chinese? A cultural modeling activity system for underachieving students. American Educational Research Journal, 38, 97-141.

[18] Ladson-Billings, G. (1994). The dreamkeepers : Successful teachers of African American children. San Francisco :Jossey-Bass Publishers,

[19] Cole, J. M., & Boykin, A. W. (2008). Examining culturally structured learning environments with different types of music-linked movement opportunity. Journal of Black Psychology, 34(3), 331–355. https://doi.org/10.1177/0095798408314137

[20] Gaines, J.H. (2018). Learning literacy through the rhetorical function of the drum: the locus of sound, symbolism and reflection

[21] Locke, K. and Clark, D. (2009). Can African drumming impact the social/emotional development of young children

[22] Sharp, J. (2007). Culturally-Relevant Algebra Teaching: The Case of African Drumming. *The Journal of Mathematics and Culture,* January 2007, V2 (1)

[23] Friedman, R. L. (2000). The healing power of the drum. Reno: White Cliffs Media.

[24] Flores, K. (2011). African drumming as a medium to promote emotional and social well-being of children aged 7 to 12 in residential care. A thesis submitted in partial fulfilment of the requirements for the Doctorate of Music (Musicology) University of Pretoria Faculty of Humanities Department of Music. Retrieved October 11, 2018 from the World Wide Web: https://www.rhythmresearchresources.net/uploads/1/1/2/9/112916705/flores_african_drumming_as_a_medium_to_promote_emotional_health_7-12_yr_olds__.pdf

[25] Bittman, B. B., Bruhn, K. T., Stevens, C., Westengard, J. & Umbach, P. O. (2003). Recreational music-making: a cost-effective group interdisciplinary strategy for reducing burnout and improving mood states in long-term care workers in Advances in Mind-Body Medicine, vol. 19, no. 3-4, pp. 4–15.

[26] Bittman, B. B., Dickson, L. & Coddington, K. (2009). Creative musical expression as a catalyst for quality-of-life improvement in inner-city adolescents placed in a court-referred residential treatment program in Advances, vol. 24, pp. 8–19, 2009. B. J. Fox (Eds.), Phonological awareness in reading: The evolution of current perspectives (pp. 73–95). New York: Springer-Verlag.

[27] Ping Ho, J. Tsao, C. I., Bloch, L. & Zeltzer, L.K. (2011). The Impact of group drumming on social emotional behavior in low-income children in Evidence Based Complementary and Alternative Medicine, vol. 2011, Article ID 250708, 14 pages, 2011.

[28] Longhofer, J. & Floersch, J. 1993. African drumming and psychiatric rehabilitation. In Psychosocial Rehabilitation Journal. Vol. 16. No. 4. pp 3-8.

[29] Kalani (2004). Together in rhythm: A facilitator's guide to drum circle music. Los Angeles: Alfred Publishing.

[30] Hull, A. (1998). Drum circle spirit: Facilitating human potential through rhythm. Reno: White Cliffs Media.

[31] Reybrouck M and Schiavio A (2024) Music performance as knowledge acquisition: a review and preliminary conceptual framework

[32] Abrahamson, D., & Lindgren, R. (2014). Embodiment and embodied design. In R. K. Sawyer (Ed.), Cambridge Handbooks in Psychology. The Cambridge Handbook of the Learning Sciences (p. 358–376). Cambridge University Press.

[33] Horn, J. and Wilburn, D. (2005), The Embodiment of Learning. Educational Philosophy and Theory, 37: 745-760. https://doi.org/10.1111/j.1469-5812.2005.00154.x

[34] Kosmas, P., Ioannou, A. & Zaphiris, P. (2018): Implementing embodied learning in the classroom: effects on children's memory and language skills, Educational Media International *(PDF) Implementing embodied learning in the classroom: effects on children's memory and language skills*. Available from: https://www.researchgate.net/publication/329078772_Implementing_embodied_learning_in_the_classroom_effects_

on children's memory and language skills [accessed Apr 15 2025].
[35] Sani, Y., Wardany, O.F., Herlina, H., & Vernanda, G. (2021). The Implementation of Embodied Learning: A Literature Review. *Edukasi*.
[36] Cassell, J. (2004). Towards a model of technology and literacy development: Story listening systems, Applied Developmental Psychology, vol. 25, pp 75105.
[37] Blaine, T. & Perkis, T. (2000). The Jam-O-Drum interactive music system: a study in interaction design. In Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques (DIS '00). Association for Computing Machinery, New York, NY, USA,165–173.
[38] Neupert, M., & Wegener, C. (2019). Isochronous Control+ Audio Streams for Acoustic Interfaces. In Proceedings of the 17th Linux Audio Conference (LAC-19) (p. 5).