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Emerging Role of Robot-Assisted Occupational Therapy for Children with Down Syndrome

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Abstract. Robotic technology is becoming increasingly popular as a platform for both education and entertainment. It also provides us with new conceptual directions which might have incredibly positive impact on children with physical growth delays and intellectual disabilities. In this research project, the educational robot Roamer Too from Valiant Technologies has been used to explore the development of social skills of children with Down syndrome. In conjunction with an interactive collaborative environment, this device represents a unique opportunity for these children to fully engage in learning, play, communication, build relationships and have fun. The results of this study indicate that educational robots help to develop kids' social and learning psychologies, moving from a more standard knowledge acquisition by absorption toward acts of exploration, collaboration, and creation. As a result, children reflect social initiations, communicative competence and joint attention.

Keywords: Robot, children, Down syndrome, education, social

Introduction

Down syndrome is a chromosomal disorder that a child is born with and has for life. Children with Down syndrome have generally learning weaknesses. However, the degree of that impairment differs from one child to another. The majority of children with Down syndrome will learn reasonably well, given a few adaptations to the learning context. There is a list of few ideas that are used for maximizing the learning potential of children with Down syndrome such as: keeping simple the teaching process, keeping things real while demonstrating a step, teaching without testing them while providing opportunities for play and exploration [1][2][3]. Play experiences are very helpful for teaching new skills. They are natural and appealing to the child. Even when children are on their own, the play situation is where they learn how things work and how their bodies can adapt [1]. Exposing the child to many different types of play situations helps to facilitate working knowledge in different areas.

Considering these facts, and knowing that children with and without disabilities naturally find robots to be engaging and respond favorably to social interactions with them [4][5][6], even when the child typically does not respond socially with humans, it is very appropriate to use the occupational therapy to boost their social and communicative initiatives. Occupational therapy is concerned with a child's ability to participate in daily life activities, to help improve a child's motor, cognitive, sensory processing, communication, and play skills with the goal of enhancing their development and minimize the potential for developmental delay [7]. When this therapy is combined with educational robot kits (such as, for example, Roamer robot [8]) and adequate curricula [9] children will develop a stronger understanding of mathematical concepts such as number, size, and shape in much the same way way—if not better—than traditional materials do. Roamer Too robot [8] is a flexible and modular robot which allows students to easily modify it

in order to meet the needs of the learning activity. In this project, the Roamer was fed with logical statements in a set order to execute a sequence of commands, with the end result being to follow a predetermined path, from a simple straight line to ever-increasingly complex patterns and sequences.

The overall objective of this paper is to see whether the Early Year Roamer Too robot will help children to be more interactive and cooperative among themselves when they work in group or individually at various activities, particularly mathematical activities (drawing various geometrical objects). With this project we believe to contribute in identifying problems that need to be solved in educational robotics and avenues on how robotics might be used to make special needs education more effective. More specifically, how Roamer Robot will be effective when used in extracurricular activities with children having a Down syndrome.

Methodology

To explore more effectively the attitude of children towards the educational kits, in this case the Roamer robot, we have employed the "Focus Group" methodology to gather the data. Just as in the dynamics of real life, through the focus groups the children are able to interact, influence each other and discuss openly. Taking into consideration the lack of data in Kosovo, we have developed focus groups in one of the branches of Centre for Children with Down Syndrome (CCDS), which is located in Ferizaj, Kosovo. This project involved a total of 11 (eleven) children with some of them participating in individual sessions. Individual sessions are held for children who have more obstacles in speaking. The study was done with the permission of parents with whom, one author (V. K.) and psychologist of the center talked individually.

Aiming to have the best possible authenticity, we divided the groups in two. First group was composed of four children whereas second group was composed of seven children. The reason why we made this group division was to see where the children will feel more comfortable learning and working with Early Year Roamer Too robot when they are alone and thus feel more free to express themselves, even if they make errors when they press any button, or when they are grouped in team, learning and working together.

Results and discussion

The focus groups we established at the CCDS helped us to investigate the effectiveness of Roamer robot in interaction and cooperation among children while they work in group or individually at various activities in the center. First group was composed of four children with Down syndrome with whom one author (V. K) had the opportunity to work separately. All children who participated in this study came in individual sessions (outside the regular one) to work extra hours with their psychologist Yllka Mani. From 4 (four) children who participated in the study, 3 (three) of them were males and 1 (one) of them female. The children age vary from 7-10.

Table 1. *Frequency distribution for the characteristics of the sample, first group*

Participant (n=4)	Gender	Age
1	Male	10
2	Male	9
3	Male	7
4	Female	8

The nationality of 4 children is Kosovar and all of them are residents of Ferizaj. With every child with whom Venera Krasniqi worked, author (V.K) introduced herself and then the "Roamer robot Too". She started describing the steps of robot activation (how the robot can be turned on and off). Then, continued with commands (always referring to the commands with shapes and colors) so they will be able to recognize and remember better their purpose. The same steps were repeated in three other weeks with other three children, starting from the first day, where the author describe and explain the robot activation up to the exercises practiced with the robot commands.

All the steps taken in first group were repeated in the second group too. In the second group, however, a total of 7 (seven) children with Down syndrome participated in the study.

Table 2. *Summary of second group data*

Number of participants (n=7)	**Gender**	**Age**
1	F	8
2	M	9
3	M	7
4	M	7
5	M	7
6	M	13
7	M	10

A feature of working with this group is that, all exercises were demonstrated with mutual cooperation between them as compared to the first group where children were had to work individually because they were in their individual sessions with psychologist. When we introduced the robot (as in the first group), all children were motivated and enthusiastic. They all were watching and listening carefully what the principal investigator (PI) Venera Krasniqi was saying. The PI tried to talk slowly and each sentence related to the robot was accompanied with the demonstration (touching the robot) because concrete or-hands-on approaches are more effective.

