The design and development of a mobile communication tool for autistic individuals – AutiSay

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Abstract: Children diagnosed with autism spectrum disorders (ASD) often have social communication difficulties and/or display restrictive and repetitive behaviours. This paper focuses on the social communication difficulties and the design of a mobile application to be used as a communication tool between the autistic child and his/her caregivers. The advances in mobile ubiquitous technologies provide an opportunity to develop a tool to improve the social communication of the autistic child. Relevant design requirements were identified and incorporated into an application that is highly customisable. The application has undergone a usability inspection to collect feedback for further refinement.

Keywords: mobile application; assistive technologies; usability inspection for autistic apps; social communication difficulties; SCD; autism; mobile communication autism.

1 Introduction

The paper discusses the design and development of AutiSay, a mobile application which assists autistic children to communicate with their caregivers, parents, teachers and therapists. The application does not purport to replace professional services and care; rather it is an assistive tool supporting the work of the professionals and the caregivers. The application leverages itself on the mobile device market as its growth forecast is a compelling reason to reach out to the autistic community, especially those that do not have easy access to professional services. According to Gartner, the device market is forecasted to grow 6.9% in 2014 and 5.9% in 2015. This translates to approximately 2.5 billion units shipped in 2014. Tablet is shipping at an increase of 38.6% while desktop PC is at a decline of 6.6% from 2013 (Gartner Inc., 2014). This forecast shows that 2014 is the year that the number of tablets shipped is increasing much faster in proportion to desktop devices. The implication is that the choice of device for work, social and communication will be a hand-held mobile device in some form. Mobile applications are on the increase and App store and Google Play dominate the volume in applications. To date, the App store has over 1.2 million applications (Perez, 2014) and according to AppBrain, the number of applications on Google Play is about 1.3 million (AppBrain, 2014).
Arguably, mobile applications have become platforms for social change, education, lifestyle and health to some extent. This should not be a surprise as current mobile devices such as smart phones and tablets are equipped with rich-features which encourage the development of applications to improve the quality of human life. More mobile applications on health-related issues are appearing on the landscape such as applications for monitoring sleep apnea, diabetes and communication applications for ASD and other health-related conditions. In particular, the ‘smartness’ of mobile tablets is useful for creating applications for ASD. For example, such applications could take advantage of the built-in camera, video and voice recorder to capture a mother’s instructions to her autistic child. The AutiSay application takes advantage of a features-rich iPad tablet to create a social communication tool that has potential to be customised for different languages and cultural norms. It is also hoped that the tool would be adopted with ease, due to the recent advances in mobile and ubiquitous technologies.

A usability inspection was conducted on AutiSay and the findings show the features are understandable and useful, with the exception of the ‘activities’ feature. It also shows that the vocabulary used for the titles and headings are clear and familiar; however the test users are mostly neutral on the layout of the application. On ease of using the application, majority of the test users feel it is easy to configure contents and the application is ready for child use.

This paper is an extended version of work originally reported in Proceedings of the Fourth INNS Symposia series on computational intelligence in information systems (INNS-CIIS) 2014, presented during the conference in Brunei Darussalam (Voon et al., 2015). The extended version includes new works such as the usability inspection, and the outcomes of the inspection (described in Sections 7 and 8). The extended version has also expanded the scope of the literature review (Section 3), expanded the section on design specifications of AutiSay (Section 4) and re-written the conclusions (Section 9) to address the new findings.

2 Background research

The term autism spectrum disorder (ASD) is generally used to describe a group of complex disorders of brain development (Autism Speaks Inc., 2014a). In the USA, one of the tools for ASD diagnosis is based on the guidelines of the fifth edition of the diagnostic and statistical manual of mental disorders (DSM-5) published in May 2013 (American Psychiatric Association, 2014). The previous manual, DSM-IV recognised autism disorders as three distinct subtypes: autistic disorder, Asperger’s disorder, or pervasive developmental disorder not otherwise specified (PDD-NOS). The new DSM-5 diagnostic manual have merged all the distinct autism disorders into one umbrella diagnosis, collectively referred to as ASD. Furthermore it has also created a new diagnosis for social communication difficulties (SCD). SCD describes individuals who have SCD without the repetitive behaviours or restrictive interests typical of autistic individuals (Autism Speaks Inc., 2014b). It should be noted that SCD is not included in the ASD domain as it defines a group of individuals with related but separate symptoms. DSM-5 is a significant departure from DSM-IV as it has narrowed the autism disorders to two specific domains: social communication domain and restrictive interest and repetitive behaviours domain. Clearly the revised criteria under DSM-5 would have an impact on
clinical adaptation of diagnostic practices and documentation to fit the criteria. This would also impact on the type of mobile applications developed for ASD, as developers would have to incorporate features to fit the criteria.

