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Remote Training to Support Children with Autism in Inclusive Educational Robotics Activities

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Abstract
Educational Robotics (ER) is a motivating and essential method of experiential learning with cognitive and social benefits for children of all ages. Children with Autism Spectrum Disorders (ASD) have shown specific benefits from participating in Inclusive ER activities (IERa) using LEGO type robots in terms of their social and cognitive skills. Children with ASD and their families were severely isolated during COVID-19 pandemic. Neither the social skills' intervention nor ERa were available to them. "Come Robotics" project was developed to investigate how ER remote training in collaboration with caregivers at home could have an impact on social skills development and prepare children with ASD to participate effectively in IERa with typical peers after COVID-19 isolation. The specific for IERa, Search and Share Strategy (SaSS) was taught remotely via three online sessions to three children with ASD in collaboration with their caregivers in order to explore whether the remotely taught SaSS could be transferred to face-to-face IERa with typical peers and the children with ASD. In order to facilitate feedback and dissemination in the context of typical and non-typical education, the material, methodology, and results of the action were recorded.

Keywords: Collaborative activities, remote learning, ASD, COVID-19, peer groups.

Introduction

Educational Robotics (ER) has developed at a rapid pace, attracting more and more students by combining play with learning. According to scientific findings, ER promotes a variety of skills such as collaboration, critical thinking, problem-solving (Rudovic et al., 2018) while encouraging engagement, enhancing autonomy and initiatives (Bharatharaj et al., 2017). Possible difficulties in social skills can adversely affect the individual's personal development and social and professional relationships. Social dysfunctions are often more pronounced in people with Autism Spectrum Disorder (ASD). These conditions limit the ability to participate adequately and satisfactorily in social and learning environments (Nanou & Karampatzakis, 2022). Multiple benefits for both autistic and typically developing children are reported by clinical and research efforts that participation is key to childhood development and key to learning for children with autism.

Children with autism have the same desire to participate in educational robotics, but their difficulty in participating in group activities limits their opportunities. Specific educational programs are designed for students with ASD to enhance their social participation in various ERa. Although limited studies have been conducted on robotics as a facilitator for social interaction among students with ASD in inclusive environments (Nanou & Karampatzakis, 2022). There is a lack of research on supporting students with autism remotely in educational robotics activities. The need to utilize distance education practices with the cooperation of their parent caregivers for the benefit of students with autism is imperative in our time.

To enhance collaboration and participation, we have included the SaS Strategy in this program. SaSS was designed to help children with ASD be able to participate in groups (with typical and non-typical children) during IERa (Tsiomi & Nanou, 2020). First implementation

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of the SaSS was in our previous work where the participation of children with ASD in an IERa group with peers was studied (Nanou et al., 2021). Although the data showed an increase in the children's participation in the construction part as well as greater autonomy and resolution of initiatives more effective methodologies have to be investigated in order for children with ASD to increase their level of functionality in teamwork and become more effective. During the Covid-19 condition, this training could be realised only remotely. This was a challenge that has to be investigated as there was no prior experience.

Research Design

The aim of this study

The aim of the present study was to investigate the degree and the quality of participation of children with ASD in face-to-face Inclusive Educational Robotic Activities after remote SaS Strategy training. Specific goals were set concerning a) the investigation of the level and degree of participation in remote training with the support of their caregivers and b) the investigation of the difficulties in order the improvement remote SaSS training methodology c) the level and quality of participation during face-to-face IERa d) the impact and the opinions of the caregivers and educators concerning the SaSS effectiveness.

Research questions

More specifically the study aims to give answers to the following questions:

- What is the level and the quality of the participation of children with ASD in LEGO construction during the remote SaSS training?
- What is the level and the quality of their participation in LEGO construction during face-to-face SaSS training?

Research Methodology

In this study, an action research was designed according to the model of Lewin (1948). This includes 4 phases which are: Plan, Act, Observe and Reflect phase. During the Plan phase, designed and defined the action research questions, the methodology to be followed as well as the tools. In the next phase, the implementation of the action research is organized in two stages: Stage I (remote sessions) and Stage II (face-to-face sessions). The Observation phase focused on monitoring action research implementation and collecting educational data. Finally, during the Reflect phase, the training data collected was analyzed and feedback was given. This particular method was chosen as it is suitable for problem solving, enhances participants' abilities, is collaborative, uses data feedback, and includes evaluation and review (Hult & Lennung, 1980).

Research validity and reliability ensured by the mixed methodology of concurrent research for data collection and analysis (Tobi & Kampen, 2018). Data were analyzed by different methods. More specifically "concurrent parallel design" was chosen to "take different but additional data on the same topic" in order to develop a more comprehensive understanding of the phenomenon, comparing multiple levels within a system (Morse,1991; Creswell & Plano Clark, 2011). Different methods of assessment and different methods of data collections were used to obtain complementary data on the participation of children with ASD in IERa. For the data collection specific tools were applied: caregivers' interviews and self-completed questionnaires, educators' research diaries in conjunction with participation observation protocols.

