Teachers' Perceptions around Digital Games for Children in Low-resource Schools for the Blind

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ABSTRACT

Most children who are blind live in low-resource settings and attend schools that have poor technical infrastructure, overburdened teachers, and outdated curriculum. Our work explores the role digital games can play to develop digital skills of such children in the early grades. Recognizing the critical role of teachers in introducing children to technology, we conducted a mixed-methods study to examine which attributes of digital games teachers find useful for children and what challenges they perceive in integrating digital games in schools for the blind. Our findings indicate that teachers prefer games that align well with curriculum objectives, promote learning, improve soft skills, and increase engagement with computers. Despite being overburdened and lacking technological support, teachers expressed strong enthusiasm to integrate these games in school curriculum and schedule. We conclude by discussing design implications for designers of accessible games in low-resource settings.

CCS CONCEPTS

• **Human-centered computing → Accessibility**; *Empirical studies in HCI*.

KEYWORDS

Digital Games, Teachers, India, Visual Impairment, Children, Accessibility.

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1 INTRODUCTION

India is home to one-third of the world's blind population [14]. Nearly two million children in India have blindness or severe visual impairments [60]. A vast majority of them (92.5%) are deprived of educational opportunities [60], and in particular, denied opportunities in STEM. In contrast, the STEM opportunities for the general population in India has exponentially increased in the past couple of decades; India has the third largest scientific and technological manpower in the world [18], albeit with severe under-representation of people with visual impairments.

Similarly, the IT sector has experienced a boom in India in the past two decades, employing nearly 3.5 million people directly and another 12 million indirectly [48]. Realizing the growth potential of IT, particularly in areas like cloud computing and AI, the Government of India has made these areas a priority for education and skilling [5]. However, the government report lacks any mention of skilling people with disabilities in general or with vision impairments in particular. Even the curriculum content for computational thinking of children (starting from grade 1) created by ACM India [15] is limited to sighted children. Unless a corrective course is taken, it is likely that children with visual impairments will grow up to be adults without any prospects of a career in computing. Given the systemic marginalization of blind children and lack of accessible content and curriculum for them, there is an acute and urgent need to introduce digital skills to them at a young age. To address this gap, we conducted a workshop with teachers to explore whether digital games have the potential to improve digital skills of blind children in India, most of whom live in low-resource environments [55, 79, 80].

The use of games and play to augment learning of children with disabilities in the Global North is well-studied [10, 39, 42, 64–66, 68]. However, there is a severe paucity of research that examines how children with disabilities in low-resource environments play digital games. As a result, much is unknown about the opportunities digital games can offer to marginalized blind children, and the practical challenges in integrating these games into low-resource blind schools that have poor technical infrastructure, overburdened teachers, and inflexible curriculum. Before introducing these games in the schools for the blind, we must ask, for example, how familiar these teachers are with digital games, what is their learning curve to play the games, would teachers find digital games useful for blind children, would these games complement the current curriculum for computer instruction, and do teachers have the bandwidth and resources to introduce digital games? Without engaging teachers, knowing their workflows and preferences, any classroom-based intervention is likely to fail. Recognizing that digital games' impact cannot be additive or transformative in and of itself [75], our work sets out to conduct formative research to examine teachers' perceptions and preferences around introducing digital games for blind children in low-resource environments. Specifically, we sought to answer the following research questions: **(RQ1)** Which attributes of digital games teachers find useful for blind children and why? and **(RQ2)** What challenges and issues teachers perceive in integrating digital games in schools for blind children?

To answer these questions, we partnered with a local non-profit organization with deep expertise in designing accessible study materials for blind children and a long history of partnerships with schools for the blind in low-resource regions. Our exploratory study included three phases and used a mixed-methods approach. In the first phase, we visited seven schools for the blind in Karnataka, India and examined their state, infrastructure, and curriculum. We also conducted surveys with computer teachers to understand their workload and skill sets. In the second phase, we organized a day-long workshop with the computer teachers from these schools and used existing accessible digital games as technology probes [29] to investigate what aspects of digital games teachers value and why (RQ1). We incorporated elements of Ludic Design for Accessibility [12, 72] into the workshop to place playfulness at the center of the design process. In the third phase, we conducted semi-structured telephonic interviews to examine the challenges and issues teachers perceive in integrating digital games in the school schedule and curriculum (RQ2).

Our findings show a strong enthusiasm from teachers to integrate digital games into the curriculum for blind children. During our workshop, most teachers interacted with digital games for the first-time and saw them as a promising tool to improve student engagement and curriculum learning. Teachers also projected digital games to help improve students' soft skills (*e.g.*, coordination, listening and recall) and digital skills (*e.g.*, keyboard orientation, typing, touch sensitivity). They preferred games that had novel concepts, simple rules, familiar interaction modalities, and high engagement. Despite teachers' drive to integrate games into the school curriculum, we found little evidence about the feasibility of a successful integration due to limited computing infrastructure, lack of technical support, and lean teaching resources being the major hurdles. In summary, we make the following contributions to HCI4D and Accessibility community:

(1) We present formative insights about blind schools' poor infrastructure and teachers' (in)experience in offering digital skills to blind students in low-resource environments.
(2) Based on teachers' experiences and perceptions of digital games, we provide actionable insights on how accessible digital games should be designed for blind children in low-resource environments.
(3) We identify the challenges and tensions in integrating digital games in school curriculum, and provide recommendations for policy makers and administrators to include blind children in initiatives to promote digital skilling.

In the paper that follows, we first discuss related work at the intersection of digital games, accessibility, and Human-Computer Interaction for Development. We then describe our methods and activities including school visits, a workshop with teachers, and follow-up interviews. Next, we present how our partner organization selected games for the workshop and describe our key findings from our multi-phase, mixed-methods, exploratory study. Our discussion offers design implications for designers and builders of accessible games for blind children as well as highlights pragmatic challenges in integrating these games in the schools for the blind in low-resource regions.

2 RELATED WORK

We now situate our research in a body of related work examining digital games for people with visual impairments and their integration in school environments.

2.1 Accessibility and Digital Games

A large body of research examines the design and evaluation of digital games for people with visual impairments [8, 16, 19, 21, 73]. Researchers have used alternative mechanisms like auditory and vibrotactile feedback to make new and existing digital games accessible, fun, and engaging for blind gamers [9, 25, 38, 45, 62, 70]. For example, Drosos et al. [16] developed a Tic Tac Toe game incorporating spatial audio to provide immersive gaming experience to blind children. Carvalho et al. [9] used a range of sound frequencies to design a music rhythm based puzzle game on smartphones. Gutschmidt et al. [25] built an accessible version of Sudoku by using sound and haptic feedback. Such accessible games offer players an engaging and playful experience to learn subject material and enhance their digital literacy skills [17, 23, 43, 50]. For example, Roth et al. [62] used a combination of sound tones and haptics to teach concepts of Euclidean Geometry to blind adults. Connors et al. [13] used a spatial audio-based simulator game for teaching players with visual impairments to navigate unfamiliar physical buildings. Magnusson et al. [40] created a game using geolocation, sound, and haptic feedback to make mobility training engaging for blind gamers.

While these studies are a promising first step, a key caveat is that they focus only on people with visual impairments in developed regions: most of whom own smartphones, reliably connect to the Internet, are familiar with accessibility tools, and rely on technology support networks and scaffolding. Unfortunately, despite acute prevalence of blindness and vision impairments in low- and middle-income countries, there is a severe paucity of research that examines the design, deployment, evaluation, and use of digital games for people with visual impairments in low-resource environments. In this work, we conduct formative research to bridge this gap and examine the perceptions and attitudes around introducing digital games to blind children in low-resource environments.

