Computational Thinking as Play: Experiences of Children who are Blind or Low Vision in India

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ABSTRACT
Torino is a tangible programming environment designed for teaching the computational thinking curriculum in the UK to children who are blind or low vision (henceforth, just children) in an inclusive setting. In this paper we describe the experience of children in Bangalore, India, when Torino was introduced to them as a toy for creating and sharing stories, songs and music. We conducted 12 play sessions with 12 children (4 girls and 8 boys) with diverse backgrounds belonging to three different schools for the blind. We briefly present the reasons for play being central to our effort of bringing computational thinking to children who are blind and low vision in India, and share some experiences of the children and some insights that we have gathered so far: Children not only enjoyed every session, they rapidly moved from playing with pre-created examples, to making changes, to demanding that their favorite stories be told. In observing such play, we could infer that they have grasped the basic concepts of computational thinking–flow of control, variables, loops– though not articulated in that vocabulary.

Author Keywords
Digital skills, primary school, pedagogy

CCS Concepts
•Human-centered computing → Empirical studies in HCI; Accessibility technologies;

INTRODUCTION
A career path in computing could be transformative for people who are blind or low vision, and this is reflected in numerous efforts on digital skilling for the blind [8, 16, 17]. A more fundamental requirement is to introduce them to Computational Thinking (CT) [14] at an early age. Many countries, including the UK, have made computation thinking part of the regular curriculum starting at the primary grades [3, 2, 5, 21, 10] and there are corresponding efforts to introduce CT skills to children who are blind or low vision [22, 12, 9]. Torino is a tangible programming environment developed at Microsoft Research Cambridge to teach the UK CT curriculum to children who are blind or low vision. It consists of different instruction beads and a hub which when physically connected constitute computer programs that generate digital music or stories [23, 19]. The environment includes a PC software and a guide for teachers which lays out lessons, assignments and projects and has been demonstrated to be effective in teaching CT to children in integrated school settings [23, 19]. Its success has resulted in Torino being released as a commercial product called CodeJumper [6].

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Research Question: Can we present Torino as a toy for creativity and play, with stories, songs and music, and still introduce concepts of computational thinking to children in India?

A curriculum for CT has been recently created under the aegis of ACM India [4], but it is for sighted children and is yet to be introduced as a requirement in mainstream schools. Children who are blind or low vision face serious challenges in acquiring a quality education in India, home to the largest number of people who are blind or low vision [1], who also occupy the lowest socio-economic strata and are denied numerous opportunities ([13, 20] and numerous references therein). A vast majority of children who are blind or low vision attend, if at all they are able, schools for the blind that have the following characteristics: There is a shortage of teachers, who teach multiple subjects, and children from multiple grades are often combined into a single class due to this shortage. Many teachers are themselves blind. There are insufficient resources including lab resources and hardly any special educators. There is a wide variance in the age of children in the same grade since many parents find out about the availability of schooling for the blind fairly late. These factors have resulted in a vast majority of such children being denied STEM education beyond grade 7 across the country. Given the importance of computational thinking skills, we believe that an alternate approach is needed to ensure that these children are not similarly denied access to CT. We believe an approach centered on play is a viable option, given the strong evidence on effectiveness of play for learning over traditional methods [11, 14, 7, 15, 18]. In what follows, we describe the research methodology, the study and early insights and learnings, and conclude with our plans for this ongoing research.

STUDY METHODOLOGY
The study comprised of multiple play sessions conducted in school premises where participants played with the toy kit in pairs, with mild oversight from the researcher, and with a teacher present nearby [Figure 1]. Each play session lasted for 45-60 minutes. For the first play session, participants were given either a story or a song that they were familiar with fully programmed in Torino and were shown how to explore

Figure 1. Children playing with Torino in school during play session.

the various parts, with hand-holding to manipulate the basic elements of Torino: the hub, play button, volume button, on/off switch and play pod. The researcher helped participants when they were stuck for significant time or if they asked for help. Participants were encouraged to explore and ask questions. 12 children (8 boys and 4 girls) in the age group 7 to 13, either blind or partially sighted participated in the study. The study, including video recordings, was approved by the ethics boards of both MSR and International Institute of Information technology, Bangalore, which incubates VE Trust. We also introduced a child assent process by which during each session a verbal acceptance to participate is sought from the child, in addition to the consent from the school, the teachers and the parents.

OBSERVATIONS

Overall, children liked these play sessions and would quote it as "favorite part of the day". Together with their peers, they discovered several features not mentioned to them like, multiple channels to play different songs, playing music and rhymes in parallel using channels, being able to upload own songs and stories, playing song lines for multiple times using loop pod, etc. To avoid possibility of confusion, initially only a set of play pods was given to children in their first session. However, this soon changed to giving the full kit after a group of children accidentally found the full kit and played with all the pods in their first session. Children found on their own that some pods do not have sound dial on them, and they cannot use them for making sound, and were confused about their purpose. This creates an opportunity for pods like pause pods, if-then-else pods, and merge pods to be introduced via stories or songs which highlight their function and makes them appreciable to young children.

The joy of play was evident and we infer that this is not just due to the novelty, since they continued to enjoy multiple sessions with the same enthusiasm. We believe it is because the children were encouraged to explore and play with no expectation that they 'learn'or 'complete'anything. In some cases, children were very shy to start playing with the toy until researchers stepped away from the play zone. This was a lesson from our pilot studies that we not only create an environment where children feel no pressure to learn but also feel no pressure to play.

Children, in teams of two, made multiple programs on Torino. Simultaneously playing instrumental music on one channel and poetry on another, playing jumbled story lines in order, playing their favorite animal sounds in the middle of stories for multiple times using the loop pod are some of the examples where children demonstrated their understanding of concepts like sequence, threads and loops. Like their programs on Torino, children's conversation with each other also gave us several insights. It is important to note here that there was great diversity in the participants background, as well as level of vision impairments. However, while playing with their peers, children helped each other in finding features which they explored and in finding and solving bugs in each other's programs. While we also saw some dominating behavior during play, allotting separate time for each child to showcase their program helped in keeping the play spirit up. Second session onward, children got bored of content from previous sessions and always demanded newer content and in most cases, content of their choice. Language played a huge role here: we added custom content in local languages like Kannada, Tamil and Hindi since most of Torino's default content is in English.

From observations of the Torino programs that children created and played with, it can be easily inferred that they have grasped the fundamentals of CT and programming: flow of control, variables, loops, bugs, etc., though not in the same vocabulary. The primary challenge in our ongoing research is to systematically establish that the learning objectives of CT are being met, while at the same time not distracting from play and creative exploration.

CONCLUSIONS AND FUTURE RESEARCH

In this paper, we talk about insights from our study on introducing computational thinking as play for children with vision impairments in India while using a Torino, a tangible programming environment developed for children in the UK. Children involve in collaborative play and learning while coming from diverse backgrounds. The observation sessions demonstrated importance of maintaining an environment of creative freedom and exploration for playful learning. Every child, without exception, wanted more play time and more individualized content. As part of our future work, we intend to devise ways to establish the children's real grasp and retention of concepts, and to understand challenges in integrating this approach in to the school curriculum and practice including the training needed for the teachers.

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