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ประสิทธิภาพของการใช้หนังสือบอกเล่าเรื่องราวทางสังคมในรูปแบบอิเล็กทรอนิกส์เสมือนจริง Augmented Reality (AR) เพื่อลดพฤติกรรมที่ไม่เหมาะสมของเด็กออทิสติก

The Effectiveness of Using Electronics Augmented Reality (AR) Based Social Story Book to Decrease Inappropriate Behaviors of Children with Autism

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อ 1) เพื่อศึกษาพฤติกรรมที่ไม่เหมาะสมของเด็กออทิสติกและ 2) เพื่อตรวจสอบประสิทธิภาพของหนังสือบอกเล่าเรื่องราวทางสังคมในรูปแบบหนังสืออิเล็กทรอนิกส์เสมือนจริง (AR) เพื่อลดพฤติกรรมที่ไม่เหมาะสมของเด็กออทิสติก กลุ่มเป้าหมายเป็นแบบเฉพาะเจาะจงซึ่งเป็นเด็กออทิสติก จำนวน 5 คน เป็นการวิจัยกลุ่มตัวอย่างเดี่ยว (Single subject design) A-B-A design งานวิจัยได้เริ่มจากการสำรวจพฤติกรรมด้านทักษะทางสังคมที่เป็นปัญหาของเด็กออทิสติกทั้ง 5 คนแล้วนำไปวิเคราะห์ถูกแต่งขึ้นในรูปแบบหนังสือบอกเล่าเรื่องราวทางสังคม นำไปพัฒนาต่อเป็นหนังสืออิเล็กทรอนิกส์เสมือนจริง (AR) จำนวนห้าเล่ม (หนึ่งเรื่องต่อเด็กหนึ่งคน) ปัญหาพฤติกรรมด้านทักษะทางสังคมของเด็กออทิสติก ได้แก่ 1) คำพูดที่ไม่เหมาะสม 2) ควบคุมอารมณ์ตนเองไม่ได้ 3) ไม่มีความอดทน 4) ไม่มีปฏิสัมพันธ์ทางสังคมกับผู้อื่น และ 5) ไม่สามารถปรับเปลี่ยนกิจวัตรประจำวันที่เกิดขึ้นได้ งานวิจัยใช้วิธีการเก็บรวบรวมข้อมูลในรูปแบบ ABA (Baseline–intervention–withdrawal) ผลการวิจัย พบว่าในภาพรวมการออกแบบหนังสืออิเล็กทรอนิกส์เสมือนจริง (AR) อยู่ในระดับดี (M = 4.30, SD = 0.27) การใช้หนังสืออิเล็กทรอนิกส์เสมือนจริง (AR) ที่สร้างขึ้นนั้นมีความเหมาะสมและมีประสิทธิภาพในการส่งเสริมทักษะทางสังคมและช่วยลดพฤติกรรมที่ไม่เหมาะสมของเด็กออทิสติกได้

คำสำคัญ: หนังสือเสมือนจริง / เด็กออทิสติก / พฤติกรรมที่ไม่เหมาะสม / ทักษะทางสังคม

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Abstract

This research aimed 1) to investigate the inappropriate behaviors of children with autism, 2) to examine the effectiveness of the electronics augmented reality (AR) based social story book used for decreasing the inappropriate autistic behaviors. The target group of this specific study was 5 children with autism. The study adopted a single subject research design, ABA, which involved exploring the social behavioral problems of 5 children with autism, analyzing data and creating social story books, and developing those social story books into 5 electronics augmented reality (AR) based social story books (one story per child). The social behavioral problems of children with autism were 1) speaking inappropriately, 2) being unable to control emotions, 3) being impatient, 4) having difficulties with social interaction, and 5) unwilling to have flexible routine. The data were collected using an ABA research design (Baseline–Intervention–Withdrawal). The research found that the overall quality of augmented reality book design was at good level (M = 4.30, SD = 0.27). It was identified that the use of properly constructed AR book can be effective in promoting the social skills and decreasing the inappropriate behaviors of children with autism.