Research that examines the technology needs, challenges, and aspirations of blind people in low-resource environments in developing countries is steadily increasing in the burgeoning field of Human-Computer Interaction for Development (HCI4D). For example, researchers have examined the struggles of blind people in India with current assistive tools like screen reader software [32, 44, 53, 79], barriers that impact their smartphone adoption [56], and broader challenges they encounter in workforce participation [54]. Pal et al. [52] also proposed an "accessibility infrastructure" view to understand accessibility in real-world settings in the Global South. Other researchers have examined how blind people use technology to meet their educational, financial, mobility, and entertainment needs. For example, Vashistha et al. [80] outlined the challenges low-income blind people experience in accessing educational content and discovered an informal, ad-hoc ecosystem of peer production and sharing. Kameswaran et al. [35] studied the use of ride-hailing services by blind people in urban India and showed how it impacts the notion of independence. Vashistha et al. [81] examined the non-use of mainstream social media platforms and designed accessible voice-based social media platforms and crowdsourcing marketplaces for blind people [82]. Kameswaran et al. [36] investigated the use of digital financial services by blind people and Singanmalla et al. [69] improved the accessibility of automated teller machines in India. Our work contributes to this growing body of research at the intersection of accessibility and HCI4D by conducting an exploratory study that examines the perceptions of teachers around using digital games to improve digital skills of blind children in low-resource environments.

2.2 Digital Games in Schools

Since digital games have demonstrated potential to improve learning and enhance digital skills, they make an interesting proposition for being introduced in the school curriculum. There have been several studies examining the role of teachers in introducing digital technology into the school curriculum in resource rich regions like Kuwait, the United States, and Switzerland [6, 37, 59, 63]. While these studies establish that teachers play a central role in the successful introduction of technology in schools [46, 74], there are several challenges in introducing such games into the school curriculum, including creating the learning environments around digital technology [22], availability of computing infrastructure [24, 58], intermittent access to internet [11], imparting digital skills in pedagogy training of teachers [57], and evaluating effectiveness of such technologies in advancing curricular objectives [71]. These considerations are even more pivotal for schools for the blind in low-resource environments that often operate under severe budgetary constraints and have limited (sometimes dilapidated) infrastructure, have blind students coming from marginalized low-income families, and have overburdened teachers lacking advanced technology skills. Our work extends this literature by examining the state of schools and teachers of blind children and outlining practical challenges in integrating digital games in their schools in low-resource environments.

A rich body of HCI4D literature has focused on teachers in low-resource environments and examined ways to enhance the quality of instruction, help them plan lessons and deliver content, and improve teacher support networks [7, 28, 57, 76–78, 83]. However, research that examines the attitudes, preferences, and perceptions of teachers about digital games is severely limited [31, 34]. While Kam et al. [34] describes the wide cultural gap that exists between existing video games and the understanding of such games by sighted children in rural areas in the developing world, clearly, much is needed to bridge the gap between the sighted and visually impaired in such environments. There exists a significant gap in understanding of which attributes of digital games teachers find useful for blind children and what challenges they perceive in integrating digital games into the schools for blind children. The work that is most relevant to ours is Torino [47]—a tangible programming environment designed for teaching the computational thinking curriculum in the UK— that was introduced in low-resource settings [30]. However, the introduction of technology was mediated by the researchers and not by the teachers in the schools [30]. To the best of our knowledge, our work is the first exploratory study that examines the willingness and readiness of teachers to introduce digital games in blind schools in low-resource environments and factors that impact their decision-making.

3 METHODOLOGY

We conducted a mixed-methods, multi-phase, *exploratory* study to examine teachers' perceptions and preferences around introducing digital games for blind children in low-resource environments. Specifically, we sought to answer the following research questions:

RQ1: Which attributes of digital games teachers find useful for blind children and why?

RQ2: What challenges and issues teachers perceive in integrating digital games in schools for blind children?

Given the paucity of research examining the state of schools for blind children in low-resource developing regions, we partnered with Vision Empower [3], a non-profit organization which collaborates actively with many such schools to make STEM content accessible to blind children. The organization helped us gain access to these schools and familiarize ourselves with the infrastructure, curriculum, and digital skilling initiatives in these schools. Our IRB-approved study took place over eight months in Karnataka, India and consisted of three phases: pre-workshop activities, workshop with teachers of blind children, and post-workshop assessments.

3.1 Pre-workshop School Visits, Observations, and Surveys

Before the workshop, we visited seven schools for blind children in Karnataka to understand the current status of these schools, their curriculum, and computing facilities. Our partner organization identified these schools to have a mix of government and private schools, schools in urban and peri-urban areas, and schools with

Figure 1: Pictures from the workshop; from left: (a) On-going ice-breaker game 'pass the parcel', (b) Participants playing Nintendo Switch Telephone game, (c) A participant playing TypeShooter game

resources on a spectrum. Our partner organization was already working with these schools, enabling us to leverage their existing rapport. Members of the research team were accompanied by the staff of the partner organization during these visits.

On average, the visit lasted around two hours, during which we informally interviewed the principal, teacher, and the facilitator who showed us the school facilities. We made detailed notes about the school facilities, classrooms, students, computer labs, and curriculum for digital skilling. For example, we observed how many computers are functional, how many have speakers or headphones, how often students visit computer labs, what are the curriculum's learning goals, what is the technical background of teachers involved in computer instruction, and do children interact with regional language content on the computers.

We invited computer teachers from all seven schools to participate in the workshop, as they are most likely to be the ones introducing computers to young students. During our visits, we observed that most teachers in these schools were visually impaired themselves and many were responsible to teach multiple subjects. Before our workshop, we requested computer teachers to fill an online survey to gain an in-depth understanding of their background, skill sets, prior experience with digital games, use of accessibility tools, and use of software for instruction. In total, the survey had 45 questions and teachers took, on average, 20 minutes to submit responses.

We requested the partner organization to shortlist suitable games for teachers to play during the workshop, that later could be introduced to students in their schools. They selected several games differing in dimensions like input-output modality, levels of engagement, and number of users. More details on the game selection process are presented in Section 4.

3.2 Workshop with Teachers

To examine our research questions, we conducted a day-long workshop with teachers to introduce them to digital games shortlisted by the partner organization. To ensure that teachers engage with games in a playful environment, we designed the workshop using the key tenets of Ludic Design for Accessibility (LDA) [72] that combines four elements of pure play [27] with a fifth element of desired side-effect. Pure play has been defined as a free activity standing quite consciously outside 'ordinary' life as being 'not serious', but at the same time absorbing the player intensely and utterly, and wherein the player has the complete freedom to engage with the activity or not. For example, the teachers had the choice to play any of the available games for as long as they wanted. They could simply watch others play as well. Another aspect of pure play is to be interest-agnostic, meaning that an activity is not necessarily connected with material interests, and no profit can be gained by it. For our workshop, the teachers had volunteered to participate and play digital games without expecting any incentive or compensation. Another key element of LDA is the expectation of desired side-effect, meaning that the activity should deliver some benefit to the activity doers or artifact users, without detracting from the above play elements. In our case, by playing digital games in an environment of pure play, we expected the teachers to reflect on their roles as teachers and think about the possibilities of introducing such games to blind children in their respective schools.

