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READING AND COUNTING INTERACTIVE MEDIA FOR CHILDREN WITH AUTISM SPECTRUM DISORDER (ASD)

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ABSTRACT

Learning for children with autism spectrum disorder (ASD) must specifically cater to their specific characteristics, but learning media specifically tailored for children with ASD is unfortunately still limited. We designed and implemented interactive multimedia adopting the syntax of PECS for reading and counting in children with ASD. Students' improvement was evaluated after learning and their behavior while learning was documented. Results showed some improvement in students' learning achievement, and all students showed an improvement in terms of behavior when learning.

Keywords: autism; reading; mathematics; learning media

ABSTRAK

Pembelajaran untuk siswa dengan gangguan spektrum autisme (ASD) harus mengakomodasi karakteristik spesifik siswa, namun media pembelajaran yang dirancang secara spesifik untuk mengakomodasi kebutuhan siswa ASD sayangnya masih sangat terbatas. Kami merancang dan mengimplementasikan multimedia interaktif yang mengadopsi sintaks PECS untuk media membaca dan berhitung bagi siswa ASD. Perbaikan yang terjadi pada siswa dievaluasi setelah pembelajaran dilakukan dan perilaku mereka ketika sedang belajar juga didokumentasikan. Hasil menunjukkan bahwa terdapat perbaikan capaian belajar beberapa siswa dan semua siswa menunjukkan perubahan dalam hal perilaku saat sedang belajar.

Kata kunci: autism; reading; mathematics; learning media

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INTRODUCTION

Autism is a developmental disorder of neurobiologic origin defined based on behavioral and developmental features (National Research Council, 2001). Autism or Autism Spectrum Disorders (ASD) are characterized by persistent deficits in social communication and social interaction, together with restrictive, repetitive patterns of behavior, interests or activities (see American Psychiatric Association [APA], 2013). Commisioned by World Health Organization (WHO), Elsabbagh et al. (2012) conducted epidemiological surveys of ASD worldwide in which median prevalence estimate of ASD was 62/10.000 or can be translated to one in 160 children in the world has ASD. Impairment in social communication and social interaction are evident traits of ASD (APA, 2013) and therefore augmentative and alternative communication (AAC) systems are used to supplement or to act as their alternative method of communication (Mirenda, 2003).

Unaided and aided techniques are two types of AAC systems in which unaided communication involves using symbols such as manual signs and gestures. In contrast, aided communication involves the use of symbols such as photographs, line drawings, letters, and words, which are used in communication systems such as Picture Exchange Communication System (PECS) (Mirenda, 2003).

Picture Exchange Communication System (PECS) is a communication system proposed by Frost and Bondy (1994) and consisted of six phases of training (Bondy and Frost, 2001) namely initiating communication, distance and persis-

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tence, discrimination between pictures or symbols, using phrases, answering questions, and commenting. PECS has been widely used and proved to be effective in improving communication for children with autism spectrum disorder (Charlop-Christy, Carpenter, Le, LeBlanc, and Kellet, 2002; Magiati and Howlin, 2003; Yokoyama, Naoi, and Yamamoto, 2006; Massaro and Bosseler, 2006; Howlin, Gordon, Pasco, Wade, and Charman, 2007; Malandraki and Okalidou, 2007; Jurgens, Anderson, and Moore, 2009; Pasco and Tohill, 2010; Travis and Geiger, 2010; Flippin, Reszka, and Watson, 2010; Hart and Banda, 2010; Park, Alber-Morgan, and Cannella-Malone, 2011; Lerna, Esposito, Conson, Russo, and Massagli, 2012; Lerna, Esposito, Conson, and Massagli, 2014; Hill, Flores, and Kearley, 2014). The improvement was even found to be retainable after 6-8 months (Yokoyama et al., 2006) or even more than 12 months after intervention (Lerna et al., 2014). Multimedia or computer program also has been used in assisting learning for children with ASD (Heimann, Nelson, Tjus, and Gillberg, 1995; Bernard-Opitz, Sriram, and Nakhoda-Sapuan, 2001; Moore and Calvert, 2002; Bosseler and Massaro, 2003; Root, Stevenson, Davis, Geddes-Hall, and Test, 2016; King, Lemons, and Davidson, 2016; Constantin, Johnson, Smith, Lengyel, and Brosnan, 2017), although unfortunately, the studies were limited to literacy skills while research exploring skills related to science and mathematical problem solving is still limited (Root et al., 2016).