KEYWORDS: AUGMENTED REALITY (AR) / CHILDREN WITH AUTISM / INAPPROPRIATE BEHAVIOR / SOCIAL SKILLS

Introduction

Generally, most children with autism have social interaction problems with peers such as lack of joint attention, avoid making eye contact, detach themselves from the surroundings, incapable of understanding others and unable to form a relationship with others (Teplin, 1997). Therefore, they are often seen isolated in the worlds of their own and are unable to form emotional bonds with others. As a result, these children with autism are likely to show inappropriate behaviors in terms of not making eye contact and not understanding things that happened well enough (Arrayavinyoo, 2003).

The children with autism often lack appropriate social skills when they need to interact with other people. Learning social skills also helps lower some

behavioral problems (Staley, 2001). Moreover, Swaine (2004) reported that good social skills are important for an autistic child because it helps him/her to develop social understanding. Without learning social skills, an autistic child cannot appropriately interpret others' behavior which leads to miscommunication and lack of relationships with others. Thus, supporting the development of social understanding in an autistic child is necessary (Swaine, 2004).

A social story is one type of children-specific invention for teaching social skills. It helps learners learn social skills through combination of visual and verbal cues. Khantreejitranon (2018) stated that using a social story invention was able to decrease inappropriate behaviors of preschool children with autism. The findings suggested that the use of properly constructed social story book can be effective in promoting the social skills and decreasing the inappropriate behaviors of children with autism. However, each social story book should be applied with caution because of the individual differences in children. Also, the social story book should be designed only for autistic children who exhibit specific inappropriate social behaviors (Khantreejitranon, 2018).

An augmented reality (AR) is defined as a technology in which real world and virtual objects are combined with a simultaneous interaction (Azuma, 1997). Also, the augmented reality (AR) is technology that visually conceptualizes the social stories. The interactive social stories are played using several tangible markers and AR technologies overlays the markers with corresponding virtual images. The new way to interpret social stories demonstrates an improvement of attraction and enhances the effects of social skills invention. Additionally, AR could be created by utilizing and connecting various innovative technologies (e.g. mobile devices, wearable computers, and immersion technologies).

However, like many other innovations, the educational values of AR are not solely based on the use of technologies but closely related to how AR is de signed, implemented, and integrated into formal and informal learning setting. To provide insights into opportunities offered by AR, therefore, the purpose of this article is to present current status, opportunities, and challenges of AR in education.

The electronics augmented reality (AR) based social story book used in the invention followed the guidelines of Gray 2004)), except for the inclusion of visual cues (Pictures) and multiple pages, which are now considered common practice for social (Gray, 2004; Sansosti, Powell-Smith, & Kincaid, 2004). Since good social skills are developed, such a child is more accepted in society (Gray & Garland, 1993). An autistic child needs to know and understand the various emotions as he/she interacts with other people. This helps the child to happily co-exist with others in society. Gray (2004) reported that social stories can help an autistic child to learn expected types of behavior by teaching specific com ponent skills that can be chained together with a larger task. Social stories can be used for variety of purposes. Gray and Garland1993)) stated that numerous uses of social stories included: (a) explaining routines or changes in routines, (b) describing social situations without intimidating, (c) teaching academic skills, (d) teaching social skills, (e) training adaptive skills, and (f) dealing with difficult types of behavior, including emotional expression, aggression, or obsessive behavior. Therefore, the new way to interpret social stories demonstrates an improvement of attraction and enhances effects of social skills invention. The researcher was interested in how AR technology would be in order to visually conceptualize the social stories. The objective of this research was to investigate inappropri-ate types of behavior of children with autism, to design the augmented reality book, and to examine the effects of electronics augmented reality books in

order to promote social skills and decrease inappropriate behaviors in children with autism. The study provided specific instructions describing how electronic augmented reality based social story books should be written. Gray (2004) gave guidelines for implementing social stories as the current study showed that the AR book was an effective teaching tool which developed social skills and helped reduce unexpected behaviors. The study added to the current literature by evaluating the extent to which AR books could effectively reduce inappropriate types of behavior of children with autism.

Research objectives

1. To investigate the inappropriate behaviors of children with autism.

2. To examine the effectiveness of using electronics augmented reality (AR) based social story book to decrease inappropriate autistic behaviors.