Using these tenets, the workshop was designed to be informal, fun, and engaging: a playful atmosphere where people freely talk to each other, no forms to be filled, no formal interviews or evaluations of any sort, and only an unobtrusive photographer capturing candid moments. For example, rather than using a conference room style seating (a central table with chairs around), we conducted the workshop in a living room style space with multiple seating options and subdued lighting (see Figure 1). The workshop had six 'game stations', one for each game. Two of these stations were a couch with a small folding table to hold the PC, three on the floor with bean bags, and one on a small computer table and chair set. We assigned a mediator at each game station to help the teachers guide through the game in case they experience any difficulties and seek support.

The workshop day began with the teachers/participants (P), mediators (M), and researchers introducing themselves using a short ice-breaker game, 'pass the parcel' (see Figure 1(a)). After that, teachers were encouraged to explore and play games by moving freely between the six game stations. After 2.5 hours of game-play, there was a lunch break, followed by another gaming session where teachers were free to play games that they liked more during the morning session. At the end of the second session, we organized an informal huddle where all participants shared their experiences.

Overall, 20 people were part of the workshop: eight teachers, ten mediators, and two researchers. Out of eight teachers, six had a visual impairment. Out of ten mediators, five were staff of the research organization and five were staff of the partner organization. We assigned a mediator to each game station instead of each participant so that each game mediator could focus on teachers' interactions with their respective game. The remaining four mediators engaged with teachers between game stations and helped them navigate from one station to the next. All mediators took notes and observed how teachers' interacted with the games.

3.3 Post-workshop Interviews

Immediately after the workshop, we created a WhatsApp group to enable workshop participants to communicate with each other easily. We also sent a link to the teachers for downloading games they played during the workshop. A week later, we conducted semi-structured telephonic interviews with teachers to get their feedback on the workshop and on the games they played. We purposely conducted interviews after a week to give teachers time to install and play games at their convenience and reflect more on their experiences. During the interview, we asked them questions about which games they liked and why, what challenges they experienced in downloading and installing the games, and what challenges they foresee in integrating the games in school schedule and curriculum. On average, the interviews lasted nearly 20 minutes. We audio recorded the interviews and later transcribed them for analysis. None of the teachers were paid to attend the workshop or participate in the interview. Instead, we arranged for their transportation and food and gave them a participation certificate for attending the workshop.

3.4 Participant Demographics

Our sample had six blind and two sighted teachers. Five of them were female and three were male. They had varied educational backgrounds: two had a master's degree, four had a bachelor's degree, one had a high school diploma, and one had no formal education. Three of them were home-schooled in the initial years while others were part of the formal education system from the beginning. Such range in educational experiences have also been reported in other studies [80]. Seven teachers were employed full-time with schools, while one teacher was an IT professional, teaching computer classes as a volunteer over weekends. Two teachers were younger than 25 years, three were between 25–35 years, and remaining three were between 35–45 years.

3.5 Data Analysis

We conducted a mixed-methods analysis to systematically analyze a wide variety of data we collected: quantitative analysis of pre-workshop teacher surveys, content analysis of WhatsApp messages, and grounded theory analysis of field notes, mediators' observations, and teacher interviews. While we draw on all data sources in order to arrive at the findings, we quantitatively analyzed survey responses in isolation to understand teachers' skill sets, accessible technology use, and gaming experience. Drawing on work from Hsieh and Shannon [26], we used a directed approach of content analysis to fill gaps in our understanding of teachers' perceptions of games they played. We used grounded theory, as outlined by Glaser [20], to analyze field notes, observations, and interviews. We subjected our data to open coding and rigorously categorized our codes to examine the attitudes and perceptions of teachers around digital games. Three authors, co-located in the same working space, regularly participated in the coding process and iterated upon the codes until consensus was reached. Over the course of analysis, they met over multiple days to: (1) discuss coding plans, (2) develop preliminary codebook, (3) review the codebook and refine/edit codes, and (4) finalize categories and themes. The first-level codes were specific, such as "preference for typing" and "limited technical support." After several rounds of iteration, the codes were condensed into high-level themes, such as "learning curriculum," "game elements," and "fun and engagement." Several other approaches including, multi-level code reviews, peer debriefing, and member checks, were used to improve the credibility and validity of the coding process. Appendix A shows our final codebook.

3.6 Positionality

All authors are of Indian origin and have conducted fieldwork with diverse marginalized groups in India. Three authors identify as female and four as male. All authors have lived in Karnataka for more than five years each and have an intimate understanding of HCI4D literature and contexts. Two authors are staff members of the grassroots partner organization, are blind since birth, and have significant experience in working with blind teachers and students. Four authors have more than five years of research experience in examining accessibility needs of people with disabilities in the Global South. We all view HCI research from an emancipatory action research mindset, aiming to conduct formative research to examine the opportunities, challenges, and tensions in using digital games for improving learning of blind children in low-resource environments.

4 GAME SELECTION PROCESS

Given our partner organization's intimate understanding of the schools for blind children, we requested them to shortlist digital games that are appropriate for the blind children and suitable for the workshop. We intended to use these games as technology probes [29] to examine teachers' perceptions about the usefulness of digital games and challenges in integrating them into the school environment.

Two staff members of the partner organization—who are blind since birth—were appointed as game selectors. They curated, downloaded, and tested several games that are appropriate for children below the age of seven years. They first explored digital games for young children in the Global North that are listed on websites like Perkins School for the Blind and WonderBaby.org. However, they had to discard most of these games either because the games needed iOS devices or Internet connectivity, making them infeasible to be used in schools where computer labs have Windows desktop and unreliable Internet access. In addition to finding games that can run offline on a Windows desktop, they considered the following rubric for game selection based on their extensive work with children with visual impairments and their understanding of the constraints experienced by schools for the blind.

- Accessibility: The game should be accessible to students with visual impairments, requiring only minimal sighted assistance. Many games like Nintendo Switch Table Tennis and Sword Fight were not selected because they were inaccessible, for example, by requiring players to move around and locate the tennis ball/sword in order to respond.
- Usability: The game should be usable to students with visual impairments. Several games, such as Battleship and Minesweeper, were not selected because their interfaces have several rows and columns, making them cognitively taxing for screen reader users.
- Affordability: The game should be free of cost available, so that resource-constrained blind schools can afford it. Several games, such as Sonokids Ballyland, were not selected because of their licensing fee.
- Playfulness: The game should be engaging and fun. The game selectors were concerned that 'educational games', though easier to be integrated in curriculum, might focus more on the learning outcomes than on playfulness, thereby making them less appealing to young children. They were also mindful to select games that have simple rules so that teachers spend less time explaining instructions to children. Several games, such as BG Battleship which enhances knowledge of matrices and Monopoly, were not selected as the game selectors found it quite complicated for a first grader to comprehend and find it interesting.
- Duration: The game should have a short play time to provide immediate gratification to players and enable the workshop attendees to experience multiple games in a limited time. Several games, such as BG Fifteen Puzzle and Freedom Millionaire, were not selected because of their lengthy play time.

The game selectors played 45 games over a period of three weeks, and finally selected five games using the rubric.

