Beyond Digital Displays: Design Considerations for Tablet Applications Targeting Children with ASD in Sri Lanka

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Abstract
Technology is being extensively used among children with autism spectrum disorder (ASD) in affluent countries. However, there is a paucity of studies exploring the use of technology for children with ASD in developing countries like Sri Lanka. Therefore, we explore the key considerations for designing software applications for children with ASD by interviewing 32 parents and 18 practitioners of children with ASD. Our findings suggest that to effectively support children with ASD in Sri Lanka, technological interventions should focus on multi-player functionalities to promote social interactions. We further identified the characteristics that are required in a software application to effectively support children with ASD in Sri Lanka, namely support for 1) timers to avoid screen addiction, 2) tangible user interfaces, 3) customization, and 4) cultural context. Based on the results, we provide recommendations to design technology for Sri Lankan children with ASD.

Author Keywords
Autism Spectrum Disorder (ASD); Digital Technologies; Social Skills; Interactive Tangible Objects.
ACM Classification Keywords

Introduction
Autism Spectrum Disorder (ASD) is a pervasive neurodevelopment condition characterized by significant impairments in social-communication and social-interactions along with stereotype restricted and repetitive behaviors [1]. Due to the aforementioned characteristics, children with ASD find it hard to embrace the traditional learning environments [5]. Some studies have revealed that children with ASD perform better with technology-assisted instructions compared to traditional teacher-directed equivalents [14]. Several studies have shown that technological interventions such as iPad and tablet applications can be effectively used with children with ASD to improve their communication [12], cognitive and social skills [4] and academic skills (spelling)[6]. Educational professionals in the United States highlighted that tablet applications are used for Augmentative and Alternative Communication (AAC), Video-based modeling, academic work and to improve turn-taking skills via sharing the tablet with peers. They further provided challenges and guidelines for using tablet applications for children with ASD in the United States [7]. However, it is not known to what extent these are valid in low resource regions like Sri Lanka.

In Sri Lanka, one in 93 children in the age-group of 0-3 years may have ASD in semi-urban areas of Colombo district [9]. Studies have shown that average age of diagnosing a child with autism is 35.8 months in Sri Lanka [10]. Further, home-based autism interventions start early as 18-to-40 months for children with ASD in Sri Lanka. Even though there are early diagnosis and technology-based intervention programs for children with ASD in Sri Lanka, there is a lack of research evidence on the use of technology among children with ASD in Sri Lanka and how software applications can be designed to teach children with ASD in Sri Lanka. Therefore, the main goal of this study was to identify the characteristics that are required in a software application to effectively support children with ASD in Sri Lanka.

Methodology
This study employed a qualitative research design using semi-structured interviews. Participants were asked to give their opinion on using technology with children with ASD in Sri Lanka at therapy and home settings. Ethical approval for this study was obtained from the Swinburne University of Technology Australia and informed written consents were granted by all participants prior to participation. Interview sessions were conducted in the Sinhalese language (the native language of the participants) at Sumaga Autism Center Sri Lanka.

Participants
Participants were recruited via Sumaga Autism Center Sri Lanka, Department of Disability Studies Ragama Sri Lanka and Colombo Medical Faculty Sri Lanka. Practitioners (therapists and special education teachers) were invited to participate if they have minimum four years of experience in one-to-one teaching or providing therapy for children with ASD under a reputed institute in Sri Lanka. Parents were invited to participate if their children have ASD, child’s diagnosis have been made not less than 6 months, and child’s age 1-18 years. Altogether 50 participants...
attended, 32 parents of children with ASD, 18 Practitioners (10-special education teachers and 8-therapists) who work closely with children with ASD. All interviews are conducted in the native Sinhalese language and participants are recruited from multiple ethnic and socio-cultural backgrounds.

Data Analysis
Interviews were transcribed and translated into English. Six step thematic data analysis process [2] was used to analyse the data. The copies of summarized reports were sent to 50% of the participants including both professionals and parents for their review. Participants were requested to comment on the accuracy of the findings according to their experience. Each participant who received the summary verified the accuracy of the results.

Results
Existing Technologies for Children with ASD in Sri Lanka
In general, both practitioners and parents believed interactive tablet applications and computer programs can help children with ASD, as they promote visual learning with immediate sensory reinforcements. Further, special education teachers highlighted that children with ASD are keen on learning with minimum guidance when given technology instead of books (See Figure 2). We found out that technology is used for different purposes for children with ASD in Sri Lanka (See Table 1). Practitioners reported that they use interactive software applications and mobile applications to engage with children to improve social, communication, educational and fine motor skills of children with ASD in school/therapy settings. Parents, on the other hand, use passive technological applications such as "YouTube" to distract the child when they are waiting in line, avoid tantrums, and for educational purposes. Participants highlighted that they used both desktop computers and tablet applications in therapy and home settings with children. However, practitioners identified rather than a desktop application, tablet-based applications will be more suitable for children with ASD as most children with ASD has limited fine-motor skills to operate mouse and keyboard effectively.

Concerns for Using Technology and Expectations
Even though technology can be beneficial for children with ASD in Sri Lanka, participants have concerns when using technology.