The data of the interviews were triangulated with the data of questionnaires and observations, while at the same time the observations were successful of triangulation with each other - those of the independent and the participatory observer. In the context of this data research from different sources intersected to confirm or reinforce each other. Thus, each data source informed their final analysis data in such a way that each finding of the research would emerge as a result of its confirmation of at least one more data source. This triangulation lent credibility to the research findings (Almeida, 2018). Data triangulation was applied, aimed at enhancing the validity of the results (Cohen, Manion & Morrison, 2007). Research methods and tools were associated with the purposes of the research and the coding framework with which they would be analyzed data.

Participants

Three (3) children with ASD, all members of Interdisciplinary Network for Special and Intercultural Education (Include), were chosen to participate in the action research. The selection criterion was, a) to be diagnosed with functioning Level II of ASD, b) to study at different educational degrees and, c) interest for LEGO education according to their parents. As revealed by the parents' interviews children exhibited the following characteristics: Child A: a girl thirteen (13) years old who attends high school with parallel support. She expresses herself syntactically well but has selective speech. She found it difficult to socialize and prefers individual play. Child B: a boy seventeen (17) years old who attends a special school. His concentration on an activity is low and his speech is limited. However, he learns quickly through imitation, as his mother said. Child C: a boy who is ten (10) years old and attends primary school with parallel support. His speech is limited, and he needs encouragement to communicate. He does not interact with other children, which is why he has no friends. When he likes an activity, he expresses it either verbally or with gestures of pleasure.

During Stage I, the three (3) children with ASD participated in collaboration with their caregivers. During Stage II, the three (3) children with ASD participated in collaboration with six (6) peers of typical development. The action research and the educational process was realized by three (3) team coaches and six (6) observers who were all women.

Place, schedule, and educational equipment

Each Stage of the action research was completed in three (3) sessions, 45 minutes each. At the Stage I was used LEGO Education Simple Machines Set. At the Stage II LEGO Education WeDo 2.0 Core Set was used. The sessions are implemented at "School for All" where afterschool inclusive activities take place to develop innovative inclusive practices and equitable education. At both Stages LEGO Education was chosen as it is visualized in the construction manual and the children can organize their constructions. Also, the children see in real time their creation with the materials they have found themselves.

Educational methodology

The SaS Strategy consists of five (5) steps which were presented verbally and visually to the children as illustrated in Figure 1:

- **Come** - the child is invited by the teacher to come to the training area,
- **Look** - the child is verbally encouraged by the teacher to focus on the desired point of construction,

- **Look For** - the child is encouraged by the teacher to seek to find the necessary piece either with physical or verbal guidance,
- **Find** - the child finds and confirms with the requested piece,
- **Give** - the child gives the piece and focuses on the assembly process.

Children with ASD must follow the steps one by one to participate as a "supplier" in the construction of LEGO. The Strategy helps children achieve as much as possible and even become autonomous while participating in IERa (Nanou et al., 2021).

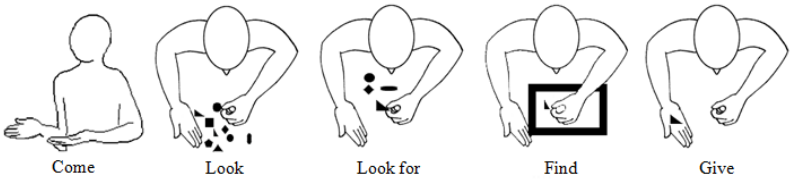

Figure 1. Steps of SaS Strategy

At the Stage I, children with ASD met with their caregiver, his/her coach from his room via tablet or pc and introduced him/herself. The two participants sat at a desk with the materials in front of them. During the second and third remote session, caregivers were taught the SaSS and studied it before the session with the children through a social story. These three sessions were completed with construction play only.

At the Stage II, each one of three children (one ASD, two typical) were based on the same strategy but played with different training material, the LEGO Education WeDo 2.0 Core Set. The child with ASD applied the strategy taught, in remote sessions as a supplier. He/she was looking to find the necessary piece of LEGO that the child of typical development was showing from the manual. After he found it, it was given to the other typical development child to continue assembling.

Data Collection

In order to achieve the purpose of the research and to provide answers to the research questions, seven data collection tools were designed and implemented. In particular, the following tools were used:

- A questionnaire was given to parents before the project started to detect their expectations from the action.
- Interviews of parents of children with ASD via Skype with the aim to collect data concerning their child and their collaboration.
- The observation protocol. In each session (remote and face-to-face) there was one Independent Observer (IO) note on whether the children assembled the LEGOs with guidance (physical, verbal) or autonomously. According to the observation protocol, the score is interpreted: 0 = no response, 1 = response with physical guidance, 2 = response with indication and verbal guidance, 3 = response with verbal guidance, 4 = response autonomous.
- The Daily diary of the child's participation in the group, recorded by the Participant Observer (PO). After the end of the program, individual interviews were conducted with the parents which focused on the benefits of the child's participation.