- Hangman: This is an accessible version of this classic word guessing game, the computer thinks of a word and the player attempts to guess it by suggesting letters one at a time. The player wins if they guess the word correctly within a predefined number of attempts and loses if all attempts are exhausted. To notify the outcome of their attempt to the players, there is audio feedback associated with correct or incorrect letter input to the word. At the end, the game uses cheers and claps audio to mark a player's victory.
- Simon: This game involves remembering musical notes. Figure 2(a) shows a round of Simon in play. Each round starts with a single musical note and information of an arrow key to play that note. Each time the sequence is repeated successfully by the player using the four arrow keys, the sequence gets extended by another note, thus requiring the player to remember to press one more key. This continues until the player makes a mistake.
- TypeShooter: This game aims to teach and improve typing skills of a player (Figure 2(b)). The game-play involves typing a sequence of letters using the keyboard to shoot the approaching monsters. The game incorporates spatial sounds to notify the player of the approaching monsters from different directions, and to announce the sequence of letters to be typed and keyboard inputs made by the player. The sequence of letters is chosen to encourage the use of touch typing.
- Pizza Game: Pizza is a suite of games for children aged 3-7 years. On pressing any letter key, an object with a name starting with that letter appears visually, and the name is spoken along with a sound associated with that object. This game teaches the player association between letter, object, and sound of that object. On pressing a number key, the number pressed is displayed, spoken, and the number of objects are counted. Figure 2(d) shows a screenshot from the counting pizza game.
- UNO: In this computer version of the classic multi-player card game, the player needs to finish the assigned set of cards to win. The game uses audio to inform the players about the cards they have, cards thrown by each player in a round, etc. There are keys associated for every action, such as to shuffle your cards, repeat audio for your opponent's card, and pick extra cards, among others.

Nintendo Switch mini-games. Our partner organization focuses on enhancing STEM education for blind children. Based on their experience, teachers in blind schools consider tactile interactions as a crucial mode of learning. Hence, they were keen to examine teachers' perceptions about tactile and proprioceptive dimensions of gaming. The game selectors considered smartphone games that could provide such experience, but struggled to find any that are appropriate for young children. They then examined the potential of using Nintendo Switch games as a high-fidelity technology probe [29]. Although the Nintendo Switch did not meet the affordability or accessibility requirements, it provided a large range of tactile games, including multi-player games, to expediently choose for our study since it is a high-volume gaming platform. The game selectors played 28 Nintendo Switch mini-games with the help of a sighted researcher, and selected the ones that were fun to play and accessible with minimal set-up assistance.

Nintendo Switch has two wireless handheld controllers, called Joy-Cons. Figure 1(b) shows the two Joy-Cons, coloured blue and red, that can be attached to the console tablet screen as shown in Figure 2(c). During the workshop, the inaccessible content of the Nintendo Switch games was conveyed to players by the sighted mediator, for example, by reading aloud or repeating game instructions at the beginning and scores at the end of game. In total, we used six Nintendo Switch games, two of which were single-player and the remaining were multi-players.

- Baby: The player has to put a crying baby to sleep, by cradling the Switch console like a baby (see Figure 2(c). It is played in the handheld mode with Joy-Cons attached to the screen.
- Eating Contest: The player has to eat maximum sandwiches in ten seconds. Players have to hold the Joy-Con IR sensor near their mouth and make large bites for it to be recognized.
- Ball Count: Two players compete with each other to guess the number of balls in a closed box, by feeling the haptics of the ball rolling in their respective Joy-Con.

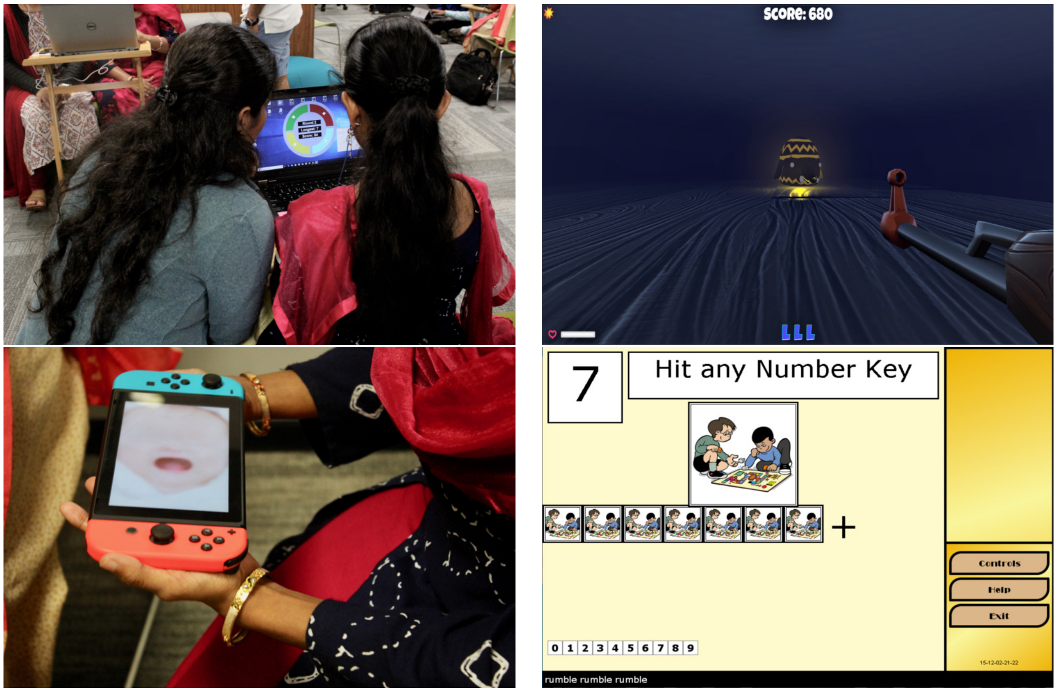

Figure 2: Games played during the workshop; from left: (a) A participant playing Simon game, (b) A screenshot from Type-Shooter game, (c) A participant playing Nintendo Switch Baby game, (d) A screenshot from Pizza game

- Shave: Two players compete to shave their virtual beard faster to win the game. Players receive haptic feedback through Joy-Con which helps in locating the beard.
- Telephone: Two players play against each other to pick up the ringing telephone (Joy-Con) faster and say "hello" (Figure1(b)).
- Safe Crack: Two players play against each other to open a safe with the help of variation in the haptic feedback provided by their respective Joy-con.

5 FINDINGS

We now present the findings from the pre-workshop school visits, workshop with teachers, and the post-workshop interviews to examine the state of schools for blind children and to investigate which attributes of digital games teachers find useful for blind children and what challenges they perceive in integrating digital games into these schools.

5.1 State of Schools and Teachers for Blind Children

Our visits to seven schools for blind children in Karnataka found the schools to be highly diverse. They differed greatly in infrastructure, funding sources, teachers' and students' socio-economic background, computing resources and curriculum, and language of instruction. We describe this diversity as differences in physical and human infrastructure.

5.1.1 Physical Infrastructure. Out of seven schools we visited, six were primary school (up to grade 7) and one was secondary school (up to grade 10). Students were expected to switch to integrated schools after graduation. Two schools (S3 and S7) were government-owned, while the remaining five were owned by private organizations: two by Hindu religious organizations, one by a Christian missionary organization, and the other two by non-religious organizations. All the schools followed curriculum designed by the Karnataka state government, with a range of accommodations mainly due to lack of resources and expertise. For instance, we found two schools skipping geometry curriculum due to the unavailability of tactile material needed to teach basic concepts of geometry.