1. Technology restricts social interactions: As practitioners (n=12) pointed out, most technological applications (i.e., iPad applications) are designed for single user mode, only child to tablet or child to computer interaction will be promoted by them. One practitioner said, ‘I see most children with ASD get
isolated. They do not tend to interact with anyone else when they are using their smartphones or iPad. Children with ASD have social interaction issues. Unless technology itself enforces them to interact with others, technology is not helping them'. If technology is not designed to support social interaction, it may lead children less interacting with their peers while moving into their own technology bubble. Practitioners unanimously agreed that unless technology itself enforces to engage with their friends or family, children with ASD might get isolated inside technology. Further, we also found out only one application called ‘Story Maker’ is used to improve social skills of children with ASD in Sri Lanka. Practitioners further highlighted this application does not promote social interaction with peers but focus more on teaching social understanding of children with ASD. Therefore, they highlighted the need of designing applications that support social interactions to avoid social isolations promoted by technological interventions for children with ASD.

2. Screen addiction: Practitioners and parents believed children with ASD are more prone to screen addiction than typically developing children. Unlimited access to digital devices can promote screen addiction. Most parents (n=15) believe that technology can be addictive for their children, as they had observed their children develop an addiction towards watching YouTube, one parent reported, ‘My son used to watch BabyTV and YouTube a lot at home. He got addicted to them and now he somehow manages to go to YouTube and watch videos even when we put some other educational program on the tablet’. Nevertheless, most practitioners feel technology can be beneficial, and that addiction and social isolation to technology could be avoided if used with the adequate amount of social interactions within a limited time frame (10-15 minutes per session).

3. Lack of 3D learning: All practitioners pointed out most technological interventions are limited to two-dimensional screen-based learning. They further reported, for healthy brain development, it is important that children engaged with physical objects rather than only dealing with 2D virtual environments. One therapist explained, ‘Most tablet applications are in two-dimensional form, where the child cannot learn by touching the objects. At our therapy sessions, we use a lot of physical objects for a child to interact’. Practitioners strongly believed that manipulation of physical objects is a crucial element of motor control and cognitive understanding. Therefore, practitioners use physical toys at therapy sessions to facilitate physical play for children with ASD (See Figure 3).

4. Facilitating the child’s interest: Both practitioners and parents reported children with ASD have different interests. Furthermore, practitioners highlighted the importance of customizing the learning materials according to child’s level of knowledge and learning requirements. However, participants pointed out most applications lack support for customization, which enables adding new learning materials, personalized images and sounds. A special education teacher explained, ‘When we use the computer applications we always have to stick with the images the application provides. Sometimes the child does not like to color the picture provided by the application’.

5. Cultural context: One of the most common frustrations reported by both parents and practitioners is lack of applications that support the Sinhalese
Language (the native language of the target groups). One parent reported, ‘One of the biggest problems we face is finding Sinhalese applications for our children.’ Further, practitioners reported children with ASD require applications based on real-world scenarios that they can relate to such as going to the shop or cleaning the house.

**Design Implications**

Our findings suggest when designing software applications for children with ASD in Sri Lanka, five main concerns need to be addressed. One of the biggest concerns that all practitioners had was lack of social interactions when using software applications though practitioners believed that using technologies for children with ASD could promote social isolation. To resolve this problem, we suggest having multiple users in software applications so that children get enforced to interact with the other users. Studies have shown that multi-player multi-touch games on tabletop devices encourage collaboration and social interaction for children with ASD [13]. However, tabletop devices might not be suitable for countries like Sri Lanka due to the high cost and we need to look for alternative solutions to support multi-player functionalities with affordable touchscreen platforms for Sri Lanka. In addition to social interactions, screen addiction is another area that most parents highlighted. To avoid screen addiction, most practitioners believe technology must be given for a short period with regular intervals. This can be achieved using timers in software applications. By implementing timers and enforcing time limits for playtime, we can restrict children using technology for a longer period. Another key functionality that was lacking in commercially available software applications is physical interaction with objects. It has been identified that use of touchscreen tablets without interaction with physical objects might be disadvantageous for the fine motor development of preschool children [8]. Therefore, bridging physical components with digital platforms is crucial when developing applications for children with ASD. This can be achieved using Tangible User Interfaces (TUI) [11]. Though there has been some research exploring the use of TUI with children with ASD [3], most of them were conducted using tabletop applications. Therefore, in future research, we need to explore more affordable TUI for children with ASD in low-income countries like Sri Lanka. To address the concern of facilitating child’s unique interests we propose support for customization and personalization in software application design. This customization should allow teachers and parents to add new teaching materials, change teaching materials and personalize feedback according to child’s unique interest. Another concern most parents and practitioners had was designing software applications that support Sri Lankan cultural context. The ability to support native languages of children with ASD in Sri Lanka is a critical element when designing software applications for children with ASD in Sri Lanka. However, to date, there is no software application based on empirical research that supports the Sinhalese language for children with ASD. Hence, there is a clear need for research on software applications targeting the specific ethnic background in Sri Lanka.

**Conclusion and Future Work**

We have identified that promoting social interaction via technology is a key aspect that needs to be focused when designing software applications for children with ASD in Sri Lanka as most Sri Lankan parents and practitioners believe technology can socially isolate
children with ASD. In addition to social interactions we found out four important characteristics when designing interactive learning tools for children with ASD in Sri Lanka namely, 1) avoid screen addiction by adding time restrictions in the application, 2) bridge physical objects with digital platforms via TUI, 3) support child’s unique interests via customization, and 4) support for cultural context via embedding real-world scenarios related to Sri Lanka in Sri Lankan native languages. In the future, we aim to design interactive software applications based on the aforementioned five characteristics for children with ASD in Sri Lanka.

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References