All children that were included in the focus groups are registered also in regular schools (i.e. they are involved in a regular teaching process). Activities within the CCDS are extracurricular activities that adapt individual scholar needs for every children. Typically achievements of children with Down syndrome in math are at a lower level than those in reading ability. Given these facts, the purpose of this paper is to see whether the Early Year Roamer Too robot will help children to be more interactive and cooperative among themselves when they work in group or individually at various activities, and particularly mathematical activities (drawing various geometrical objects). Throughout this project, an interactive evaluation procedure has been used, which has been defined as the way in which participants stayed on task during the activity, how they communicated with each other and the principal investigator, and the nature of manipulation of the robot. To characterize the interaction, three indicators were used (*a*) *engagement*, (*b*) *substantive conversation*, and (*c*) *knowledge production*. The first one describes to which extent participants demonstrate a high level of motivation by remaining on task. The second indicator captures the participant's occurrence of interactions and discussion during the activity. Third is an indicator that describes the degree to which participants were able to manipulate information and materials (e. g., the robot) to solve problems and create their own learning. The interactive process has been evaluated by using a five-point scale evaluation, with one representing a "low" level and five a "high" level.

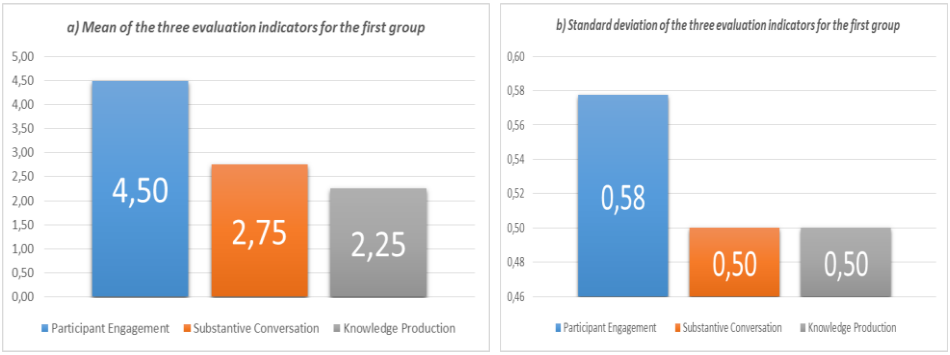

Figure 1. *(a) Mean and (b) standard deviation of the three evaluation indicators for the first group. Blue, orange and gray bars correspond to participant engagement, substantive conversation and knowledge production, respectively*

The children in the first group showed a medium level of interactivity demonstrated by ratings for each indicator ranging from 4, 5 for level of engagement, 2, 75 for substantive talk and 2, 25 for knowledge production. Even though children stayed on task, the results of the first group show that individual sessions are not too effective.

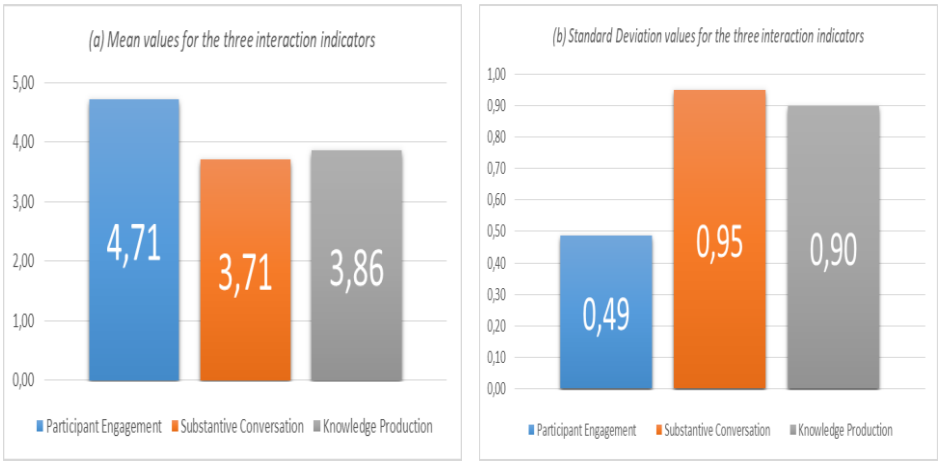

Figure 2. *(a) Mean and (b) standard deviation of the three evaluation indicators for the second group. Blue, orange and gray bars correspond to participant engagement, substantive conversation and knowledge production, respectively.*

Second group showed a high level of interactivity demonstrated by high ratings for each indicator ranging from 3.86 for knowledge production, 3.71 for substantive talk to 4.71 for level of engagement. On the average, participants stayed on task, even though less engaged in substantive occurrences of verbal interactions, they had the opportunity to manipulate the robot and work with it.

Conclusion

Initial judgements were performed to determine how effective Early Year Roamer Robot is when interacting with young children having Down syndrome, with the goal of understanding the potential of such a robot to encourage skill acquisition (motor, language, intellectual, social, etc.) during the child development process. Eleven children between ages 7 to 13 years old participated in this study. Four of them took individual sessions with the robot while the rest worked as a team. The quantitative results were somewhat indecisive but are leading to on-going improvements in the design. In general, it was found that children with Down syndrome enjoy playing with robots (robotic toys) and respond differently to them than to human educators or non-interactive toys. This research shows that children exhibit a high level of interactivity, demonstrated by high ratings of the evaluation indicators. Interaction indicators such as engagement, substantive conversation and knowledge production were higher when working in a team than in individual sessions, indicating thus that team work boosts both children motivation and competitiveness more effectively than individual sessions. The Early Year Roamer Robot helps children to reflect social initiations, communicative competence, and joint attention.

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