Details related to the computer labs and curriculum are listed in Table 1. Although each school had a computer lab, the size of the lab varied anywhere from 7 to 14 computers. The computers were running on old and outdated versions of Windows. Most of these computers were procured from used markets or were donated to schools. Although five school labs had Internet connectivity, they were connected to a slow (1Mbps) wired connection, which often did not work and required regular maintenance.

To provide auditory output to blind children, computers in four labs used headphones and in the other three used speakers. Although speakers helped the computer teacher to keep track of students' progress, it did hamper the experience of other students, often resulting in a chaotic learning environment. All the computers were equipped with accessibility tools like magnifier and screen reader software. We found the preference for screen readers in these schools to be split between JAWS and NVDA. All schools used a pirated copy of JAWS due to the inability to afford its licensing fee. Despite many students struggling with English language, none of the schools taught students to interact with digital content in regional languages.

Three schools introduced computer classes early (in grade 1 or 2), two in primary school (grade 4 and 5), and one in secondary school (grade 8). Despite having a functional computer lab, some schools (*e.g.*, S2) were unable to offer computer classes due to a lack of a qualified full-time computer teacher. Computer classes were organized as 30–45 minutes long sessions and focused on keyboard orientation and typing. None of the schools had a well-defined curriculum for digital skilling and sessions were mostly organized on-the-go. In higher grades, some students were also introduced to Microsoft Office, web browsing, and folder management. Only two schools (S1 and S5) used a digital game to teach students typing skills.

5.1.2 Human Infrastructure. Despite a small sample of eight teachers, we were surprised to find a rich diversity in their technology skills, teaching responsibilities, and pedagogical approaches. Most teachers (N=6) in our sample had completed computer training programs offered by non-profit organizations, such as Enable India [1] and Snehadeep Trust [2]. During the training, they learned to use keyboard, screen reader software, Microsoft Office Suite, popular Internet websites, and social media platforms. All of them reported being proficient in using computers with a screen reader, and could do touch-typing. However, only two teachers had knowledge of basic coding skills or software development, while the rest only knew what they learned in the training program. We also found a high variation in their prior computer experience, ranging anywhere from 7–28 years. With respect to the prior gaming experience, they were largely ignorant about computer games; only two teachers had interacted with an audio-based computer game before.

Due to the limited number of qualified teachers and funding, all computer teachers were also responsible to teach other subjects, including Maths, English, and Science, dramatically increasing their workload and limiting the time needed to develop and revise digital learning curriculum. Teachers also complained about the high student-teacher ratio. They had fewer desktop computers compared to students in class, forcing students to share computers during lab sessions. This is in line with prior work which reports shared use of computers in classrooms for sighted students in HCI4D settings [31, 58]. We also found rich variations in the pedagogical approaches teachers used to instruct digital skills. For example, two teachers reported using online resources to teach typing skills across all grade levels, two teachers ran the computer lab sessions in an unstructured manner to attend to students with varied levels of digital skills, and a few had well-defined teaching objectives and expected outcomes at different grade levels. A teacher shared:

> *"For grade one to five, I only give verbal instructions and ask students to touch and feel the keys. For grade six to eight, I use verbal instructions, ask them to identify keys, and type small words. For grade nine and ten, I ask them to type sentences or use typing tutorials with time limitation."*

Finally, teachers in our sample reported lack of support to develop and revise digital curriculum. They did not know whom to ask for help and guidance. None of them were part of any offline or online teacher support group. Several teachers felt that they were working in silos, and expressed the need to draw support from teachers in other schools for the blind. They also wanted school administration to organize professional development and digital skilling workshops to inform them about the latest pedagogical tools and techniques.

5.2 Perceptions about Digital Games for Blind Children

During our interviews, teachers perceived a range of benefits—like curriculum-based learning and improved digital and soft skills—of integrating digital games into blind schools. Table 2 shows the emergent themes based on comments from teachers on different games they played during the workshop.

5.2.1 Learning Curriculum and Improving Soft Skills. Consistent with finding from Kam et al. [33], we found high levels of enthusiasm for games that lead to knowledge gain and outcomes in accordance with the school curriculum. For example, when teachers were asked to select the top three games from the workshop, they preferred games—like Hangman, Typeshooter, and Pizza—for which the learning goals of the current school curriculum tightly tethered to the game-play. Hangman was selected by six teachers in the top three games mainly for improving English vocabulary, while TypeShooter was selected by four teachers for teaching touch typing. Teachers also mentioned how students can improve numeracy and mathematical skills by using the Pizza games. Teachers felt that these games address a real gap in the skills of blind children and also have potential to bring benefits to some teachers. For example, a teacher preferred TypeShooter over all other games for "*personal benefit*" to increase her own typing speed.

> "*Students can learn and improve their typing speed using this* (TypeShooter) *game and so can I.*" - Participant 6.

Four teachers also placed emphasis on introducing games that could potentially improve blind children's soft skills, such as concentration, patience, memory, listening skills, recall, and tactile sensitivity, among others. In line with prior work [67], teachers stressed the importance of soft skills for well-rounded development of students to be successful both *"academically as well as in life."* Several teachers mentioned in-class activities, for example, using stories and repetition of poems, they have incorporated in the curriculum to improve students' recall, concentration, and listening skills. Most teachers found the Nintendo Switch games to be more appealing for improving soft skills of students. Here are two such examples:

> "*Baby and Telephone game, both increase concentration... can improve listening skills too.*" - Participant 2.

> "*I liked the Safe Crack game because of the vibrations, you know. Children are very sensitive to vibrations. For blind children, it is important what they touch and feel, this game will improve their sensitiveness.*" - Participant 8.

Two teachers (P1 and P4) referred to the Simon game as "*memory game*," and liked that the game forces players to remember things, thereby enhancing recall skills, listening skills, and concentration.

Schools	Available Computers	Functional Computers	Headphones	Screen Readers	Internet	Computer Class Starts	Computer Classes/Week	Computer Teachers
S1	14	All	Yes	JAWS	Yes	Grade 4	4	2 (P3, P8)
S2	8	All	Yes	JAWS	Yes	NA	0	0 (P7)
S3	12	All	No	Both	Yes	Grade 1	4	2 (P1, P4)
S4	7	All	No	Both	No	Grade 2	4	2 (P5)
S5	13	8	No	NVDA	Yes	Grade 5	1-2	1 (P2)
S6	9	8	Yes	NVDA	Yes	Grade 8	3	1 (P6)
S7	10	8	Yes	Both	No	Grade 1	4	1

Table 1: Infrastructure in computer labs of the schools for the blind in our sample.

Games	Positive Reactions	Negative Reactions	Integration in Schools
Hangman	- improves vocabulary - uses cognitive skills - easy to understand rules - very engaging	- difficult to guess the word - require English language skills	- more suitable for middle school students
Simon	- easy to learn - improves memory and concentration - relaxing music - improves typing speed - somewhat engaging	- demands lot of attention - has high cognitive load - not as engaging as other games	- more suitable for primary school students
TypeShooter	- improves typing speed - teaches keyboard orientation - easy to understand rules - engaging fictional elements - use of spatial sound	- steep learning curve game - scores were hard to discover	- suitable for primary and secondary school students - most aligned with current digital curriculum
Pizza Game	- useful to teach basic math - use sound of real-world objects	- boring - too slow to play	- aligns well with Math curriculum - useful for students in grade 1–2
UNO	- improves logical thinking - engaging	- many complex rules - steep learning curve - difficult to explain to students	- not aligned with curriculum
Nintendo mini-games	- improves listening skills, concentration, and touch sensitivity - requires physical movements - easy to follow instructions - use haptics and vibrations - very engaging	- inaccessible game instructions - difficult to orient controllers	- useful to introduce haptic-based technology - require new infrastructure - expensive

Table 2: Participants' comments on workshop games.

