Design and Development of an Educational App for Children with Autism

Yeyu WANG A[a],
Xiuhan WU[a],
Luying XIONG[a]
Feng-Kuang Chiang[*a]
[a]*School of Educational Technology, Faculty of Education, Beijing Normal University, China*
*fkchiang@bnu.edu.cn

Abstract: Children with Autism Spectrum Disorders (ASDs) have three main symptoms; serious verbal and nonverbal barriers, social difficulties and stereotyped behaviors, as well as restricted interests. To improve the sociability of children with ASDs, more and more researchers and computer technicians are developing and designing educational apps to assist them. This application uses simple scenarios from real life with social games to increase their interest in verbal communication. It is proved to be effective according to feedback from professional researchers and experienced teachers in the domain of special education.

Keywords: Autism Spectrum Disorders (ASDs), app design, social skills, verbal communication

1. Introduction

According to the American Psychiatric Association (APA) (2000), children with ASDs are marked by pervasive developmental disorders: serious verbal and nonverbal barriers, social difficulties and stereotyped behaviors, as well as restricted interests. Thus, social interaction disorders and verbal communication barriers are typical symptoms of ASDs, which are detrimental to the mental growth and social communication of children.

Nowadays, therapy for ASDs in China focuses on medication and traditional behavioral therapy, which is a huge financial burden for families with autistic children. However, in the last few years, researchers all over the world have focused on a new form of treatment using educational apps based on the mobile devices. In the past five years, the amount of research has increased every year. The educational apps assisting children with ASDs are not only effective but also potential for the future (Aziz et al., 2014).

This paper illuminates the design idea of the app with related theories supporting and the experiment to evaluate the effectiveness of the function aiming at improving the vocal communication of children with ASDs.

2. BLESS Design Approach

On the ground of the ASDs literatures we found and the research conducted by related scholars, we present BLESS-- a series of design principles aiming at enhancing the social communication of

children with ASDs. The BLESS emphasizes the five aspects of app design: Briefness, Linguistic, Entertainment, Selectable and Scenarized. The theory and design of App is shown in Table 1:

Table 1 Summarization of BLESS Design Principles

BLESS Design Principles	APP Structure	Applied theory	Design Details
Briefness	User interface design	The feature of children with ASDs: focusing too much on the details(Meng, 2008; Frith, 1989)	This app uses simple interface to avoid complex stimulations. All the scenes are painted in 2D pictures by Photoshop.
Linguistic	Object presenting	Picture Exchange Communication System (PECS) and Augmentative & Alternative Communication (AAC) (Aziz et al., 2014; Min & Wei, 2013; Yufu et al., 2010)	This app combines AAC and PECS using pictures to assist children with ASDs to make social communication. Additionally, audio instructions and verbal communications are emphasized for the purpose of promoting social ability. The audio instructions can be the standard model for children with ASDs to communicate and correct the wrong pronunciation.
Engagement	Game module	Effective game intervention (Yingmei, 2011)	This app uses social games to improve social communication ability, which is attractive for the children.
		Applied Behavior Analysis (ABA) (Shukla-Mehta & Callahan, 2009; Low, 2014; Qiong, 2014)	Using medals as rewards to reinforce the right behavior and trying to reduce the possibility of the improper response.
		The feature of children with ASDs: echolalia in verbal communication.	Using echolalia to encourage children with ASDs in imitative learning and leading them to make verbal communication, which is easy for the children to achieve the goals.
Selectable	Overall structure	Flexibility of educational app for children with ASDs(Rasche, 2013; Aziz, 2014; Shukla-Mehta, Miller & Callahan,, 2009; Hayes et. al, 2010; Ludlow, Wilkins & Heaton, 2006)	In the settings, the color selection and character selection can be flexible according to the preference of children with ASDs.
Scenarized	Main Scene	Generalization	The scenes in the app are abstracted from the daily life, which helps the

			children with ASDs to apply the social skills learned from the app in daily life more easily and generally.

3. Approach and Method

3.1. Design and Development

3.1.1. Overall Structure

This app contains two sections: the parent's section and the children's section. The two parts are closely related and interdependent in function. Because of the differences between children with ASDs, the variety of selections is considered particularly important during the process of design (Rasche, 2013; Aziz, 2014; Shukla-Mehta, Miller & Callahan,, 2009; Hayes et. al, 2010; Ludlow, Wilkins & Heaton, 2006), especially for the color preference. In the parent's part, parents can adjust the style of the interfaces and other factors which can influence the interests of the children, such as "Color Style," "Character," and so on (Figure 1). For the rewarded medal, there are many different styles, which can cater to different children's taste as shown in Figure 2.