Methods

Research design

This research was conducted using an ABA single subject design. The duration of this study was 4 weeks, 5 times per week, for a total of 20 sessions. The study was conducted in three stages as follows: the first stage was administered for 5 sessions (A1 = baseline), the second stage was to use the electronic augmented reality based social story books and token reinforcement for 10 sessions (B = invention), and the third stage was the withdrawal phase for 5 sessions (A2 = withdrawal).

Participants

Five children aged between 9-10 years with a diagnosis of autistic disorder (ASD) were selected from classroom. The participants were autistic children and had impairments in social skills, including inappropriate interactions with

others and behavioral problems in social situations.

The criteria used to select the participants for this study were: (a) diagnosed with ASD, (b) aged between 9 and 10 years, (c) high functioning autism, (d) parent's consent, and (e) teachers' permission to participate in the study.

The first participant was a 9-year-old boy, Nu, whose target behavior was making inappropriate use of language. He was diagnosed as high function autism and had to be treated daily by a speech therapist and a muscle therapist. Also, he was treated with medicine to control his behavior. Nu was the youngest in his family and he had one older brother. Apparently, he always spoke inappropriately in a conversation. For example, when the teacher asked him about the lesson, he spoke things that had no meaning and nonsense. Nu often spoke impolitely with friends and teachers; for instance, saying bad words to people and hurt their feeling. While Nu was studying in classroom, he sometimes shouted about the story that nobody asked him. The teacher had to stop him and bring him back to the lesson. Therefore, Nu's teachers and peers described his behavior as annoying and distracting.

The second participant was a 9-year-old boy, Pe, whose target behavior was unable to control emotions, which led to screaming and being irritable. This behavior often disrupted the activities of both other students and teachers. However, he sometimes showed frustration without knowing the cause. According to his main teacher, his reading comprehension level was equivalent to an intermediate grade. He was well adjusted to school activities, and no challenging behaviors were observed. Pe was selected because he was diagnosed with autism, demonstrated at least first-grade reading skills, and was considered preferring specific teachers. He had a cheerful smile when he was

talking about something that was funny for him.

The third participant was a 10-year-old boy, Sun, whose inappropriate behavior was being impatience. He was unable to wait for anything, and he preferred to be number one in everything. He wanted to be first in any activities. Moreover, he did not often share toys with friends when he played. When he played, he cheerfully smiled. He liked to draw pictures with crayons. Sun had no patience for a long wait. If he couldn't get what he wanted in time, he would be upset and scream. He had a lot of crayons, markers, pencils, and color-magic pens that he took home. According to his main teacher, his conversation skills were good and he could respond to other people. Sun was an intelligent autistic child. He was able to tell a story in pictures. However, Sun did not like when the teacher told him to share his things with friends.

The forth participant was a 10-year-old boy, Tom, whose target behavior was lack of social interaction. He didnot want to do anything, and he preferred to be alone and separate from everyone. Every day, the teacher had to tell him what to do in every step. He was diagnosed with autism and had to be treated daily by a speech therapist and a muscle therapist. Also, he was treated with medicine to control his behavior. He rarely spoke. He did not understand conversations with others, and hardly respond to them. Tom was unable to participate in a conversation, and his speech was generally limited to two-or-three-word utterances. He was able to follow basic instructions, but unable to accomplish self-care needs independently. His academic skills included being able to read more than 300 sight words, writing simple sentences with prompting, and performing three-digit addition without renaming. The teacher noticed that Tom tapped whenever he was happy, that was, whenever any of his expectations associated with his daily routine was fulfilled.

The fifth participant was a 9-year-old boy, Lic, whose target behavior was unable to deal with flexible routine. He liked to do everything with the same schedule and did not like anyone to change it. He was unable to accept changes. When there was a change, he felt sad, cried, shivered and lost control of himself. Sometimes he felt frustrated, especially, in the morning when he was away from his parents. Also, he felt frustrated when his parents picked him up late. Although, the teacher tried to explain to him, he did not understand their conversations, and he could not control his feeling. Lic was unable to participate in a conversation, and often did not respond to a conversation with anyone when the schedule changed. Lic had to be treated with medicine to control his behavior.