- At the end of the project parents also completed a final questionnaire. Answers from two questionnaires (initial and final) were compared at the end of the program. From the comparison of the results of the measurements before and after the program, we collected the results regarding the success or otherwise of the action research (Damaskinidis & Christodoulou, 2019).
- Interview with mothers after the end of the program.

Findings

In order to focus on the collaboration between parents and children the initial questionnaire given to the parents collected data on their relationship with the child mainly on their cooperation in everyday life. Collected data from the questionnaires of caregivers showed that all parents believed that cooperation is respect and equality in participation. They also replied that they cooperate positively by playing with their child (100%), reading (100%), cooking (66.7%), tidying the house (66.7%) and sports (33.3%), as presented. It was found that all parents had the intention to cooperate with their children but did not know how to approach them. Regarding the first research question, for the participation of children with ASD during the remote SaS Strategy training, the data collected demonstrates children's response to the strategy learning and if they cooperate with their caregivers. Two of the three children with ASD had an increase and a steady upward trend from the first to the third remote session as shown in Figure 2. Scores correspond to averages compiled from protocol observations.

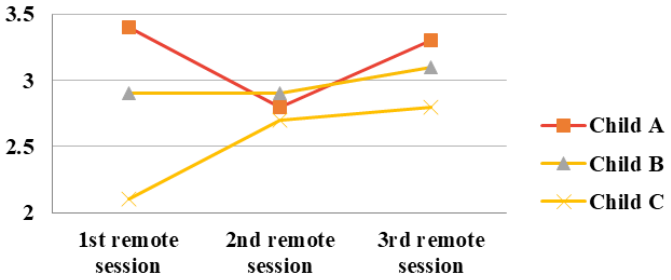

Figure 2. Children's response to strategy in three remote sessions

In more detail, according to observers' diaries and observation protocol, Child A, the girl with ASD in all remote sessions scored 3.17. In the first session, the protocol score was graded 3.4 which means looking at the assembly instructions and looking for the bricks with the mother's suggestion. In the second remote session, the girl after the 2nd step wanted to abandon so her score was 2.8. In the third session, the steps that were planned for the previous meeting were repeated. She kept her attention on the pieces and followed the instructions of the instructor and the attendant. However, she proceeded to the next steps with greater ease and completed the last step autonomously with a score of 3.3. Observation protocol and Observers' diaries for Child B recorded that he was in a good mood during the first remote session. He followed his mother's verbal instructions to locate the piece but while he was finding the piece, he did not give it to his mother. During the second remote session, he was obviously faster in assembly. He completed the steps only with verbal guidance from his mother. At the third remote session, the boy was initially irritated, constantly shaking his

hands and head. He completed all the steps of the strategy with verbal and physical guidance from his mother.

For Child C data showed that from the first remote session, the boy participated extremely in the construction part. He started the construction by completing the steps of SaSS with physical and verbal guidance from his mother. The same rhythm was maintained in the second meeting, following the strategy more with verbal guidance. In the third and last distance meeting, he managed in the last two steps of the construction to complete independently.

Regarding the impressions after the end of the program, all mothers responded that their child cooperated effectively with them in assembling LEGO and SAS Strategy contributed to this. All mothers emphasized that the strategy helped them cooperate effectively with their children and reinforced respect and equality in their participation in play. Two of the mothers emphasized that their child's verbal communication was strengthened, and emotions manifested during the workshops such as joy, and anticipation, while no mother answered that there were effects on their child's eye contact.