Overall, these findings indicate that teachers in our workshop focused on the comprehensive learning opportunities that games could offer.

5.2.2 Fun and Engagement. We found that our efforts to make *playfulness* central to the workshop experience worked; all mediators reported that teachers enjoyed the games during the workshop and interacted freely with other participants between game-plays. During the interviews, teachers mentioned how much they enjoyed playing games at the workshop and how it has influenced their thinking on what types of games should be introduced in schools for the blind. In addition to the preference for games that improve knowledge and soft skills, teachers also indicated enthusiasm to introduce games that enable students to have fun and engage with digital technology generally, even when the games did not seem to offer any direct knowledge gain or skill development. We delved deeper to understand what constitutes fun and engagement from the teacher's perspective, when they discussed the role of games in the classroom context. We found that multiple factors, including novelty or familiarity with the game, play duration, interaction modalities, and complexity of rules, impacted perceptions around fun and engagement.

Novelty vs. Familiarity in Play and Input Technology. A majority of the teachers (six out of eight) were playing computer games for the first time. Due to the lack of prior gaming experience, we found mixed reactions with a few teachers appreciating the novelty, while others complained of difficulty in understanding the game. The UNO card game received the most varied comments by the teachers. For example, Participant 7 adored UNO for the interesting gaming experience and was of the opinion that it will be engaging for school children too.

> "*I enjoyed the card game a lot because I have never played cards before. I was fully involved... throughout the game I was wondering what card to put and things like that. Also, if you see, with respect to kids even, this is a good game because it will keep them entertained.*" - Participant 7.

On the other hand, Participant 3, who had also never played a card game before, experienced severe difficulty in understanding UNO rules. A mediator explained:

> "*She* (Participant 3) had a lot of difficulty understanding how the game is played. For instance, concepts like what it means to play a card, distribute cards, cards on our hand, had to be explained. She also wanted to play with physical cards first." - Mediator 5.

In contrast, many teachers' preferred games that they have played in offline settings, for example, UNO, Hangman, and Simon, mainly because it reduced their learning curve. Mediator 4 reported how Participant 1 and Participant 4 enjoyed playing the Simon game since they recalled it as a type of "*memory game*" they used to play in their childhood. Similarly, Participant 8 found Hangman to be similar to the word game she plays with her students in the classroom, and was convinced that her students would enjoy playing a digital version of Hangman. These teachers believed that if students are familiar with the game-play, it would be easier for them to play that game in a digital setting and playing such games digitally will mainly contribute towards their digital skill development.

The novelty was not limited to the game-play, interaction modalities also impacted how teachers perceived games to be novel. For example, many teachers felt excited when playing Nintendo Switch games because it was their first experience interacting with a gaming console. While Participant 4 and Participant 6 found the use of Joy-Cons in Switch games to be "*new*" and "*fun*", some teachers (*e.g.*, Participant 2) favored a keyboard over Joy-Cons due to his familiarity with the keyboard. We saw interesting tension between novelty and familiarity, which is well-documented in HCI literature. Teachers enjoyment in playing games during the workshop may be attributed to their increased interest in the new technology (*i.e.*, novelty). However this novelty may also have resulted in a steep learning curve, thus negatively impacting their first-time digital gaming experience.

Usage of (Multiple) Modalities. Digital games commonly utilize a combination of three modalities—vision, audio, and tactile (vibrations or other movements)—to engage players. To make games accessible to people with visual impairments, developers mainly rely on the audio modality on computers, and auditory and vibrotactile feedback on handheld devices. Mediators noted that teachers were more interested in playing multi-modal games on Nintendo Switch that utilized both audio and vibrotactile feedback. A mediator shared:

> "*In the Telephone game, teachers would carefully wait to receive the ringing-vibrating phone (Joy-Cons)... In the Shave game, the vibration of Joy-Cons on trimming the beards was a funny and unique experience for some teachers... Participant 2 and Participant 8 said that they really enjoyed the use of vibrations in Safe Crack.*" - Mediator 2.

For games that only had auditory feedback, participants enjoyed them more when it used "*funny*" sounds and audio in an engaging manner, often to indicate a reward or punishment. For example, Hangman uses sound cues to inform the player about the outcome of the game. Mediator 3, who has visual impairments, reported that participants expressed "*emotions of joy*" on hearing sound associated with an object in Pizza game. During our interviews, teachers also echoed how they liked the use of spatial sound in Type Shooter game and wide-ranging sounds in Pizza game to enable learning about the sounds of daily objects. They expressed confidence that multi-modal interaction and funny sounds will keep students engaged. These findings indicate that teachers liked multi-modal games more than uni-modal games while suggesting that uni-modal can be made more fun and engaging by using spatial sound or wisely incorporating audio feedback.

Rewards and Competition. In the post-lunch workshop session, teachers were encouraged to play games that they liked more during the morning session. We observed that teachers played specific games multiple times, either to improve their scores or to beat their opponents. Challenge is an essential characteristic of instructional computer games, as it engages a player's self-esteem [41]. For instance, putting a crying baby to sleep is a challenging task and with the added performance rating, participants were keen on playing the game multiple times. Similarly, for Hangman, a mediator shared:

> "*Teachers were very happy after guessing each word* (in Hangman). *Even when some of them were not able to guess a word, they still wanted to play more to win the next round.*" - Mediator 4.

Apart from competing with themselves, four teachers stated that they liked multiplayer games because they allowed them to compete with other mediators and teachers. They appreciated how multiplayer games strengthen social skills by creating more opportunities for informal social interactions and found this to be invaluable for their students. Mediator 7 echoed the sentiment and observed strong motivation among teachers to win the game when competing against an opponent.

> "*The child in each teacher clearly demonstrated that the competitive element in the Telephone game made it attractive for them as each of them wanted to win.*" - Mediator 7.

On the other hand, two teachers reported feeling conscious of their performance in a multiplayer game. For example, Mediator 5 reported how some teachers, who were playing UNO for the first time, were worried if they were playing the game correctly. Multiplayer competition added a new dimension to the game, and teachers visited the same game-station many times to compete with a different partner. Mediators reported that over time teachers gained confidence. Many of them came back to play more rounds of the games which they mentioned not enjoying initially, as now they were more equipped and were competing with a different player. Engaging, competing, and rewarding game-play, along with challenges representing real-life situations or dramatization of such events, helped these games in presenting an immersive play experience to teachers. Several mediators noted that built-in rewards, like promotion to next game level, kept participants engaged. Teachers also expressed that rewards, competition, and team play would be useful attributes to keep students engaged with digital games as the novelty effects wear-off.