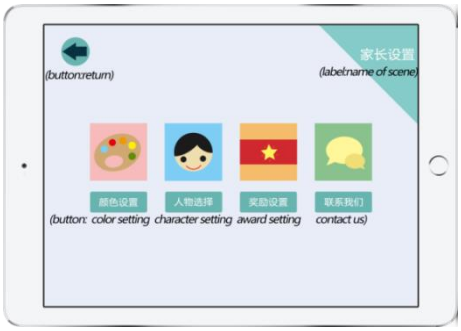

Figure 1. Interface of Parent's Section

Figure 2. Rewarded Medal

After entering the scene, the object presenting module and the game module are available. The object presenting module includes simple introductions of some common goods in daily life as well as the standard pronunciations of the objects. The game interface can help improve the social skills of children with ASDs through the social games, which requires the children with ASDs to satisfy the virtual character in the app.

3.1.2. User Interface Design

Meng (2008) put forward that the children with high-functioning forms of autism perform well on the Embedded Figures Test, which indicates that the children with autism pay more attention to details. Frith (1989) proposed the Weak Central Coherence Theory, which stated that normal children or adults pay more attention to the Gestalt (whole) structure, while the children with ASDs are just the opposite. They lack "built-in propensity," which is normal for average people. They cannot integrate extensive stimulation. Based on this theory, this app is designed according to the principle of simplification, using simplified scenes and objects related to daily life, such as dining room, living room and bedroom. This design helps the children with ASDs to apply the social skills learned from

the app in daily life more easily and generally. The Figure 3 is the interface of scene selection.

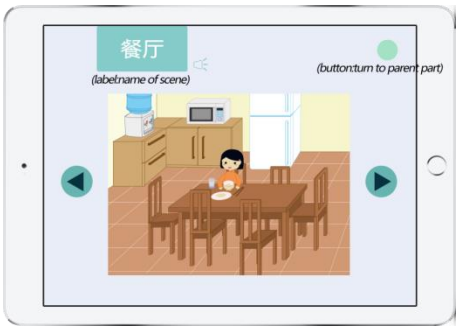

Figure 3. Interface of Scene Selection

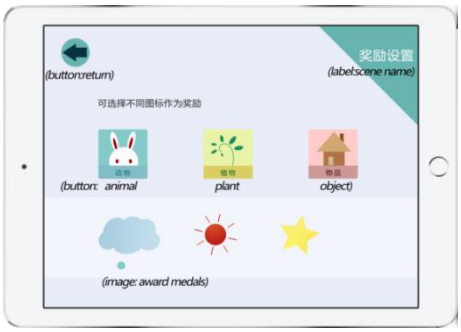

Figure 4 Game Module

3.1.3. Main Scene Design

3.1.3.1. Object Presentation

Augmentative & Alternative Communication (AAC) is a way to increase (no problem) the form of input so as to help children with ASDs to understand social behaviors of others and enhance initiative social communication (Aziz et al., 2014). AAC is used in Early Intervention Programs (EIP), which help children with ASDs awaken their potential. To increase the form of input information, AAC also utilizes Picture Exchange Communication System (PECS). PECS is a communication skill for children with ASDs, who have limited verbal and nonverbal social communication skills that use pictures to help them communicate spontaneously (Min & Wei, 2013). PECS is proven to be effective in the intervention of children with ASDs and significantly improves the children's emotional expression and control (Yufu et al., 2010). An app called Mocotos uses a Picture Exchange Communication System (PECS).

Based on the purpose of improving the verbal communication skills of children with ASDs, this app emphasizes verbal communication and uses audio instructions as well as pictures. The audio instructions can provide an example of common social communication and also correct the mistakes in pronunciation.

3.1.3.2.Game Module

Although children with ASDs are usually less skilled players compared to average children, the current level of children with ASDs offers the possibility for game interventions (Yingmei, 2011). Children with ASDs improved in social communication during game intervention with researchers. At the same time, the ceremonial behaviors are significantly reduced. Therefore, it is effective to use games in the therapy of children with ASDs and improve their social skills. In the game module, the app focuses on guiding children with ASDs to have daily social communication with the virtual character, such as asking for help, making invitations as shown in Figure 4. The social communication is based on a specific scene, which helps children to use the social communication strategy in real life. Additionally, this app uses the echolalia features of children with ASDs, encouraging them to learn by imitating the right example in the app and promoting their social ability.

The engagement is vital for the games based on the computer or mobile terminal, which contains a significant concept—"flow" firstly proposed by Csikszentmihalyi (1990). It should be

moderately difficult but keep challenges instead of being too difficult (lose faith to achieve the goal) or too easy (lose the interest of involve with the game). In this app, the difficulty levels of the social game can be scaled upward. In the first level, the virtual character in the app makes direct and simple requests towards the children with ASDs, like asking for an apple which is clearly shown on the table. On harder levels, children with ASDs must find milk, which implies that they open the refrigerator first. So the higher the level is, the more complex the social communications can be. However, the change of the level gradually comes, which will make it easier for the children to accept the difficult level. Some examples of feedback in the different levels are as follow.