Materials

Augmented reality (AR) is described as a technology that integrates real images with virtual objects simultaneously (Azuma, 1997). Hence AR is supporting the real world rather than replacing it with synthetic environment. By creating the magical feeling of a 3d object appearing on top the physical world such as texts, photos, audio, animations, videos and 3-dimensional models (Delello, 2014). AR gains and keeps the attention of the student that is difficult in other form of education (Sirakaya & Cakmak, 2016).

The electronics augmented reality (AR) was used via HP Reveal Program on smartphone. HP Reveal, formerly known as Aurasma, was a free application for iOS and Android devices. It used advance image recognition to blend the real-world with rich interactive content, such as videos and animation. The electronics augmented reality (AR) used to decrease inappropriate behaviors of children with autism were designed in five stories as follow: 1) Manners of speaking, 2) Manners of expression, 3) Manners of waiting, 4) When I come to

school, and 5) Pick me up. The electronics augmented reality (AR) based social story book used in the invention followed the guidelines of Gray (2004), except for the inclusion of visual cues (pictures) and multiple pages, which were now considered common practice for social stories (Sansosti et al., 2004). The AR book contained one cover page and eight instructional pages. Each instructional page had one sentence per page with a colored picture (21 cm x 15 cm) at the center of the page above the sentence. Each child had a different story book.

Figure 1 Electronic augmented reality based social story books

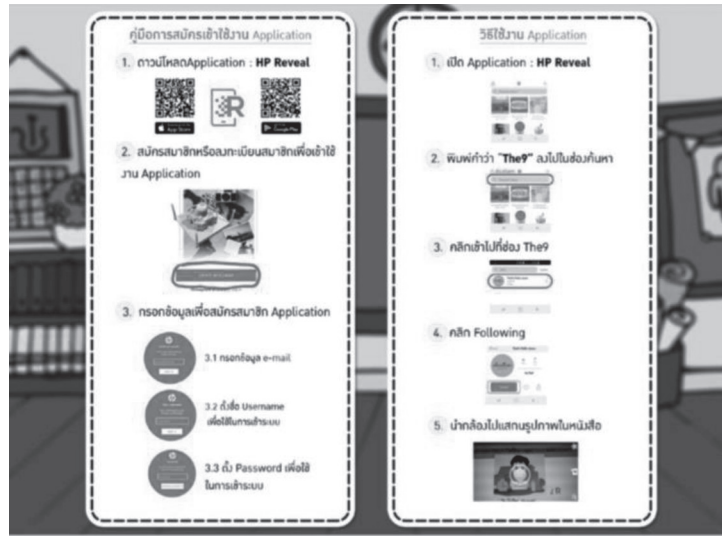

Figure 2 How to use the electronics augmented reality book

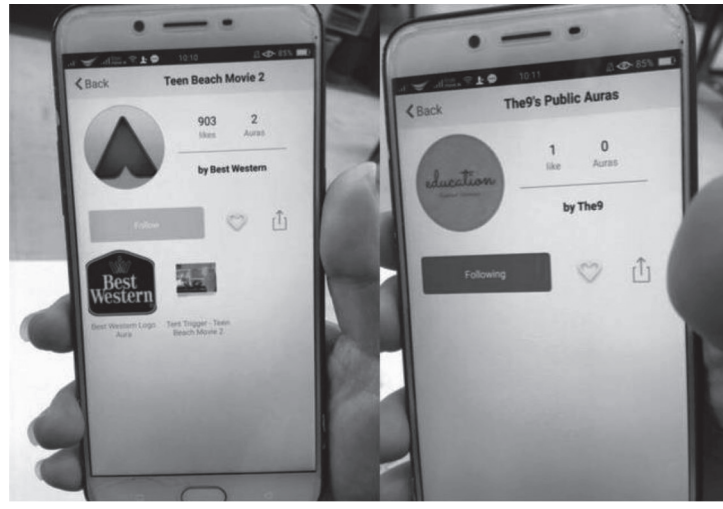

Figure 3 Create account to smartphone

Figure 4 Using use the electronics augmented reality book

Procedures

The research process conducted in three phases. The study of the problematic social skills using survey research methodology was performed in the first phase. The effectiveness of the experimental results using a single subject ABA design was subsequently investigated in the second phase. For the single subject ABA design, the augmented reality based social story books were created in electronic books—with five different stories (one story per child).