Instructions and Rules Complexity. Teachers found a few games to be "*too long*" or "*too slow*," mainly because of the complex game rules resulting in a steep learning curve. Mediator 5 reported that a minimum of three rounds of UNO were required for most teachers to grasp the basic rules. Teachers were hesitant in playing games with complex rules, primarily because they wanted to explore all the games in the workshop before it ended. As a result, they avoided games requiring longer time investment for game-play or understanding instructions, due to the "*fear of missing out on other more interesting games.*" Instead, they enjoyed playing games that were shorter and easy to understand. For example, Participant 3 and Participant 6 liked the Nintendo games more due to the shorter duration of game-play and minimal rules. As another example, although the Pizza game was conceptually easy to understand, it had lengthy instructions, making the game slow at the beginning. This resulted in players getting restless and losing interest. A mediator shared:

> "*They did not want to wait for the instructions and would press numbers/letters too soon resulting in no action in the* (Pizza) *game.*" - Mediator 3.

During our interviews, several teachers noted that not only blind children would find it easier to play simple and shorter games, it would also be very convenient for teachers to integrate such games in computer lab sessions that are often organized in an ad hoc manner.

5.3 Integrating Games in Schools

Teachers expressed strong enthusiasm to introduce digital games they played during the workshop in their respective schools. They discussed the current status of computing resources and teaching infrastructure in their school's computer lab, and possible future requirements for installing, running, and troubleshooting these games. Teachers also shared opinions about their ability to use specific games in their school curriculum and challenges they perceived in integrating games in the school curriculum and schedule.

Based on requests from teachers, an online weblink was shared with all teachers to download four digital games from the workshop—Hangman, Simon, Pizza and UNO—along with instructions for installation. In addition to sharing the weblink, our partner organization downloaded the games in a pendrive and gave it to the teachers since the schools have unreliable and slow internet connectivity. Two teachers (Participant 1 and 5) faced technical difficulties in installing the games, which were resolved by our partner organization over phone calls.

Although we did not ask the teachers to incorporate these games in their teaching, we found that the teachers made extensive plans about which games to use, which grades to use them for, how to include them as part of the curriculum, and how to ensure that the games help them achieve learning objectives. For example, three teachers (Participant 1, 2 and 8) mentioned the availability of free periods in their routine which they were planning to use for introducing these games. Apart from that, they planned to let the students enjoy these games whenever a teacher is absent and the computer lab is available. P2 and P8 were already using a typing software in their schools and mentioned that they were excited to use more such games to teach words, math skills, and soft skills. With regards to specific games, teachers shared elaborate plans of introducing them as part of the curriculum.

> "*I can introduce this* (TypeShooter game) *for grades 4 and 5. Our students will be learning basic Braille till grade 3. From grade 4, they start to use Braille to write sentences and notes so this will be very helpful.*" - Participant 2.

Similarly, Participant 4 was looking forward to introducing the Simon game for grade 1 to 5 students, while Participant 8 wanted to first familiarize herself with the game before introducing it to her students.

Given the limited availability of functional computers in the school (see Table 1), most teachers emphasized that they need more hardware resources—like donated laptops, computers, smartphones, or Nintendo devices—to accommodate all class students in the computer lab. Lack of the physical infrastructure was perceived as the key hindrance in integrating digital games in blind schools. As an other example, three teachers (Participant 1, 4, and 5) complained about the inadequate number of headphones in the computer lab, due to which the students have to use the screen readers on speakers, thereby creating a noisy environment not conducive to learning, especially when other students are playing games. In contrast, Participant 2 believed that students would be highly engrossed in playing games and would not get disturbed by the screen reader sound from other computers. Recounting his prior classroom experience, he shared:

> "*I give them a game to learn typing and they are so curious, they get lost in it.*" - Participant 2.

Teachers felt that after the initial game installation, they may not require further assistance with troubleshooting and maintenance from the researchers, as all the schools rely on external technicians for fixing recurrent issues in their computer labs. However, in practice, the technicians took several days to weeks to fix issues, often forcing teachers to rely on teaching digital skills "*by theory or verbally*".

Overall, we found the teachers to be highly supportive of the idea of students playing digital games from an early grade, for learning, fun, and digital skill development. Despite teachers' drive to integrate digital games in the school curriculum, we found little evidence about the feasibility of such integration due to limited computing infrastructure, lack of technical support, and lean teaching resources being the major hurdles in such endeavours. Most teachers did not anticipate a range of challenges that they might have to experience, such as selecting appropriate digital games, dealing with crashes and bugs, understanding game requirements, evaluating students' engagement, among others, if digital games are integrated into curriculum and schedule. In spite of the enthusiastic comments and early results showing teachers drive and desire to integrate games in classrooms, we believe a careful scaffolding that trains the teachers to play complex games, helps them troubleshoot common issues, and encourages them to develop plans that tightly integrate a handful of games into the curriculum is needed.

6 DISCUSSION

Overall, all teachers in our study enjoyed playing digital games during our workshop. They shared several factors that need consideration when designing games for blind children and when integrating these games into school curriculum and schedule. After the workshop, they were enthusiastic in introducing similar games in their schools. The goal was not limited to helping students meet the curriculum objectives, but also to teach them soft skills, to increase their fun and engagement in school activities, and to make them digitally skilled. Teachers also preferred using digital games because they struggled to get blind students interested in computer learning particularly since they lacked: (1) a well-defined and well-developed curriculum, and (2) pedagogical techniques and classroom management strategies aimed at improving engagement. Such computer games offered them the possibility of increasing student participation and thereby, learning. Teachers proposed utilising multi-modal games for enhancing touch sensitivity of young children with vision impairments. Games were appreciated for their familiar controls, easy to understand instructions and simple rules, and engaging game-play challenges. Teachers also discussed their school infrastructure in terms of the number of computers and teachers required to introduce these games. Based on the mediators' observation notes and teachers' comments during the interviews, we propose key design recommendations for game designers to help them develop more relevant accessible games for blind children in low-resource environments.

6.1 Design Implications

Contextualized Games. To enjoy a game, context plays a crucial role. During the workshop, we found that a few participants had never played a card game before, and were not aware of some rewards (like 'rubber duck') and terminologies. For example, one teacher had never eaten a Pizza, and was hesitant to play the Pizza game thinking it might require some contextual understanding. In line with prior work with sighted students in rural India [33], our work highlights the need to develop digital games that are rooted in local norms and settings for them to be enjoyable by blind people in low-resource environments.

Another key aspect that differentiates the needs of blind children in low-resource environments with those in resource rich settings is the school type. As per reports, only 0.5% of the total number of children with visual impairments attend integrated schools in India [60]. On the other hand, most games in the past have been proposed for integrated schools, such that sighted and children with visual impairments can play and learn together [47, 84]. This highlights the need to develop accessible games that do not depend on even minimal sighted assistance. All game elements, including game instructions, play mechanism, game score, and interaction, must be accessible. This places stricter accessibility constraints on the game developers.

Introduce Vibrotactile Games. The overwhelming positive experience with the Nintendo games, in spite of the accessibility issues, points to an unmet need for vibrotactile games and apps for children and adults with visual impairments. Given the increasing availability of smartphones with built-in IMUs, apps and games that use vibrotactile modalities need to be developed to provide an alternate avenue for exploration and enjoyment by the community, including in educational apps. Moreover, all games do not have to be digital. For certain games with complex rules, such as UNO, it may be better to first introduce tactile accessible UNO cards in the classroom, as that might provide more fun and learning at minimal cost. This approach can help children learn and master the complex game mechanics first, without trying to learn both the game and the digital skills at the same time. Once the students are comfortable with physical cards, they can be introduced to the digital version of the same game to increase their digital skills. Similarly, even games played with the standard 52-card deck, such as Solitaire, can also be initially introduced using physical cards. Thus, both physical tactile games and smartphone-enabled vibrotactile games can play an important role in imparting learning.