Recent statistics indicate that ASD is prevalent world-wide. According to the US Centers for Disease Control and Prevention (2010), global prevalence of autism has increased 20-fold to 30-fold from studies conducted in the late 1960s to early 1970s (Centers for Disease Control and Prevention, 2014). It is unclear if the increase is due to a broader definition of ASD and/or better skills in diagnosis based on the criteria of DSM-IV, DSM-5 and other accepted diagnostic methods. However an increase in the number of individuals with ASD cannot be ruled out. Table 1 illustrates autism prevalence among some countries.

Table 1  Autism prevalence among some countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Autism rate (children)</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1:909</td>
<td>Peking University Health Science Centre (2005 estimate) (Zhang and Ji, 2005)</td>
</tr>
<tr>
<td>USA</td>
<td>1:68</td>
<td>US Centers for Disease Control and Prevention ADDM Study 2010 (Centers for Disease Control and Prevention, 2014)</td>
</tr>
<tr>
<td>South Korea</td>
<td>1:38</td>
<td>The American Journal of Psychiatry (Kim et al., 2011)</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1:625</td>
<td>Ministry of Health, Malaysia (MaHTAS, 2014)</td>
</tr>
<tr>
<td>UK</td>
<td>1:263 (boys), 1:1,250 (girls)</td>
<td>BMJ Open (Taylor et al., 2013)</td>
</tr>
<tr>
<td>India</td>
<td>1:250</td>
<td>Autism Society of India (2015)</td>
</tr>
<tr>
<td>Brunei Darussalam</td>
<td>1:150 to 1:1,000</td>
<td>Society for the Management of Autism-Related Issues – Training, Education and Resources (SMARTER), Brunei (Marilyn, 2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Child Development Center (CDC), Ministry of Education, Brunei Darussalam (Thien, 2014)</td>
</tr>
</tbody>
</table>

Table 2  Number of children with ASD registered in centres in Brunei Darussalam

<table>
<thead>
<tr>
<th>Centre</th>
<th>Number of children registered (ASD)</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Ladders</td>
<td>18 students age from 2–11 years</td>
<td>Learning LADDERS, statistics to date 26 December 2014</td>
</tr>
<tr>
<td>Pusat Ehsan</td>
<td>Unknown</td>
<td></td>
</tr>
</tbody>
</table>

Note: Statistics are gathered through direct communication with the centres.

Official statistics on ASD are difficult to come by in Brunei Darussalam and this accounts for the wide variance of the autism rate in Brunei Darussalam as reported in Table 1. At the time of gathering information on ASD in Brunei Darussalam, there are three centres catering to the specific needs for children with ASD: SMARTER, Learning
Ladders and ‘Pusat Ehsan’. ‘Pusat Ehsan’ accommodates various special needs including ASD; it is unsure the depth of ASD facilities offered. Table 2 provides the number of children registered in these centres.

