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Interaction Design Principles for Edutainment Systems: Enhancing the Communication Skills of Children with Autism Spectrum Disorders

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Abstract

Owing to deterioration in communication, approximately 50% of individuals diagnosed with Autism face challenges in developing functional languages. To assist these individuals become more relaxed and comfortable during these activities, installed educational games on mobile devices can be used. Although there are many new mobile applications available for individuals with Autism, they are difficult to use; particularly in terms of user-interface design. An analysis of existing apps developed for children with autism shows that app design principles are projected according to interaction design (IxD) which fulfills the users' requirements in a more efficient way. The analysis involved five applications and pointed out fifteen suggestions regarding the design principles. This paper presents the suggested recommendations for the design and development of prototype apps for autistic children. It introduces edutainment systems design principles, which are designed to assist in the development of communication skills in children diagnosed with Autism-spectrum disorders.

Key words: Autism Spectrum Disorders, Interaction Design Principles, Enhancing Communication Skills, Children, Edutainment

1. INTRODUCTION

Autism is indicated by three symptoms. The first is challenges or difficulties faced in social interactions in terms of personal emotional expressions, and understanding or recognizing other people's emotions. The second is communication, that is the use of verbal and non-verbal languages; and the third is pattern of repetitive or restricted behaviors which can be linked to new environmental adaptation (Schwenck and Freitag, 2014). Individuals with Autism Spectrum Disorders (ASD) exhibit delay in the development of language and speech (Achmadi et al., 2014). A child with these symptoms will exhibit difficulties in learning and participating in an educational atmosphere unless the conditions are addressed early (Hansen et al., 2014). Numerous techniques and treatments are utilized today to assist children with ASD in learning. These methods includes several language or speech therapy, assistive technology, medications, music therapy, sensory integration therapy, visual schedules, holding therapy, gentle teaching, and vitamin supplements (Verschuur et al., 2013). Several studies have shown that children with ASD can develop the ability to communicate and learn using 'assistive technology (Mustika et al., 2014).

A proper educational environment for assisting or promoting learning activities outside the classroom can be provided using mobile technologies. The use of mobile devices for learning could expand the environment or scope of learning at all times and at all places. This concept has been welcomed in the description education in the future (Zain et al., 2013; Hussain et al., 2016). Modern developments in mobile applications for ASD defective children using some of the existing mobile applications have shown that mobile information and communication technologies (ICTs) could encourage and boost participation in social environments and educational environments. These applications are tablets, Apple computers, and iPads (Mintz, 2013).

2. EDUTAINMENT FOR AUTISM

Edutainment refers to the use of video games and entertainment for educational purposes (Saleh et al., 2014). Autistic children tend to be more receptive to playing games on mobile devices due to the touch screen interface and the portable size of the device. These features provide intuitive interaction, thereby, helping children focus (Petersen et al., 2014). Researches have also shown that most autistic individuals, possess high visual perceptual skills (Mazurek and Wenstrup, 2013).

Again, studies have proven that autistic kids utilize a great amount of their time on playing games and other electronic media (Mazurek and Engelhardt, 2013). Edutainment games offer concepts for learning in interactive ways, hence, helping children with Autism learn, especially in cases when multimedia features are combined with tangible interfaces (Saleh et al., 2013).

3. DISABILITIES OF CHILDREN WITH AUTISM

Approximately 50% of individuals exhibiting this disorder possess a slow development of functional languages due to communication downturn (Ribeiro et al., 2014). Moreover, communication and interaction with autistic individuals (children) is difficult due to insufficient verbal and nonverbal communication ability (Aziz et al., 2014).

Children with ASD can learn while playing using technological devices which helps to capture their attention (Dehkordi and Rias, 2014). To help these children become comfortable and relaxed during these activities, educational games on mobile devices can be used (Ribeiro et al., 2014). This technique used in learning has been widely introduced among children with ASD (Petersen et al., 2014). However, this approach also comes with problems. Specifically, the existing mobile applications developed as learning aids for people with Autism are difficult to use (Lyan et al., 2015 ; Hussain et al., 2016). The user interface design brings about the challenges, with its limited features including icons with fixed sizes and a display which presents all of the associated vocabulary on the same screen. Learning process will become easier and more successful for some children if fewer and larger icons are displayed on the screen (Xin and Leonard, 2014).

Majority of the existing applications in the domain of communication are intended to develop the vocabulary skills of autistic children. However, the applications do not focus on improving communications skills which can be achieved if an interactive process is embraced (Ribeiro et al., 2014). Furthermore, applications that are aimed at improving communication skills possess very complicated systems having large vocabularies which function as a type of text to speech program for higher functioning non-verbal autistic individuals and other non-verbal disorders (Nancy et al., 2014 ; Hutchison, 2014).

4. INTERACTION DESIGN

Interaction design (IxD) is the discipline of designing interactive products to support people in their everyday lives. It defines the behaviour of systems and is concerned with form and content, as related to system behaviour and user input (Preece et al., 2007). IxD consists of three dimensions; the form, the behaviour, and the content (as shown in Figure 1).