Curriculum Alignment. Most teachers expressed interest in introducing digital games that are well-aligned with curriculum objectives. In order to do that, the games must have different levels for it to be appealing to students in different grades. For certain games, such as Hangman and TypeShooter, adding grade-specific levels seems non-trivial. Moreover, these games can also be customized to have different levels within a grade, to attend to students with varying skillsets. Additionally, teachers were also enthusiastic to introduce digital games that improves soft skills, which are beneficial to be successful not just academically, but in life too.

Kids Safe Games. Post-workshop discussion with the teachers made us realize that a few of the games introduced during the workshop were not appropriate for young children. For instance, Hangman requires the player to know how a person is hanged, which may be disturbing for children. Safe crack incentivized players to open a locker and steal money. Similarly, Type Shooter promoted gun violence. Teachers emphasized the importance of including games that not only are age appropriate but instill good values and local traditions in students. They also suggested improvements in digital games they played, for example, re-designing the Type Shooter game to a balloon popper game where players pop approaching water balloons thrown at them by their friends while playing *Holi* (a popular festival in India).

Minimal Instructions. Teachers complained about the lengthy and complex instructions of some games like UNO and the Pizza game. Our findings indicate that designers should carefully construct game instructions such that they are easy to explain and understand. It should convey the minimal required information to the player. Instructions can also be introduced at different stages of the game-play, as and when required, in order to reduce the wait time to begin the game.

6.2 Role of Policy Makers, Non-Profits, and School Administrators

In spite of the several constraints faced by teachers in blind schools, their energy and enthusiasm to explore a completely new area, like digital games for children with vision impairments, was encouraging. Based on the conversations with our partner organization, it emerged that the school administration has been surveying ways to make learning interesting and playful for their students. Our proposed approach of digital games synergizes well with their intended goals, and with the teachers' buy-in, we found the school administration to be open to explore the use of such games in their school curriculum. While such acceptance and willingness to adopt games in education is important for a bottom-up intervention, for digital games to be truly integrated in the curriculum across India and for appropriate resources to be allotted, it is crucial to get support from the policy-makers and bureaucrats in state and national governments. Fortunately, the Indian government recently enacted a new National Educational Policy [4] which focuses on promoting a shift from activity-based learning to play-based learning, which might provide the necessary policy backing to support digital games and play-based curricular content in schools for the blind.

To achieve successful nationwide scaling, it is critical that teachers are trained to effectively use games for imparting curricular content and soft skills. Nonprofits with expertise in conducting accessibility-related training, such as Vision Empower and Enable India, can play a pivotal role in organizing such teacher workshops and training sessions. The role of non-profits in capacity building of teachers was apparent during our school visits wherein we observed the close interactions between teachers, school administrators, and our partner organization.

Along with schools and non-profit organizations, agencies like the ACM India need to work towards making their computational thinking curriculum and resources accessible to children with a range of disabilities. Additionally, the remarkable diversity of teachers in our small sample is an indication that even if the curriculum is "standardized" for blind children, its implementation might be uneven and dependent on teachers' skills and access to resources.

As discussed before, a majority of the teachers in schools for blind children are themselves blind, and have attended schools similar to the ones we visited. Often, they have limited technological know-how, making it difficult for them to debug and troubleshoot hardware and software crashes themselves. It is important that teachers are given training not only to install and use digital games, but also basic maintenance and troubleshooting skills in order to sustain these interventions in the long run. One way that can be done is to create and foster online teacher support networks, where both sighted and blind teachers share resources and strategies to integrate digital games in school curriculum. We found that these support groups existed in offline settings in schools in our study. However, they were mostly limited to teachers in the same school. There is an opportunity to expand such *knowledge communities* [51] to online settings so that they bridge institutional boundaries, thereby enabling teachers across different schools to share resources and provide support to each other. The role that teacher support organizations play in supporting and fostering these online communities is significant, and crucial for the uptake and deployment of such futuristic solutions.

6.3 Limitations

A major limitation of the study is that only eight teachers participated in the workshop. We wanted to keep the number of participants to less than ten due to the very open ended nature of the research question with no prior research to fall back on. We required at least one mediator per participant to ensure that the workshop can be playful while rigorous observations could still be made. We however note that previous studies with visually impaired users have also been conducted with only five participants, due to unavailability of a large user group [49, 61]. Second, the number of schools in our study is also fairly small and self-selected from the small set of schools that worked with our partner organization. Most of them are located in and around Bangalore and hence the findings in this work cannot be generalized to the diverse environments beyond the state of Karnataka without further research. Third, we planned to conduct more workshops that could lead to new insights, given the diversity of perceptions and experiences about digital games. We also planned follow-up physical interactions with the teachers to evaluate how much of game play they retained a month after the workshop and to see if they had the games installed in their school computers and if the games were functional etc. However, due to restrictions related to the COVID-19 pandemic, we could only do phone call interviews as a follow-up with the teachers to ascertain the same. We are currently evaluating how these trainings and interactions could be performed online with the major constraint that many of the teachers who are blind have very little experience with online interactions and learning.

7 CONCLUSION

This work explores the teachers' perceptions of integrating digital games in resource-constrained Indian schools for the blind. Since most teachers in these blind schools have no experience with digital games, we conducted a day-long gaming workshop for the teachers, in partnership with a local non-governmental organization specializing in developing accessible STEM content. Based on the workshop with eight teachers, survey of blind schools, and post-workshop interviews, we uncovered constraints and opportunities in introducing digital games for learning in schools for the blind in India. We found the benefits teachers expected the digital games to impart to their students to be very comprehensive, thus not only limited to teaching the curriculum, but also to teach soft skills, for fun, engagement and collaboration, and finally to make the students digitally skilled. Based on the results, we propose design considerations for the game development community, which will help them to develop accessible games relevant to the Indian schools for blind. We also outline recommendations for school administrators and governmental agencies to support integration of digital games in schools for the blind.

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A CODEBOOK

Theme / Code	Count	**Theme** / Code	Count
Game Element (48.58%)	**137**	**Integrating Games in Schools (17.02%)**	**48**
Instructions	20	Willingness	21
Gameplay	18	Limited technical support	7
Replayability	11	Lack of awarness about accessible games	6
Novelty of technology	11	Free periods to use games	3
Vibrotactile modality	10	Curriculum workload	5
Auditory modality	9	Requirement of computers	3
Accessibility	8	Requirement of headphones	3
Rules	8	**Learning Curriculum (10.99%)**	**31**
Rewards	8	Vocabulary	16
Familiarity of gameplay	8	Typing skills	10
Familiarity of technology	6	Numeracy skills	5
Novelty of gameplay	4	**Learning Soft Skills (7.09%)**	**20**
Duration	4	Memory	4
Competitiveness	4	Concentration	4
Context	4	Logical thinking	4
Kid friendly content	4	Listening skills	3
		Touch sensitivity	3
Fun and Engagement (12.05%)	**34**	Patience	2
Entertainment	23	**Feedback on the Workshop (4.25%)**	**12**
Social interactions	6	Engagement	6
Engagement	5	Social interactions	3
		Performance anxiety	3

Table 3: The complete codebook that resulted from our analysis of mediators' notes taken during the workshop, chat transcripts of teachers' WhatsApp group, and teachers' response during interviews. The codebook shows six themes (bold) and 38 codes, including the prevalence (%) for each theme, and the total count of each theme and code.