A third stage time trial was over 4 weeks, five times per week with a total of 20 times, was performed in the experiment mentioned above. Eventually, a study of the effectiveness of the electronic augmented reality based social story books using survey research methodology to develop the social skills of children with autism was examined in the third phase.

Data collection and inter-rater reliability

A 15-s cues partial interval recording system during 50-min daily observations was used to record the behavior of each participant over 4 weeks. In order to have inter-rater reliability, the researcher and an assistant researcher collected the observational data for each participating child. The assistant researcher coded 80 percent of the observational data for reliability. Inter-rater reliability data was gathered 20 times per child during the study (once a week for 4 weeks), representing 80 percent of the observations. Agreements were calculated by dividing the number of intervals in which the observers agreed by the number of agreements plus disagreements and multiplying by 100. An inter-rater reliability coefficient of 0.80 was required between the coder. For Nu, Pe, Sun, and Lic, the inter-rater reliability was 100 percent, but Tom's inter-rater reliability was 80 percent.

Social validity

The 5-rating-scale assessment form was created to evaluate the quality of the electronics augmented reality invention. There were 9 aspects with total 29 items, including: 1) font/ language (3 items), 2) picture (3 items), 3) voice (3 items), 4) connection (4 items), 5) background (2 items), 6) pattern (2 items), 7) presentation style (3 items), 8) book style (4 items), and 9) augmented reality (AR) (5 items). Data analyses used for this research were frequency, percentage,

mean, and standard deviation. The research found that the overall quality of augmented reality book design was at the good level (M = 4.30, SD = 0.27) and the quality of picture and book style was at the excellent level (M = 4.80, SD = 0.44; M = 4.80, SD = 0.27) respectively.

Results

In the first phase, 5 problematic social skills were identified among five autistic children, consisting of: 1) inappropriate use of language, 2) unable to control emotions, 3) impatience, 4) lack of social interactions, and 5) unwilling to deal with flexible routine.

In the second phase: an augmented reality based social story book was designed in 3 steps. Step 1: the social stories used in the invention were written by following the guidelines of Gray (2004), consisted of one directive sentence, descriptive sentence and perspective sentence which should contain no more than 8 sentences. There were five stories described as follows: 1) Manners of speaking, 2) Manners of expression, 3) Manners of waiting, 4) When I come to school, and 5) Pick me up. Each book should be applied with caution because of individual differences in children. Also, the book should be designed only for children with autism who exhibit specific inappropriate social behaviors. Step 2: the electronics augmented reality (AR) was prepared by using HP Reveal Program on smartphone. Step 3: the quality of the electronics augmented reality invention was evaluated by experts. The research found that the overall quality of the electronics augmented reality invention was at the good level with the average score of 4.30 and the quality of the picture and book style was at the excellent level with the average score of 4.80.

Table 1 The quality of electronics augmented reality (AR) book

Evaluation list	*M*	*SD*	*Level*
1. Font/ Language	3.70	0.44	Good
2. Picture	4.80	0.44	Excellent
3. Voice	3.60	0.54	Good
4. Connection	3.50	0.50	Good
5. Background	3.90	0.22	Good
6. Pattern	4.00	0.00	Good
7. Presentation Style	4.40	0.41	Good
8. Book Style	4.80	0.27	Excellent
9. Augmented Reality (AR)	4.60	0.41	Good
Total	**4.30**	**0.27**	**Good**