- Stage 1: the virtual character asks for an apple.
  - If the children with ASDs reply for the social requirement and satisfy the virtual character, they will get encouragement like "Thanks! It is so sweet of you!"
  - If they don't, they will get an instruction like "I'm sorry. I don't like anything else except apples. Could you please give me an apple?"
- Stage 2: the virtual character asks for something to drink.
  - If the children with ASDs reply for the social requirement and satisfy the virtual character, they will get encouragement like "Thanks for the milk!"
  - If they don't, they will get an instruction like "I'm sorry. But I do want to have something to drink. Could you please open the refrigerator and find something to drink?"

When children with ASDs finish the tasks according to the requirements of the app, the rewarded medal will be shown to reinforce the right behavior of children with ASDs. This design combines with ABA, which is proven to be effective in promoting social abilities of children with ASDs by using the pattern of setting an example and giving rewards (Shukla-Mehta & Callahan, 2009; Low, 2014). Qiong (2014) points out two rules of giving reinforcement: giving the preferred reinforcement and immediate feedback and strengthening of right movement. This app follows the rules stated by Peng, allowing the parents to set the type of medal according to their children's preferences.

4. Research Design

The research can be conducted from three aspects: effectiveness, reliability and validity. Technicians and researchers will evaluate the app in the profession field. Children with autism, teachers and parents are the main participants in the experiment. Case study and observational method will be mainly used in the research of children, while interviewing method will be used in the research of teachers and parents. Children with autism will use the application by themselves. Meanwhile researchers will record children's emotional responses, task performances and other behaviors. Invisible buttons behind interfaces will accurately count clicking times in each part of the interface, used to analyze which parts catch children's attention most. Parents and teachers will also use the application and give feedbacks as the references for further improvement of application.

5. Conclusion

The design and development of APP aimed at improving the social skills of children with ASDs by focusing on satisfying their needs with increased flexibility. At present, the app has achieved basic

functionality. With assessment by professional researchers, teachers in the special educational field, and parents of children with ASDs, the effectiveness of app has been demonstrated. However, it has also been shown there is room for further optimization and functions in a future version.

Acknowledgements

Our work is supported by the Fundamental Research Funds for the National Engineering Research Center of Educational Technology, and Faculty of Education in Beijing Normal University (CXTD201401).

References

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders, text revision (4th ed.).* Washington, DC: American Psychiatric Association.

Aziz, M. Z., Abdullah, S. A., Adnan, S. F., & Mazalan, L. (2014). Educational App for Children with Autism Spectrum Disorders (ASDs). *Procedia Computer Science*, *42*, 70-77

Ludlow, A. K., Wilkins, A. J., & Heaton, P. (2006). The effect of coloured overlays on reading ability in children with autism. *Journal of Autism and Developmental Disorders, 36*(4), 507-516.

Shukla-Mehta, S., Miller, T., & Callahan, K. J. (2009). Evaluating the effectiveness of video instruction on social and communication skills training for children with autism spectrum disorders: A review of the literature. *Focus on Autism and Other Developmental Disabilities*.

Hayes, G. R., Hirano, S., Marcu, G., Monibi, M., Nguyen, D. H., & Yeganyan, M. (2010). Interactive visual supports for children with autism. *Personal and ubiquitous computing*, *14*(7), 663-680.

Rasche, N. (2013). *Design strategy for the development of applications for autism instruction* (Doctoral dissertation, PURDUE UNIVERSITY).

Meng, Z. (2008). An Experimental Study of Cognitive Style in Children with High-functioning Autism. *(Master's thesis, East China Normal University)*.

Frith, U. (1989). Autism: Explaining the enigma.

Min, L. & Wei, F. (2013). Literature Review of PECS in the Intervention of Children with Autism. *Journal of Suihua University*, *33*(10), 93-98.

Yufu, Z. , Hongmei, T. , Yan, H. , Bin, Z. , Li, Y. , Xianlan, L. & Zhi, Y. (2010). Experimental study of PECS effect on autistic children's emotional cognition. *Chongqing Medical Journal*, *39*(13), 1

Yingmei, M. (2011). An Overview of Foreign Researches into the Play-based Intervention of Autistic Children. *Chinese Journal of Special Education*, *8*, 64-66.

Csikszentmihalyi, M. Flow: The Psychology of Optimal Experience. New York: Harper & Row (1990).

Low, A. (2014). *Utilizing the iPad to teach students with autism self-management* (Doctoral dissertation, CALIFORNIA STATE UNIVERSITY, FULLERTON).

Qiong, P. (2014). Suggestion of Using Reinforcement in Learning Activities of Children with Autism. *Journal of Mental Health in Primary School and Secondary School,* (4), 39-40.

Shukla-Mehta, S., Miller, T., & Callahan, K. J. (2009). Evaluating the effectiveness of video instruction on social and communication skills training for children with autism spectrum disorders: A review of the literature. *Focus on Autism and Other Developmental Disabilities*.