Children diagnosed with autism have in common an impediment in social interaction. This is characterised by SCD and restrictive and repetitive behaviours. However the severity of the impairments and behaviours differ respectively in each child. DSM-5 classified three severity levels for diagnosis: Level 1 ‘Requiring support’, Level 2 ‘Requiring substantial support’ and Level 3 ‘requiring very substantial support’ (Autism Speaks Inc., 2014b). In communication, children with ASD tend to delay speaking and learning to use gestures. Some experience significant language delays and are non-verbal or nearly non-verbal. Even when they start to develop speech, they have difficulty combining words into meaningful sentences (Autism Speaks®, 2014a). There are several systems in place to help autistic individuals to learn to communicate such as picture exchange communication system (PECS) (The National Professional Development Center on Autism Spectrum Disorders, 2010). Children using PECS are taught to use pictures to communicate needs and learn new behaviours (National Autism Resources, 2014). PECS is also incorporated in the TEACCH® Autism Program, a clinical, training, and research program based at the University of North Carolina at Chapel Hill. TEACCH® was established by the North Caroline Legislature 1972 (Mesibov, 1996) and has become a model for other programs around the world (Autism Speaks®, 2014b). Studies (Ozonoff and Cathcart, 1998; Panerai et al., 2002) indicate that TEACCH® has success as an effective intervention for autism. The findings of how PECS is incorporated into successful programs such as TEACCH® are a crucial design consideration for AutiSay.

3 Related work

At the time of writing this paper, the ‘Autism Apps’ locator tool listed over 60 autism applications under communication (USA app store) (TouchAutism. 2014), with several applications modelled after PECS; e.g., PictureCanTalk (App Consult Pte Ltd., 2014) uses PECS approach to construct sentences using customised communication boards and pictures which speak. Once a sentence is constructed, an audio speak feature is activated. The focus is on constructing sentences and teaching autistic children to ‘speak’ in a structured manner. It has customisable picture catalogues to add pictures and voice during setup. AutiSay uses a similar approach to build its picture catalogue and to directly record a personalised voice into each picture. However AutiSay focuses on communication without constructing sentences. It uses a simpler form of PECS by touching on the pictures directly to speak. The voice in a picture is recorded during contents setup. This simplicity lets the child focus on communicating a need rather than worry about learning language structure at this stage of their development.

EducateMe is an early beta version and influenced the direction of AutiSay. Figure 1 is a screen shot of EducateMe. The main screen is the Activity List. The menu is a list of icons located at the bottom of the screen. The seven features on the menu is a mix of learning characteristics and traits. This mix presents a difficulty in classifying EducateMe. Consequently, based on common terms to classify autism applications (Table 3), AutiSay provides only three categories: activities, communication and
LifeSkills. Therefore the EducateMe features ‘emotions’, ‘thirsty’ and ‘hungry’ would be categorised under ‘communication’ in AutiSay. EducateMe was tested at SMARTER and the technical aspects were reviewed by peers at the Institut Teknologi Brunei (http://www.itb.edu.bn) and by industry practitioners working at the BAG networks.

Figure 1  Main screen of the EducateMe application [1], the menu is located at the bottom of the screen [2], selecting the emotions icon on the menu opens up the emotions template [3] (see online version for colours)

Table 3  Common terms used for classifying autism applications

<table>
<thead>
<tr>
<th>Terms classifying autism applications</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication, social skills, behaviour</td>
<td>These six classifications for autism applications are based on a ‘wheel’ developed by Mark Coppin [October 2012]. The design is based on the Pedagogy Wheel designed by Allan Carrington and modified by Cherie Pickering.</td>
</tr>
<tr>
<td>Need for sameness or routine, sensory sensitivity</td>
<td>Difficulty with traditional learning methods</td>
</tr>
<tr>
<td>Communication, education, autism, fun</td>
<td>Development autism research technology (DART), the University of Edinburg used these four classifications to organise and review autism applications.</td>
</tr>
<tr>
<td>Art, books, communication, earliest learning, math and pre-math</td>
<td>These five classifications is a sample list of anecdotal classifications compiled by a parent of an autistic son, an autistic adult and a speech language pathologist (SLP).</td>
</tr>
</tbody>
</table>

Source:  
1Wheel developed by Coppin [October 2012] can be referred at http://goo.gl/F0gW8w  
2http://www.unity.net.au/allansportfolio/edublog/?p=324  
4http://www.dart.ed.ac.uk/asdtech/app-reviews/  
5http://goo.gl/B7vHb
Applications for autism display similar characteristics such as:

- **Prevalent use of pictures.** Pictures are used to communicate words, emotions or to form sentences.
- **Audio recording.** Use audio recording to represent the ‘speaking’ voice of the individual to communicate needs or emotions.
- **Focus on learning traits.** Emphasis is on common learning characteristics and traits typical for ASD. Classifications of learning characteristics and traits are influenced by the symptoms rather than the diagnosis (severity-level) (Autism Speaks Inc., 2014b) for ASD.
- **Single learning characteristic or trait.** ASD applications tend to focus on only one particular learning characteristic or trait in a single application, e.g., ‘Look into my eyes’ application focus on developing a particular social skill, eye contact. There are few exceptions such as AutisMate (SpecialNeedsWare, 2014) which covers several learning traits under different categories such as communication, social skills, among others.

Studies (Bogdan et al., 2012; Nelson, 2013) have shown that autism applications on hand-held devices have positive effects on the development of the autistic child when used appropriately and with intent of its development. In 2010, A research team from the Center of Excellence on ASD at Southern Connecticut State University conducted a study on a mobile application iPromptś® to investigate its use by educators working with students with ASDs (Bogdan et al., 2012). Results were positive: 88% teachers in the group feel such tools can be used to help students with ASDs. The National Professional Development Center (NPDC, 2015) on ASDs has documented and identified 17 evidence-based practices (EBPs) which are effective with students with ASD when implemented correctly. The EBPs approved by NPDC include visual schedules using pictures and symbols have shown to be effective intervention for children with ASD (Sulzer-Azaroff et al., 2009). The schedules provide predictability to routines and hence reduce behaviour issues (Bryan and Gast, 2000).

## 4 Design specifications for the AutiSay application

The design of AutiSay takes into account the review of its beta version and is informed by the review of the previous literature and guidelines of established practices for the treatment of autism, specifically common classifications used in autism applications and PECS. It is also influenced by the practices adopted by SMARTER (2009) which in itself has met international standards. Figure 2 is a view of the use case diagram for AutiSay. The use cases are identified based on how the ‘actors’ will interact with the application (system) in order to achieve the goals of communicating a need and personalising contents. These use cases are the basis for the refinement of the requirements specifications and represent the scope of the application. The main ‘actors’ are the autistic child and the parent. The autistic child interacts with the application through four use cases: edit profile, communicate a need, perform a life skill and create a now next list. Edit profile is the only use case where the child can directly configure his own picture and ‘own’ the application. The other three use cases translate into features where
the child uses the pictures and sounds in the categorised catalogues for communicating or to be guided step-by-step to perform a life skill.

**Figure 2** Use cases diagram for AutiSay (see online version for colours)

The parent interacts through six use cases mainly to configure contents that are relevant for the child. The use case for login is ‘include’ into three use cases: create an activity, create a communication category and create a life skills category. The create an activity use case allows parents to populate the activities catalogue. The latter two use cases preserve classifications of learning traits common to ASD, i.e., communication and life skills. Communication conveys needs such as hunger and emotion while life skills incorporate learning contents that require the need for sameness or routines. This is an essential consideration for parents to align groups according to these learning traits and preserve familiarity of terms which have meanings for the child. For example, as the child develops to identify places that they want to visit, parents can create a group ‘places’ under communication and capture the images and audio names of the places in the ‘places’ container; thereby creating a way for the child to communicate a need to visit a particular place.

The use cases ‘create a communication need’ and ‘create a step-by-step life skill process’ have dependent relationships to ‘create a communication category’ and ‘create a life skills category’ respectively. This relationship ensures the preservation of the learning traits classifications discussed above. Furthermore parents have flexibility to configure contents to enforce PECS, i.e., the use of familiar pictures and common symbols to support familiarity of routines. This is a crucial consideration as the NPDC on ASDs has identified the use of pictures and symbols to be effective with students with ASD when implemented correctly (Sulzer-Azaroff et al., 2009; Bryan and Gast, 2000). Apart from pictures and symbols, parents have the option to make the pictures talk by
recording voices that are already familiar with the children or even to record their children’s voice. The ability to record real voice is important as NPDC has identified the use of speech generating devices as effective for early intervention (evidence-based practice).