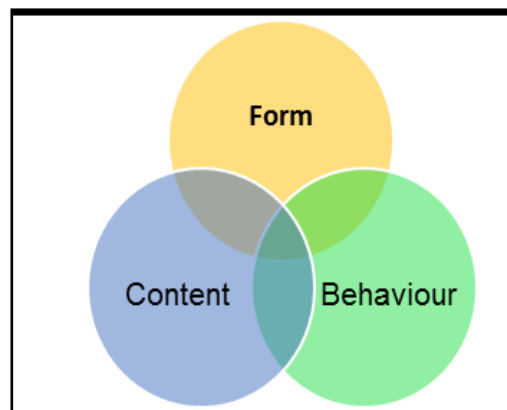


Figure 1. IxD dimensions with Form, Content, and Behaviour

The form is the interface physical layout which includes fonts, colours, buttons, figure, and labels. The Content represents what is presented to the user, and the behaviour refers to the manner in which the content is presented to the user. The behaviour is also associated with the user's experience as well as feelings after accessing the content (Aziz et al., 2013). Although this definition can be applied to many design disciplines, the precise focus on content, form, and behaviour will differ depending on the design (Cooper et al., 2007). Furthermore, it is implicitly comprehended that the objective of interaction design is to generate good use qualities. This depends on the design scope or domain. Productivity tools are generally good as long as the users' professional goals are supported without going against their personal goals (Löwgren, 2001).

Interaction design should be placed highly in a product for its core interface, features, and functionality (Petersen et al., 2014). A developer should follow interaction design principles closely, especially for mobile applications. Thus, the layout and the interface would be able to drive the participants to use the prototype confidently (Petersen et al., 2014). Moreover, "interaction designers strive to create meaningful relationships between people and the products and services that they use, from computers to mobile devices to appliances and beyond" (Alves, 2013).

Corrective measures to support autistic individuals typically begin immediately after diagnosis. This process often consist of the use of a wide variety of visual tools. These artifacts draw on images, text, and tangible objects to represent both abstract and concrete real-world concepts. Utilization of these visual artifacts have proven to minimize the symptoms related with cognitive, social disabilities, and communication; specifically for autistic individuals (Cohen and Sloan, 2007). Educational games installed on mobile devices promote relaxation and comfort during learning activities for these children (Ribeiro et al., 2014). Educational games also presents concepts of learning in an interactive fashion and hence, assist autistic children in learning (especially when multimedia features are combined with tangible interfaces) (Saleh et al., 2013).

However, this approach has some drawbacks of its own. Specifically, existing mobile applications intended to assist learning for autistic individuals are difficult to use. These difficulties are brought about by the design of the user interface, which has limited features (Lyan et al, 2015). For general game play, the developer must consider ease of use for people with Autism, as they require a certain level of difficulty (Barry et al., 2008). Hence, the educational software design technique for autistic individuals must adapt specifically to the needs of those it was aimed for (Shields, n.d.). At the beginning of this paper, it was proven that learners with Autism are attracted to technology.

However, there is a need for a revised interface design for optimal benefits and opportunities, and also to facilitate learning and understanding for special need learners (Barry and Pitt, 2006). Presently, the design principles associated with interaction design for cognitive impairment are general and not closely or sufficiently associated with the needs of autistic children (Vaishnavi and Kuechler, 2007). In this current paper, Interaction Design presents a solution for envisioning how design principles can be utilized for application development to improve communication skills in autistic children (children with ASD).

5. RESEARCH METHODOLOGY

The research activities were performed by coming up with significant suggestions. Next, related works were reviewed to comprehend the existing mobile application design. As reviewed in related works, the analysis of the current apps was performed to deduce the appropriate and significant design principles of the edutainment app for autistic children with communication challenges based on interaction design (IxD). The final specific design principles will be presented in the concluding part of the paper. The detailed research design of this paper which is based on the general design science methodology, is presented in Figure 2.

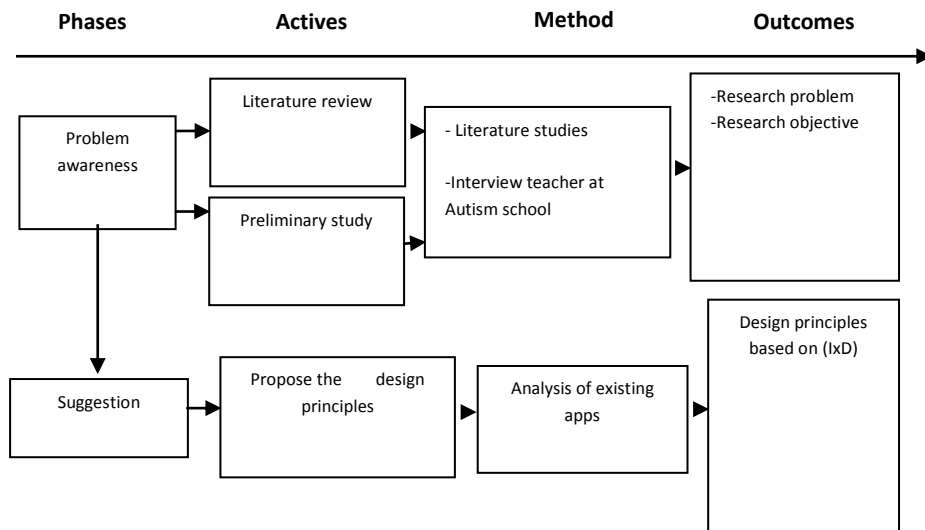


Figure 2. The Science Methodology of Design Research.