Note: N = 5

In the third phase, the researcher studied the effect of the electronic augmented reality based social story books. This research was conducted using an ABA single subject design. The duration of this study was 4 weeks, five times per week, with total 20 sessions. The results of this study showed that the electronics augmented reality intervention could decrease inappropriate behaviors in children with autism. It also revealed that the following implementation of the AR book based social story, Nu, Pe, Sun, Tom, and Lic demonstrated a significant reduction of targeted inappropriate behaviors compared to the baseline (A1) performance. During the invention (B), all five participants' percentage of inappropriate behaviors indicated a slight decrease but remained low. As the withdrawal (A2) continued, the percentage of inappropriate behaviors for Nu, Pe, Sun, and Lic showed a slight decrease, but remained low whereas Tom's percentage of inappropriate behavior indicated a slight increase. Overall, the data showed that during the invention, the five participants demonstrated levels of inappropriate behaviors that

were significantly lower than their baseline performance. The results supported the previous studies which found the reductions in inappropriate behaviors through the use of electronic augmented reality books (Kuttler, Myles, & Carlson, 1998).

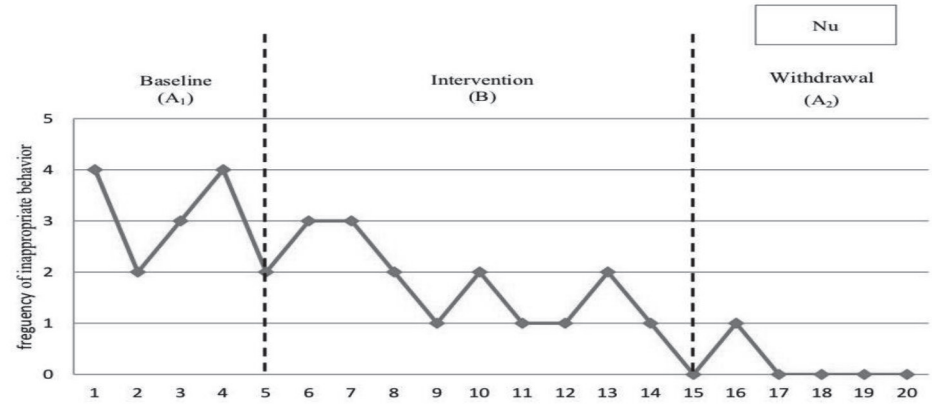

Figure 5 Duration of inappropriate speech (first participant)

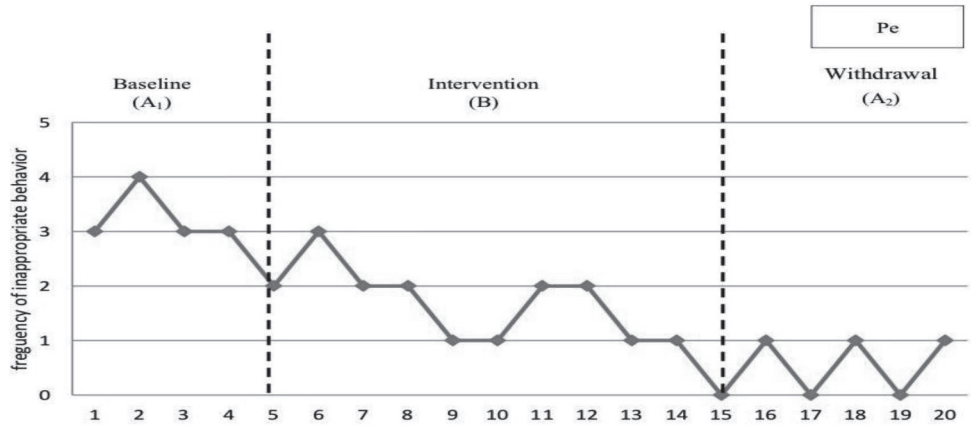

Figure 6 Duration of inappropriate action (second participant)