Mayes and Calhoun (2006) studied learning disabilities in children with the clinical disorder and found that 67% children with ASD suffer from learning disabilities in reading, writing, and math. Although Hsu and Yueh (2007) found that mathematical ability difference between high functioning ASD children with the normed population was dismal, research consistently found that math is a subject that students with ASD struggle on (Russell, Jarrold, and Henry, 1996; Mayes and Calhoun, 2006; Koegel, Singh, and Koegel, 2010; Wei, Lenz, and Blackorby, 2012; Bae, Chiang, and Hickson, 2015; Kim and Cameron 2016). Mathematical calculation proved to be challenging for children with ASD in which children with ASD takes longer time in processing counting task compared to normal children (Russell et al.,1996) and even had significantly lower calculation scores when compared to students with learning disabilities (Wei et al., 2012). Children with ASD only able to solve zero to one math problem per minute (Koegel et al., 2010), had low mathematical knowledge and word problem solving ability (Bae et al., 2015). The difficulties that children with ASD encounter when learning mathematics were due to their difficulties in conduct executive functions for learning mathematics (Kim and Cameron, 2016). Fortunately, learning setting that thoughtfully designed to cater to ASD children's needs will improved their mathematical ability (Koegel et al., 2010).

The promising benefits of Picture Exchange Communication System (PECS) and computer-based instruction, as well as limited research exploring mathematics teaching in children with ASD, elucidated the merit of research exploring multimedia-adopting PECS in teaching mathematics for children with ASD. In this paper, we reported the implementation of interactive multimedia adopting PECS' syntax for teaching reading and counting to children with ASD.

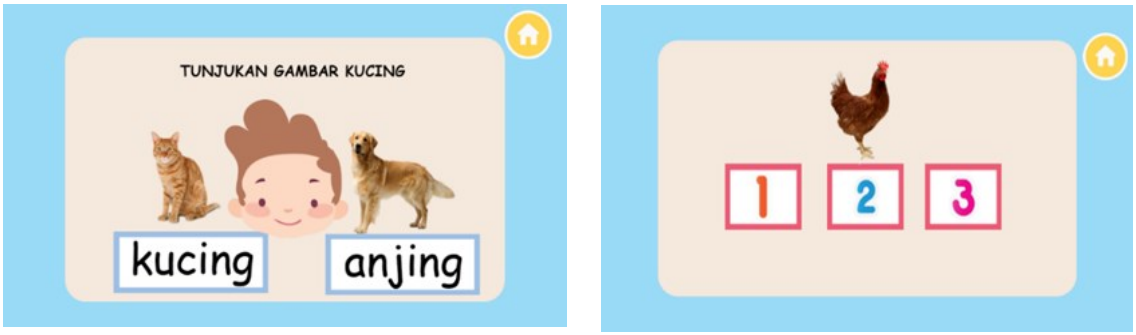
METHOD

Reading and Counting Interactive Media (RCIM)

Reading and Counting Interactive Media (RCIM) was arranged according to six phases in PECS syntax: I) initiating communication (initiating communication), II) distance and persistence (expanding the use of pictures), III) discrimination between symbols (choosing symbols or pictures with its corresponding message), IV) phrases (introducing sentence structures), V) answering question (answering questions), and VI) commenting (commenting). RCIM underwent reliability and validity evaluation before it was deemed valid and ready to use in this pilot study. Within RCIM, there were three functional buttons, one button for each material description, music, and game. By clicking the 'game' button, students were directed to the game with four subthemes: two-footed animal, four-footed animal, fruit, and flower. For reading, students, for example, were asked to pair words with pictures (Figure 1a) according to the command from the media. For counting, students, for example, were asked to point the correct number of animal(s) (Figure 1b). If students finish every stage in the game and scored 70 points or more, 'smiley face' will appear on the screen (Figure 1a), whereas if the points were below 70, 'sad face' will appear on the screen.

Subjects and Experiment Design

Subjects were four students with ASD (11-13 years old) enrolled in one of special education schools in Bandung, West Java, Indonesia. All of the students were diagnosed as Low Functioning Autism (LFA) children. To evaluate students' initial and subsequent reading and counting ability, they were subjected to pretest (before using the media) and posttest (after using the media). After a brief explanation from their teachers, students were asked to access RCIM and follow every instructions in the media. Every response and behavior while accessing the RCIM was documented, and teachers were interviewed at the end of learning activity. Duration in which students gave full attention while using the media was documented as focus duration (minutes), with 30 minutes as maximum duration.



