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Effectiveness of smart toy applications in teaching children with intellectual disability

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ABSTRACT

Play is an important element in a child's social and intellectual development and toys are indispensable play tools. This study investigates the effectiveness of smart toys in teaching social studies concepts to children with intellectual disability (ID). A single-subject design is used to identify such effects on teaching social studies concepts to children with ID with the help of smart toys developed within this study. The smart toys are also developed within the scope of present work. Three special education teachers and three children with moderate ID participated in the study, which was carried out in two schools in Turkey. According to the results, smart toys have a positive effect in teaching social studies concepts to children with moderate ID which is significant in development of academic and social skills for individuals with ID.

1. Introduction and literature review

In terms of child development, play has great importance in developing self-confidence, collaboration, expression of emotion, and taking initiatives [1,16,24,28]) and toys are indispensable in this respect. They also have a positive contribution to the cognitive, physical, social, and emotional well-being of children according to age groups ([3,4,9,13,18,19,29]). Children in a different age group may play with a toy in a completely different manner from each other [21]. According to the Piaget [24], children's intellectual development has 4 different stages: (1) sensory-motor (first 18 months), (2) preoperational (2–7), (3) concrete operations (7–11), and (4) formal operations (after 11). Symbolic functioning and language acquisition are the main characteristics of the preoperational stage [24]. Toy blocks in this age group promote language development. In one study, researchers gave blocks to children aged one and a half to two and a half. After six months, kids in the group assigned to play with blocks scored higher on their parent-reported tests of vocabulary, grammar, and verbal comprehension [6]. In a different study, autistic kids assigned to play with toy blocks made greater social improvements than did kids who were coached in the social use of language [15].

In today's world, computer-mediated toys are very popular among young children and smart toys are one of them. They are defined as technologically enhanced forms of physical toys in such a way that allows mutual interaction and encourages purposeful tasks [5]. According to the Fantinato et al. [10], "smart toys is a device consisting of a physical toy component that connects to a computing system with online services through networking to enhance the functionality of a traditional toy" (p.1). Another feature that characterizes smart toys is their ability to interact; while some smart toys can interact with computers, some are self-contained [5]. Additionally, while classic electronic or digital toys have properties that only enhance toys' attractiveness, smart toys offer an environment in an enhanced reality [5]. In the literature, interactive toys and computationally augmented toys [2,8], digitally augmented physical spaces (Hinske, [30]), and similar terms can be regarded as variations of smart toys.

Smart toys can be used for educational purposes. They provide an interactive environment, in which children develop social, cogniitive, and behavioral abilities [5]. In the literature, there are many experimental studies related with smart toys' positive contributions to the social and cognitive development of children ([4,13,29]). In one study, researchers observed the interaction between autistic children and a mobile toy robot during a free spontaneous game play [7]. Eye contact, posture, manipulation, and touch and were considered. The children with autism took an interest in playing with the robot. This study reveals the potential of the mobile toy robot to reduce the impairment of autistic children's skills related to social understanding and interaction. Frei, Su, Mikhak and Ishii [31], developed an educational toy, called Curlybot, which is "an autonomous two wheeled vehicle with embedded electronics that can record how it has been moved on any flat

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surface and then play back that motion accurately and repeatedly" (p. 129). It was aimed to develop intuition for advanced mathematical and computational concepts. Pilot study results revealed that children ages four and up played with the toy by engaging computational and mathematical concepts in a much more fluid and expressive fashion (previously learned at a later age and often with the aid of a traditional computer).

Similarly, Hinske [30] conducted a user study to explore the effects of the augmented play set (Augmented Knight's Castle) on interactive play and storytelling. The aim of this toy was to enrich the pretend play of children by providing sound effects and verbal reactions. According to the results, a majority of them were delighted to play with the Augmented Knight's Castle. Cassell and Ryokai (2001) developed StoryMat, providing a play space that records and replay children's stories. Based on the results, StoryMats helps the children to produce more imaginative objects in their stories than those playing with a passive mat.