5 Description of the AutiSay application

AutiSay focuses on children with ASD who show the following traits: poor vocabulary, limited use of language, difficulty with receptive language, rigid language, difficulty expressing needs and difficulty with conversations. Since the degree of severity differs from child to child, the system is designed to be flexible, and to easily capture context and contents relevant to the individual child. This high degree of customisation is one of the most important aspects of the application.

5.1 System overview

The AutiSay application is developed for the Apple iPad and requires iOS 6.1 or later. This device is equipped with a built-in camera, microphone and Wi-Fi capabilities which the application needs for customisation and accessing the app store. The iPad would also have ample disk space to accommodate the images and audio recordings. The application is written in Objective-C, the native programming language for the Apple environment, and the IDE interface (development tool) used is Xcode.

Using the parental login mode, the AutiSay application uses the camera and audio recording facilities of the smart device to capture images and audios. As shown in Figure 3, the captured images and audio recordings are stored in the SQLite database. SQLite is embedded and preinstalled in the iOS by Apple. Images are captured and stored in portable network graphics (png) format while sounds are in Apple’s core audio format (caf). Captured images are captured in aspect fit, and scaled automatically by the application, to fit one of two image holders’ dimensions during edit mode. For the bigger image holder, the image dimension is 430 by 445 pixels and the smaller image holder is 160 by 160 pixels. The bigger format is used in the step-by-step instructions under the life skills feature. All other features capture image with the smaller image holder dimension.

5.2 Features overview

Refer to Figure 4 for a view of AutiSay, the opening screen is a customised image of the child using the application. From the onset this lets the child takes ownership of the application. The Welcome button opens the main screen which displays a framework of four features:

1. life skills
2. communication
3. activities
4. login feature.
Notes: The parent login mode is used to add, edit and amend the images and voices for
the life skills, communication and activities features (1). These customised media
are stored on the device using the SQLite database feature. The child uses the
child login mode to communicate and learn to perform life skills (2).

Figure 4 Opening screen (1) child takes ownership at the onset by personalising his/her own
picture, main screen (2) shows selection of four features: life skills (3), communication
(4), activities (5) and login/logout (6), activities selected by the child are shown in the
now/next containers (7)
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The life skills feature group skills that show step-by-step instructions to perform a skill, such as brushing teeth. Touching on each skill in this category opens up the step-by-step instructions to perform that skill. Parent mode allows creation of new skills on the main screen and configures contents for the step-by-step instructions. Communication feature is configurable to allow a child to express emotions and needs. Parents use this feature to teach a child to express new emotions. For example, parents can define an emotion ‘I am peaceful’ in picture and record a speaking voice for it. Activities feature gives control to the individual child to communicate doing an activity outside of the routine. As the child develops, parents can use this feature to define new activities in tandem with the child’s development. Finally, there are two login modes for the application

1 parental login
2 child login.

6 Usability inspection on AutiSay

A usability inspection was conducted on AutiSay to review the user interface, ease of configuring contents and determine users’ preference on two prototypes. Figure 5 shows the stages of the usability inspection developed and conducted on AutiSay. The usability inspection has the following stages:

• Stage 1: Formulate a set of objectives for the usability inspection.
• Stage 2: Develop a methodology for the usability inspection.
• Stage 3: Assemble test users and conduct the usability inspection.

6.1 Stage 1: Objectives of the usability inspection

The objectives of the usability inspection are as follows:

• to identify areas in the user interface where users have difficulty in understanding the meaning of a feature and/or its usefulness
• to gauge whether media such as text, colours, pictures and sounds are appropriate for use for the subject matter, i.e., autistic children
• to gauge users’ difficulty in configuring contents
• to gauge users’ preferred accessibility given two versions.