(a) (b)

Figure 1a-b. Interface for reading and 'smiley face' that appear in students scored 70 points or more (a), and Interface for counting (b)

RESULTS AND DISCUSSION

Students' Knowledge and Behavior

Pretest and posttest results suggested that students had a varying level of words and mathematical knowledge, while also showed a slight to no improvement after using the media (Table 1). Improvement was found for SE and RI (around 6 points) in which we subsequently found out that both shared a common hobby: computers related hobbies. Koegel et al. (2010) found that students' preference is essential in designing a learning setting for students with ASD, and in our study, SE and RE fascination and inclination to use the computer becomes their source of motivation for learning. For MR and RE, score improvement was not detected, but interviews with their teachers showed that there were improvement in terms of focus and behavior.

The teachers stated that MR and RE were having difficulties in terms of focus and showed a spectrum of problem behavior such as moodiness and tantrum. Both students showed an improvement in terms of focus: RE was found to remain happily seated throughout learning activity, while even though for the first 5 minutes MR seemed to be in a bad mood and utterly uninterested, he gradually feels interested and infested with the media, so much so that he remains seated throughout the remaining 25 minutes. In Moore and Calvert (2002) study, computer-based instruction successfully increased students' motivation and attention compared to manual behavioral program because interesting sound and object movement in a computer based instruction motivate the students to be attentive to their learning activity. Lerna et al. (2012) showed that PECS also exhibited this beneficial aspects in which PECS were found to improve students' attention. The use of computer-based instruction with PECS approach in our study and its effect on students' attention indicate that this combination improved students' focus and attention. The absence of prolonged moodiness or tantrum were also found in our study in which this result is in line with results from other studies of PECS (Charlop-Christy et al., 2002; Magiati and Howlin, 2003; Malandraki and Okalidou, 2007). Improvement in words and math knowledge, behavior, as well as positive response from the teacher, indicated that the RCIM merits consideration as an alternative educational program for children with ASD. The nature of the media as a flexible

Table 1. Students' Knowledge and Behavior After and While Learning Using RMIC Media

Subject	Parameters			
	Knowledge		Focus	Behavior
	Pretest Score	Posttest Score		
SE	93.65	100	30	Smiling, clapping, dancing, and uttering words while using the media.
MR	37.50	37.50	25	At first, seemed uninterested but gradually invested with the media.
RE	50	50	30	Smiling, clapping, screaming (happy), uttering words, and uttering animals' names that he knows.
RI	93.75	100	30	Smiling and clapping
Average	**68.72**	**71.87**	**28.75**	

learning tool creates a possibility for learning in non-classroom setting, for example at home. In nonclassroom setting, parents can play a role as a learning facilitator, as suggested by Park, et al. (2011) which showed that with 40 to 60 minutes of training per phase, mothers can be taught to implement PECS training with high fidelity. Availability (24 hours-365 days), one-on-one learning opportunity and extreme patience are other additional benefits from computer-based instruction (Bosseler and Massaro, 2003).

In our present study, improvement in learning achievement was only found in two out of four students, but increased engagement while learning found in all students. This finding is in line with previous studies (Heimann, et al., 1995; Bernard-Opitz et al., 2001; Moore and Calvert, 2002; Bosseler and Massaro, 2003) that also found increased enjoyment in ASD students' while using computer-based instruction.

National Research Council (2001) stressed the significance of educational approaches that emphasizes the unique needs of children with ASD, but unfortunately, research exploring mathematics teaching in children with ASD is still limited and even scarcer in Indonesia. Studies concerning autism itself are currently still limited, with the only accessible and verifiable epidemiological study concerning autism in Indonesia was the study by Wignyosumarto, Mukhlas, and Shirataki (1992) in Yogyakarta-Central Java that found the prevalence rate of autism was 12 per 10,000. This condition indicates the need for continuing efforts in exploring ASD and designing educational efforts for students with ASD. This study's nature as a pilot study indicates that the promising benefits of our media should be explored further in comprehensive research in terms of settings and sample size.

CONCLUSION

Reading and Counting Interactive Media (RCIM) improved some ASD students' reading and counting ability as well as improving all student enjoyment in reading and counting. The interactive nature of the media was the main factor in students' attention and enjoyment in learning. Large scale study is still needed to establish the benefit of the media in improving learning for students with ASD.

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