6. ANALYSIS OF EXISTING APPS FOR AUTISTIC CHILDREN

To maximize the probability of achieving success in learning for children with ASD, the app design (Edutainment app) for children with ASD need to meet some requirements (Hussain et al., 2015; Mkpjoigu and Hashim, 2016). Best design principles or practices can be applied as well to assist in this development process (Kerssens-van Drongelen and Cooke, 1997; Hussain and Mkpjoigu, 2015). Therefore, this paper analysed the existing apps for individuals with ASD, which are iCanLearn, AAC speech communicator, CommApp, Proloquo2Go App, and TapToTalk. The apps are analysed based on their merits and demerits (Khan et al., 2013; Lyan et al., 2015).

From the analysis of the existing apps, app design principles are proposed based on interaction design (IxD) which would fulfil the users' requirements or needs in a more efficient manner (Mkpojiogu and Hashim, 2016). The principles are made up of high level design goals and objectives which guide the decisions made during the design stage in the life cycle of the app development. The principles also presents unambiguous statements on particular conceptual decisions, that should present the needs relating to physical artifacts when followed (Ahmad, 2013).

The apps analysed in this paper were selected from the Android and the iPhone domain which are both currently utilized by autistic individuals. This analysis will assist an app designer in numerous ways (Dehkordi and Rias, 2014; Ahmad, 2013; Khan et al., 2013), inter alia:

- Identifying the existing products' aspects or features which need improvement by either including additional features to facilitate their use and improve comfort during use, or by modifying their appearance to be more appealing to a target group.
- Proposing or projecting design principles for an application, leading to a more efficient fulfillment of the users' requirements.
- Identifying ideas or technologies which are applicable or transferable to a modern area or function.

Table 1. Proposed design principles for autistic children based on interaction design (IxD)

Dimension	Design Principles	Suitable Design
FORM	1. User Interface	Designed to be simple, without much visual stimuli, in order to maximize the chance of concentration, comprehension and learning of the children
	2. Number of pictures	In each page, the number of pictures should be within the acceptable limit
	3. Screen size	The screen size of the images should be made very large to make it easier for the users to see the items and to enable them to correctly press/tap each item on the screen without accidentally hitting another icon/button
	4. Icon	The icon of the home page should be easily distinguished
	5. Colour	An alternative colour should be used since, often, the black colour is found to be repulsive
CONTENT	6. Guide the user through the app	To guide the user through the app, a caregiver should be made available
	7. Admin section	The admin section should be protected with a password
	8. Picture Exchange Communication System	Communication should be based on the Picture Exchange communication System (PECS), which uses images specifically developed for children with communication impairments
	9. Audio	The audio aspects should correspond with the images. It should also be user-friendly and in an appropriate number
	10. Language	The language used in this app should be given consideration
	11. Upload photo	There should be an option for uploading photographs.
BEHAVIOUR	12. Pronunciation	There should be a function enabling the pronunciation of the completely formulated sentence
	13. Evaluating parameter	There should be some evaluating parameter in the App to measure the child's growth
	14. Image life	Having images identical to real life objects facilitates easier recognition and allows children to learn more efficiently and effectively
	15. Navigation	There should be simple navigation buttons

7. DESIGN PRINCIPLE OF EDUTAINMENT APPS FOR AUTISTIC CHILDREN

From the analysis of the existing apps, this paper presents proposed principles for a more efficient design of new edutainment systems based on IxD. The design will merge the advantages of each application, hence avoiding current issues or challenges possessed by each. Also, design decisions will be presented for creating apps which are more appropriate for the target group's requirements or needs. This paper recommends the following as the proposed design principles for autistic children based on IxD (refer to Table 1).

As presented on Table 1, all three dimensions have been addressed. The form dimension presents five elements with their specific design styles. The elements are the user interface, the screen size, the number of pictures, the colour, and the icon. The content dimension has seven elements and design styles. They are a user guide through the app, PECS, admin section, audio, language, pronunciation, and upload photo. Finally, the behaviour dimension comprises of three elements as well as their suitable styles. The elements for the behaviour dimension are evaluating parameter, navigation, and image life. This paper proposes that all the specified design principles for the three dimensions be considered when developing or designing an Edutainment app which is intended to improve the communication skills of children with ASD, and hence, leading to greater learning success and user satisfaction in the autistic user community.

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