6.2 Stage 2: Usability inspection methodology for AutiSay

The usability inspection methodology developed for AutiSay is based on an ‘interactive review’ of the user interface and the coalescing of two informal inspection methods, feature inspection (Bell, 1992) and cognitive walkthrough (Lewis et al., 1990; Polson et al., 1992).
6.2.1 ‘Interactive review’ method

The ‘interactive review’ required test users to use the application in child mode with a set of pre-configured contents. Test users are prompted to explain verbally what they’re thinking about while working on the application. Feelings and opinions are captured in a pre-designed form. The ‘interactive review’ method does not obtain quantitative data, however it provides an understanding of users’ instinctive use and approach to the interface. If users express consistent uncertainty or show irritation when trying to accomplish a task, it may be construed that the interface is convoluted. Main benefits of ‘interactive review’:

1. to gain a better understanding of the user’s mental state and interaction with the product
2. terminology used by the user to express an idea or function can be adopted into the interface design, i.e., terms that are already familiar to users.

6.2.2 Adapting the feature inspection and cognitive walkthrough methods

Techniques used in the feature inspection and cognitive walkthrough methods were adapted to analyse the following:
1 understandability and usefulness of the features
2 ease of configuring contents.

Without guidance, the testers are required to access all features and observers gauged the ease or difficulty for testers to get to the features and intuitively understand what to do. This procedure is adapted from feature inspection (Lewis et al., 1990). To gauge users’ ease of configuring contents, test users are first guided to walkthrough a configuring process. Then they perform the configuring process on their own. As they go through the steps, testers observe and gauge whether they are able to accomplish each step without too much difficulty. After performing each task, they are asked to provide feedback. This walkthrough procedure is adapted from the cognitive walkthrough method.

The rationale for adapting the ‘feature inspection’ and the ‘cognitive walkthrough’ methods are as follows:

- Techniques in both methods are simple to implement and sufficiently malleable to fulfill the objectives of the usability inspection. Objectives 1, 2 are achieved by adapting the process of the ‘feature inspection’. Objective 3 is achieved by adapting the process of ‘cognitive walkthrough’. Objective 4 is achieved via the ‘interactive review’.

- Both methods are relatively inexpensive to implement, with minimum emphasis for usability and cognitive experts to be on the team and no requirement for comprehensive training.

- Both methods are field-tested and benefited projects in identifying usability issues. A study by Nielsen (1995) showed both methods have been applied in the field as they are taught or modified in some form, with respondents rating their usefulness in varying degrees. In this study, feature inspection obtained 4.3/5 rating and cognitive walkthrough a 4.1/5 rating for usefulness.

Both methods will not produce quantitative data; however the benefits are in refining further the list of identified usability issues. In the walkthrough, the focus is on the users’ cognitive processes relating to the features designed for AutiSay, with emphasis that learning to use the application should be relatively easy as it leverages on the users’ previous learned experienced.

6.2.3 Form to guide the usability inspection process and collect information

A form is strategically designed to ensure meeting all objectives as documented in Stage 1; furthermore, the layout of the form guides the process of the usability inspection methodology developed for AutiSay. The form has four sections: Section 1 captures information on the background of each participant. Section 2 focuses on the user interface, drawing responses on text, media and layout. Section 3 focuses on the ease of configuring a new skill and its contents. Section 4 seeks users’ feelings on an alternative design in comparison to the one that they have been using for the inspection. A sample of the form can be accessed and viewed online (Voon, 2015).
6.3 Stage 3: Assemble test users and conduct the usability inspection

6.3.1 The test users

The AutiSay application is designed for two types of users in a specific domain. The domain is autism and the two types of users are

1. parents
2. autistic children.

Due to the intrinsic characteristics of autism and the varying degrees of behaviour patterns of each child, the testers needed guidance and specialised assistance to manage a group of autistic children in one seating. In view of this, it was decided to conduct the usability inspection only on the parents. A usability inspection session with the autistic children will be considered based on the outcome of the inspection with the parents. A group of five test users were assembled, comprising parents and a therapist. The therapist works in a regular school with years of experience working with autistic children. The test users are considered experts in their own rights due to their experience in managing the development of autistic children. The reason for the small group is as follows: as stated earlier, the focus of AutiSay is on children who are non-verbal and have certain traits such as difficulty in expressing needs and other traits required for social communication. However, due to the difficulty sourcing official statistics and based on the findings in Table 2, the number of candidates meeting such criteria is small; 11 candidates from SMARTER qualify and only parents of five children agreed to participate. The age range of the children is six to 11 years, the same age range enrolled in the independent living skills class Level 1 (SMARTER) and display the characteristics of SCD for which AutiSay is designed for.