While most of the different countries' Early Childhood Education (ECE) curricula makes references to information and communication technologies (ICT) and computational toys [27], smart toy practices in the literature generally focus on the specific purposes of young children without disabilities, like storytelling, pretend play and so on. The number of educational interactive toys (smart toys) developed for the field of special education is limited [25,26] and a limited number of them are educational and developmental [11,17,20]. However, existing smart toy projects have not provided sufficient applications for special education consistent with the respective curricula. For this reason, the present study aims to fill this gap by developing a smart toy to teach certain social studies concepts included in the special education curriculum for children with moderate ID. In addition, researchers developing new toy technologies for young children have also conducted small-scale user studies to test the effectiveness of these toys for children. Yet, there has been a lack of empirical data about the effectiveness of smart toys as an instructional tool. On top of this, it is important to develop different instructional technologies that consider individual training needs and are usable for individuals in special education so as to provide them with a chance to improve their skills. For this reason, examining the effectiveness of a smart toy will provide valuable information about whether it is helpful or not for such individuals.

The findings of this study can contribute to the literature on smart toy-based learning, and educators, schools or any such institutions who wish to use smart toys in their learning activities can benefit from the results of this research, which also examines the following issues: the effectiveness of using smart toys in learning new concepts by children with ID and the level of success in teaching.

2. Method

2.1. Participants

The participants in this study are a homogeneous sample group including three public elementary school children with ID. This individuals met the following criteria; they all: (1) are diagnosed with moderate ID; (2) attend school regularly; (3) have sufficient visual level; (4) have IQ level over 55 as stated in the written report by The Counseling and Research Center; (5) have a sufficient level of receptive language level as assessed by their teachers (touch, show, tell and look, etc.) to follow basic instructions; (6) must not be familiar with at least one animal featured in the research.

In all, there were three subjects: The first one was an eleven year-old boy (SA), the second was a sixteen-year-old boy (TK) and the third was an eleven-year-old boy (BO) (see Table 1). All subjects' IEPs (Individual Education Program) were provided in different public schools five days a week, one- two- hour day in a private special education center. In the following, additional detail is provided to explain how these three individuals were selected for the 6th. criteria. Ten different animal toys were chosen, out of which four were randomly selected and put on table side by side. In order to find out which animal/s the subject can't recognize, 4 random animals were shown to the child. The teacher once again and randomly selected one of the figures in their mind and then asked the question to the participant to point to that figure on the table. This is repeated 4 times and in case of the subject's failure to give three correct answers out of four (3 points over 4), he is chosen as a participant. As stated before, procedure was performed by each subject's own teacher in one-to-one session. They were three special education teachers who also conducted baseline, intervention and follow-up sessions for their students. The study was done after lunch on weekdays. Before the study, the researcher held a meeting with the all teachers to inform them about the aim of the study. In their presence, a demo play was practiced to show how to use the smart toys and computer applications. Each teacher had been working with their own students for at least one year, and all have at least five years of teaching experience in special education and rehabilitation centers that provide education to children with autism or other intellectual disabilities in Turkey. The special education and rehabilitation centers in question were selected due to the high number of students attending there. The reliability data on the dependent and independent variables (inter-observer reliability and procedural fidelity data) was obtained by two other special education teachers having bachelor degrees in the education of the students with ID.

3. Instrumentation

3.1. Utilized materials

Environment (Settings)

In the study, all sessions are conducted in one private training room with one table, several chairs, one armchair, research materials, and equipment. A camera is placed in the room to record the sessions, positioned in such a way so as to observe the student's reactions and items placed on the table.

Equipment and Materials

The main component of the smart animal toys is a Radio Frequency Identification (RFID) system with a special tag attached to small-sized toys and other tags positioned inside the larger ones in a way so as to make them imperceptible to the child. In this system, an RFID reader connected to the computer recognizes the toy via these tags (see Fig. 1). The Adobe Flash CS6 was used to design computer animations, which are triggered by the transmitted tag data. Depending on the toys placed on the RFID reader, the corresponding animation appears on the computer screen. Fig. 2 represents some screen captures of the smart toy application.

4. Procedure

In order to remain in line with the special education curriculum, certain social studies concepts included in the curriculum were selected for this study. As a design procedure, a single-subject research design was chosen to investigate the effectiveness of smart toys in teaching social studies concepts to three participants with ID. A multiple baseline design across the subjects was implemented in three phases: baseline, intervention, and follow-up. During baseline and follow-up, the teacher sat across a table from the student (subject). No verbal cue was given and errors were not corrected. In the baseline sessions, four animals were placed in front of the participant (see Fig. 3) and a particular animal was asked of him (e.g. which of these is a cow? Show it!). The subject was asked to point to a particular animal in a group of four animals four times. Each time, the animal toy, which the child was asked to point to, remains on the table while the other 3 toys are replaced by new ones taken from the set consisting of 10 toys. At the baseline phase, no modeling was done to lead the subjects in anyway or any feedback as to whether they had provided a correct or incorrect