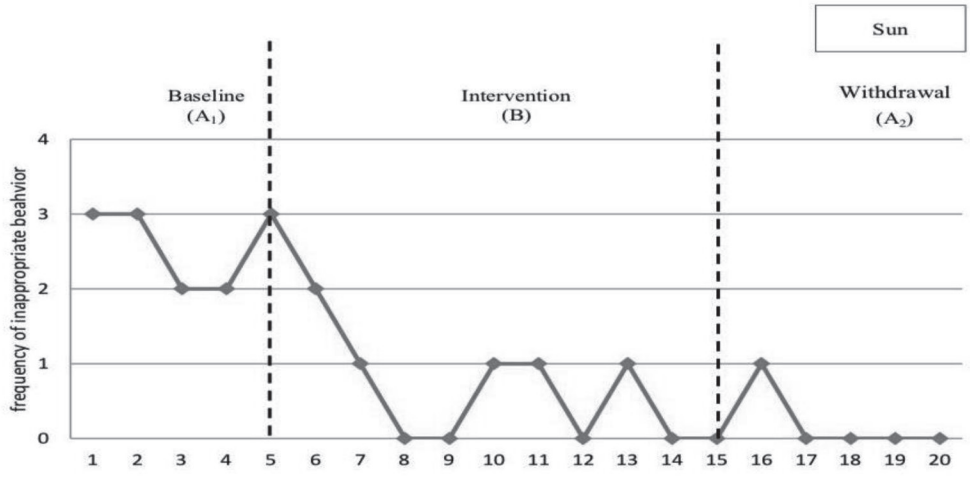

Figure 7 Duration of patience (third participant)

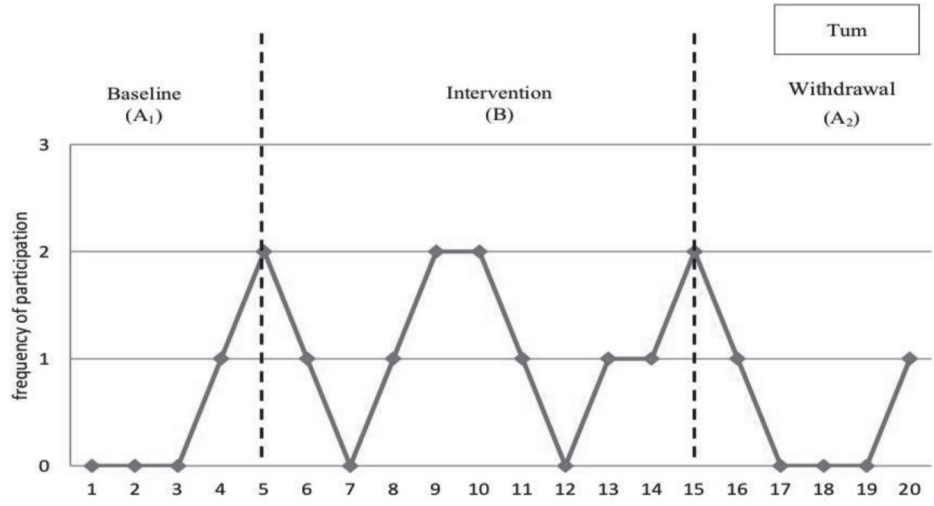

Figure 8 Duration of participation (forth participant)

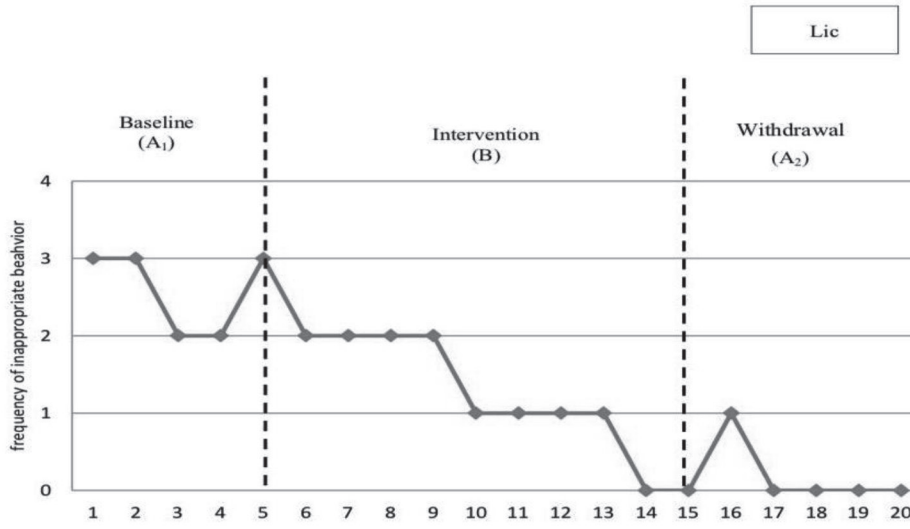

Figure 9 Duration of flexible (fifth participant)