6.3.2 Conducting the usability inspection

Prior to the usability inspection session, all testers are given training in using the application and guidance on the methodology. The mobile devices used for the inspection were all pre-configured with the same set of contents. This pre-configuration is similar to the initial state of the software on first download. The usability session is on a one-on-one format. Each test user is assigned a tester. Test users are kept at a reasonable distance from each other, so as not to influence each other’s responses. During the ‘ease of configuring contents’ part, all test users are required to walkthrough a feature and configure the same life skill using preloaded pictures from the library. The life skill chosen is ‘washing hands’ as configuring this skill has sufficient depth to gauge whether the test users’ find it difficult to configure contents. After the usability inspection is completed, all test users are assembled for a concluding briefing and general comments from the users were collected. This is the only part of the inspection process whereby their comments are aired openly to one another.
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7 Outcomes of the usability inspection

The following are outcomes from analysing the information gathered in the usability inspection:

- Outcome no. 1: understanding the features and their usefulness.
- Outcome no. 2: issues with the interface of the application.
- Outcome no. 3: identify improvements on ease of using the application.
- Outcome no. 4: determine users’ preference to access the features.

<table>
<thead>
<tr>
<th>Table 4 Summary of main findings of the four outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcomes</strong></td>
</tr>
<tr>
<td>Outcome #1: Understanding the features and their</td>
</tr>
<tr>
<td>usefulness.</td>
</tr>
<tr>
<td>Outcome #2: Issues with the interface of the</td>
</tr>
<tr>
<td>application.</td>
</tr>
<tr>
<td>Outcome #3: Identify improvements on ease of using</td>
</tr>
<tr>
<td>the application.</td>
</tr>
<tr>
<td>Outcome #4: Determine users’ predominant preference</td>
</tr>
<tr>
<td>to access the features.</td>
</tr>
</tbody>
</table>

7.1 Outcome no. 1: understanding the features and their usefulness

The following is a list of issues on understanding the features and their applicable usefulness:

- ‘Activities’ feature is confusing, with requests to concert it to a schedule termed ‘daily routine’; this enforces a planned daily routine for a child who can be independently guided by the application to perform the daily routine.
- Test users feel the ‘communication’ feature is useful and ready for use, however the pre-configured audio voice sample lack emotions.
- Test users strongly agreed the ‘life skill’ feature is useful and the step-by-step instructions for each life skill are an important consideration.

The list above is recorded during the ‘interactive review’ process, where the test users were given a walkthrough of the features and then requested to use the features on their own, giving their opinions as they ‘play’ with the features. A summary of the test users’ opinions are captured in Table 5 (points 1, 2, 3). The response shows that all test users feel strongly that ‘communication’ and ‘life skill’ are useful; however the ‘activities’ is not useful.
Table 5  Test users’ responses from usability inspection conducted on AutiSay (%)

<table>
<thead>
<tr>
<th>Questions</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Features and their usefulness:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  ‘Activities’ feature is understandable and useful.</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>2  ‘Communication’ feature is understandable and useful.</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3  ‘Life Skill’ feature is understandable and useful.</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Application interface:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4  The titles and headings are clear</td>
<td>40</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5  The vocabulary is familiar for the children</td>
<td>40</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6  Is the order of layout logical</td>
<td>20</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7  The app has a consistent layout</td>
<td>20</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8  The layout is cluttered</td>
<td>0</td>
<td>0</td>
<td>40</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td><strong>Ease of using the application:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9  It is easy to configure contents</td>
<td>20</td>
<td>40</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10 Is the app ready for the child to use</td>
<td>0</td>
<td>60</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

7.2  Outcome no. 2: issues with the interface of the application

The interface is on text, media and layout. Issues with the interface are mostly identified during the ‘feature inspection’ methodology.

- The focus on text is the use of terms to label features, whether test users can understand what each feature will accomplish simply by title and familiarity of the vocabulary. Table 5 (points 4, 5) shows test users veer towards agreeing that the terms used are understandable and the vocabulary is familiar. However, the therapist did not respond to the question directly and raised the following: text should be bigger and provide instructions on how to use the application. It is unclear if the instructions are meant for the parent, child modes or both. This needs to be explored.