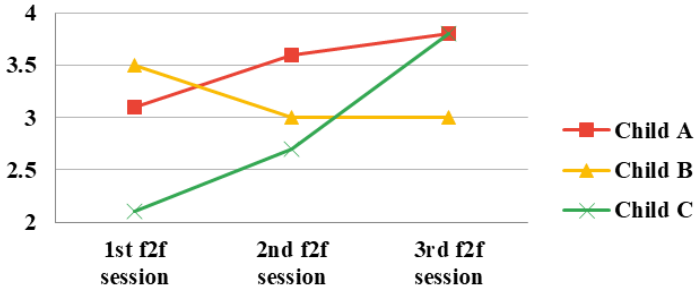

Figure 3. Children's response to SaSS in three face-to-face sessions

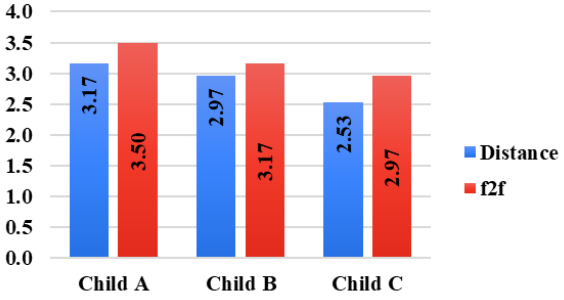

Figure 4. Overall comparison of the implementation of the SAS Strategy

Regarding the second research question, data showed that all children remained in each session with their group. They actively participated in LEGO WeDo construction part and as observers in programming. However, their interest was maintained until the end of the session, and they expressed anticipation for the next one. In particular, two observers agree that Child A completed the steps autonomously, picked the bricks, gave them to her peers, who did the construction, and did the checking (scored 3.5). They finished faster than expected, collaborated, and followed each other. In programming, she observed the way her team engaged and stayed in her seat. When the robot lit up, she clapped her hands loudly

expressing her excitement. Child B showed great interest mainly in the planning of the final construction and scored 3.17 which means that he kept his attention with a constant verbal reprimand from the coach. In the first and second sessions, he completed the construction with his team and followed the steps of the SaS Strategy with verbal guidance. He was thrilled with the construction planning and repeated words of admiration. In the third session, the boy and his team completed the construction in the expected time.

The IO and PO for Child C scored 2.97 and reports that he was anxious and did not focus on the construction. Although they completed the construction, the boy followed the steps of the strategy with verbal and physical guidance, but he did not seem to understand exactly what he was doing as he was not focusing. He found programming difficult as he could not understand how to give orders. In the second session, he managed to autonomously complete the steps "find, give". A member of his team gave him verbal instructions on where to look and which piece to find. In programming he watched the team with interest. In the third session he managed to complete the SaS Strategy autonomously. During the steps he repeated to himself "look, find, give". However, he could not plan but clapped enthusiastically when the robot was moving.

Collectively, all three children had an increase from the first to the third session, as presented in Figure 4. In particular, Child C shows remarkable improvement during the sessions. While he started the first workshop completing the steps with visual guidance by the end of face-to-face sessions, he was almost able to complete the steps autonomously.

As far as parents are concerned, they recognize the positive elements it provides to their children educational robotics activities. All the mothers stated that the training of the Strategy given to them before the start was very helpful for them and the way they would participate with their child in the program. They had a positive attitude from the beginning with a reluctance that disappeared as the workshops progressed. Coding of the data showed that all three children with ASD were making upward progress in sessions, as presented. Their scores increased in face-to-face sessions.

Conclusion and Discussion

Inclusive activities and especially in the field of new technologies make it possible for children with disabilities to participate in society by preparing them for adult social participation and finding work. This research provides answers to how SaSS can increase the participation of children with ASD in inclusive IERa during the pandemic of COVID-19. Data showed that SaSS is appropriate to enhance the participation of children with ASD in IERa remotely and promotes cooperation with typical peers during face-to-face IERa.

The SaS Strategy helped all children who participated in this project to follow the instructions, and a pattern strengthening their patience and concentration. At the same time, caregiver-children cooperation in teamwork was strengthened, despite the few sessions that were implemented. It is worth mentioning that the cooperation with caregivers was particularly supportive. According to caregivers and observers, SaSS remote sessions were successful and gave the chance to be faced with specific unpredictable circumstances such as the placement of the camera for remote workshops, sound, picture, internet connection, time, and behaviour management. All in all, children with ASD showed interest and wanted to participate with their caregivers in all sessions. This investigation was additionally challenging to find out if remote training could be used as a method of enhancing children's skills generally before their participation in IERa. Caregivers helped teach SaSS to the children before the face-to-face IERa started and worked with them during remote SaSS training. Since educational robotics presupposes the concept of cooperation, no one worked individually,

everyone had their role in the common goal of building the robot. In face-to-face workshops, the children's interest increased. An important parameter is the fact that the interventions of coaches were significantly reduced, and the children followed the steps of the strategy with minimal guidance.

Among the limitations of the research, we can include the fact of choosing a convenience sample. This fact combined with the sample size does not allow us to ensure external validity in our research. Observing a control group would probably help with this.

Remote sessions had some difficulties mainly for the observers and the team coaches. These were related to a bad internet connection, sound, and the wrong position of the camera. These were significant disadvantages that made it difficult to conduct the sessions and perhaps affected the observers' diaries. There were difficulties in placing the camera so that there was visual contact between the materials and the child. Despite the limitations of this present study, results encourage further research. Our team is ongoing and will focus on programming by children with ASD in inclusive teams. Suitable inclusive strategies focused on the programming process need to be developed in order for the children with ASD in level 2, learn the way to participate in all dimensions of ERa with their peers.

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