Discussion

Based on observations, the data showed that after the intervention performance, the five participants exhibited levels of inappropriate behavior significantly lower than their baseline performance. Since the researcher gave children the smartphone, they had known how to use the program. It stimulated children's learning and provided entertainment. All participants enjoyed and felt good to be part of using the electronics augmented reality (AR) via HP Reveal Program on smartphone. It was identified that the use of properly constructed AR book can be effective in promoting the social skills and decreasing the inappropriate behaviors of children with autism. This result showed that AR can be effective in increasing achievement. It is thought that simultaneous interaction between virtual objects and real world provided by AR application is effective in reducing assembly time (Azuma, 1997; Caudell & Mizell, 1992). These advantages give insights about its use in applied education. The present study, therefore, was done to understand the effectiveness of the

AR based social stories. The previous studies list the benefits provided by AR use in educational environments. It is known that the use of AR draws not only students' interest and attention on lessons; it also increases their motivation (Delello, 2014; Perez-Lopez, & Contero, 2013). Moreover, AR can be used in solving problems with the simultaneous interaction providing between virtual objects and the real world (Azuma, 1997). For instance, Lin et al. (2016) developed AR technology in educational activities for children with disabilities. The results showed that the AR system could help the school students finish puzzle game activities without teacher's assistance. Performance data indicated that the use of AR technology could enhance learning motivation and frustration tolerance in children with special needs. The study also contributed additional empirical evidence for research in the area of AR technology for special needs. Additionally, using AR based social stories is one of the teaching techniques using children's own experiences or stories. The AR technology combined with simulation and educational tools that can help children understand and learn to behave more appropriately and effectively in their social skills. Involved persons can also integrate social-skill training for primary level of students with autism into the teaching routine with regular students and teachers so that in the future the students with autism can learn and share with regular students in a social network. For example, Sirakaya and Cakmak (2016) developed an AR application that used on student achievement and self-efficacy in vocational education and training. It was found that the use of AR had a positive impact on students' achievement and students' self-efficacy (Sansosti et al., 2004). On the other hand, the use of AR helped learners to complete the assembly process in a shorter time with less support. Therefore, AR offers an important alternative for topics that need learner application and practice. As a result of the tests conducted on the application, Sirakaya and Cakmak (2016) stated that

the AR application is a tool that can be used in teaching (Sansosti et al., 2004).

Limitations and future research

Though this study was planned and designed carefully, there were still several limitations that need to be addressed. Considering the results obtained in this study, following suggestions are offered to guide researchers and application developers in future AR studies:

1. It was concluded in the study that the use of properly constructed AR book can be effective in decreasing the inappropriate behaviors of children with autism. This result showed that AR can be effective in increasing achievement in children with autism. However, the different results among the participants during the intervention and withdrawal phases. Based on this point, for the future studies, it should be applied the test again and should applied to other types of children with special needs.

2. Technology had definitely enhanced the learning process. Moreover, this research showed that the use of AR technology helps learners with autism to increase their achievement effectively. However, the AR creation process is quite complicated, and the cost is high. Therefore, researcher should find another method to decrease cost and make it less complicate.

3. Researchers' smartphones were used in this study. Although no problems were experienced in the use of these devices, due to their nature, they had limitations based on small screen size. Therefore, more appropriate devices, supported by related institutions like tablet, laptop, and computer, should be used in the future studies.

4. At the time of data collection, there were many factors that allowed researchers to use ABA single subject design. The duration of this study was

4 weeks, five times per week, with total 20 sessions. Even though, the results showed that after the invention performance, the five participants exhibited levels of inappropriate behaviors significantly lower than their baseline performance. However, the observation period for researcher was limited. More time for observation should be provided in order to verify that the behavior would be stagnant and would not change. Thus, the experimental results using a single subject A-B-A-B design is subsequently investigated in the future studies.

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