- Responses on media (picture and sound) are similar to the responses for text. Most parents agree or strongly agree that the picture image is of appropriate quality. There is also request to incorporate video capture.

- Responses on the interface layout are diverse, drawing no correlation on the response between the different types of test users. Responses are mostly neutral (neither) or no response. Table 5 (points 6, 7 and 8) is a summary of the responses. One reason for the diversity may be that parents have responded they could not give an opinion until they can observe their children using the application; however, they also feel that their children can be trained to use the application, therefore layout is not a mitigating consideration; implying that layout becomes familiar with repeated use.
7.3 Outcome no. 3: identify improvements on ease of using the application

For ease of using the application, the parents agree it is relatively easy to configure contents. Table 5 (points 9, 10) is a summary of the response. The response to the second question (Table 5, point 10) is of particular interest as the parents generally feel that the application is ready for child use, implying that they feel that their children can possibly use the application in its current form. This correlates to the response in Outcome #2, where they feel that the layout is not a mitigating factor as their children will be able to get use to using the application with repeated use.

7.4 Outcome no. 4: determine users’ predominant preference to access the features

Thus far, test users have been using an IOS version for the usability inspection. An alternate version was created for Android devices and test users were given a walkthrough on the Android version. The contents and the instructions to configure both versions are similar. The only difference is the method of accessing the application. The IOS version integrates all the features under one icon and the Android version separates the features in different icons. Figure 6 shows the difference in accessing the features. The parents predominantly prefer the IOS version while the therapist prefers the Android version. The reason given by the parents for this preference is similar, i.e., they prefer all features to be available from one screen layout. However, due to the small number of test users, this result is inconclusive and further inspections or testing should be conducted to determine which version should be developed further.

Figure 6 (a) The IOS version allows for all features to be accessed via one icon (b) The Android version has separate icons to access each feature

8 Conclusions

The goal of developing a mobile communication tool for children with ASD is achieved to the extent that AutiSay may be introduced to the centres for trial and adoption.
Although 60% of the parents on the usability inspection feel that AutiSay, in its current form, is ready for child use, there is scope for improvements, especially in addressing the need to incorporate a ‘daily routine’ feature. Much of its design is based on reviewed literature on the learning characteristics common to ASD, guidelines recommended by professional bodies and the methodology employed by SMARTER. There is emphasis on applying PECS, the use of common and familiar terms/classifications, and incorporating a speaking voice for the child.

A usability inspection was developed and conducted on AutiSay with a group comprising mainly parents with autistic children and a therapist with experience in managing the development of autistic children in regular schools. There is difficulty to access statistics on ASD in the country and from Table 2, only 11 participants meet the criteria and from this, five agree to participate in the inspection. The outcomes show varying differences in opinions between the parents and the therapist. Since it is a small group of test users, the findings of the outcomes are not conclusive and hence further usability inspections with different groups of test users are required to study the anomaly. The outcomes also highlighted several ways to enhance the application such as replacing ‘activities’ with a ‘daily routine’ feature.

There is also potential to further the usability inspection methodology developed for AutiSay, to be accepted for boarder use on applications in the assistive technologies domain. In the first half of the methodology, the author coined the term ‘interactive review’ to conduct a review of the features while the second half is based on adapting two known methods, feature inspection and cognitive walkthrough.

Finally, it should be noted that AutiSay is an assistive tool to support the work of professionals and caregivers with a focus on children who are non-verbal, display poor vocabulary, have limited use of language, difficulty expressing needs and difficulty with conversations.

References


Notes

1 TEACCH® – Treatment and Education of Autistic and Related Communication Handicapped Children.
2 Conversation with Lim, M. and Harbison, M., BAG Networks’ Head Office, 26 July 2013.
4 iPrompts® is an application developed by HandHold Adaptive, LLC, to provide visual support to individuals with autism spectrum disorders (ASDs). The first version released in 2009 for IOS was the application used for the study.