HE students' training towards inclusion; VR introduces SAR technologies for digital inclusion.

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Introduction

An increasing number of children around the world are with autism spectrum disorders (ASD) (Hume et al., 2021; Wong et al., 2015). According to the Autism Developmental Disabilities Monitoring Network (ADDM) report, the prevalence of children in the spectrum is 1 in 59 children (Baio et al., 2018).

Children with the autism spectrum may experience life with different, mild, or severe expressions of the disorder. Some may have a normal or high IQ, while others may have a level of mental disability. They also tend to respond impulsively to sensory stimuli, interact with objects in strange ways, and are attached to them (Feinstein, 2011).

According to the Diagnostic and Statistical Manual of Mental Disorders (DSM- V), the diagnostic criteria for the autism spectrum are found in the following:

1. Deficits in communication and social and emotional reciprocity.
2. Restricted or repetitive patterns of behavior, interests, or activities.

"Autism spectrum disorder" is divided according to the severity of the symptoms into three levels:

- Level 3 – "Need for particularly enhanced support" (serious socialization and flexibility difficulties)
- Level 2 – "Need for enhanced support" (significant difficulties)
- Level 1 – "Need for support" (difficulties)

The wide range of the spectrum requires various methods to be adopted by the teachers to assist children not only to improve their social skills about also to succeed their inclusion.

Inclusion is a system that accepts diversity, as a rule, providing high-quality education in the terms of curriculum, effective teaching, and supportive systems, for each student, in an individualized approach based on the needs of each one. Successful inclusion can be achieved in environments that promote social interaction and provide opportunities for socialization, which encourage children to engage in joint activities and to act in a socially acceptable manner (Goodman & Williams, 2007). Teachers differentiate their methods in ways that help each child feel comfortable and form positive relationships in the classroom and thus feel included in it (Emam & Farrell, 2009).

The successful inclusion of children with ASD presupposes that they should be able to:

- Participate more in joint activities and interact socially
- Be accepted and provided with social support
- Have friendship networks
- Achieve more advanced educational goals than children attending special schools (Fryxell & Kennedy, 1995).

Interventions directed to children with ASD are addressing the particular interests, weaknesses, and capabilities of every individual should be flexible and respect the time and space each individual needs to respond and progress. The final goal is to help children with ASD become more independent, be included, and thus improve the quality of their lives (Koegel et al., 2012).

In an attempt to support children with ASD in the various areas of their deficits, interventions have been carried out, which utilize the benefits of Socially Assistive Robots (SARs) (Huijnen et al., 2016).

Research utilizing Socially Assistive Robots (SARs) has been carried out in an effort to support children with ASD in many aspects of their deficits (Huijnen et al., 2016). According to those, engaging children with ASD with SAR has significant benefits in terms of improving their social skills and promoting their inclusion (Pennisi et al., 2016).

Socially Assistive Robots and ASD

SAR aims to develop effective interactions with humans, but with the primary goal of providing assistance and measurable human progress in learning, rehabilitation, skills development, etc. (Feil-Seifer & Mataric, 2005). SARs target various segments of the population, differing in age, deficits (physical/social), and need for support.

SAR is a technology that uses interactions such as speech, facial expressions, and gestures to deliver support. It is a powerful interactive tool that aids users in social rather than physical interactions (Tapus et al., 2007). With the minimum direct involvement of a skilled professional, the robot can engage in activities with the user, complete clinical roles, and provide simultaneous feedback (Feil-Seifer & Mataric, 2005). SARs are equipped with motivational, social, pedagogical, and therapeutic capabilities, allowing them to provide tailor-made interventions and rehabilitation to large groups of people such as the elderly and children with social and developmental problems, thereby improving their quality of life (Matarić & Scassellati, 2016).

Due to their social deficiencies, children with ASD must deal with a variety of social settings and must be exposed to a wide range of emotions (Baron-Cohen et al., 1985). SAR is an exciting tool that creates engaging, often playful, settings of interactions and communications that pique children's interest while also focusing their attention on the intervention's goals. They mediate interventions that motivate children with ASD to engage and involve in shared activities that improve their social skills (Abbasi, 2018,) and assist them to comprehend and express their own feelings and to recognize and accept others' emotions (Cabibihan et al., 2013).

SAR applications aim at four basic elements, according to a review of clinical use of robots for people with ASD:

- The response of children on the autism spectrum to robots compared to their response to humans
- The activation of behaviors
- Providing feedback on children's performance
- Teaching or practicing a skill (Aresti-Bartolome & Garcia-Zapirain, 2014). Robots interact with verbal and nonverbal ways and with special sensors can also respond to them. Nonverbal interaction is especially important, as children with ASD often have speech developmental delays (Kim et al., 2013). Robots create a safe environment and many opportunities for interaction by providing, if necessary, repetitive instructions with less complexity than humans, respecting the personal time each child needs to adapt and respond to the new stimuli (Thill et al., 2012).

Children with ASD can work more calmly in planned actions that imitate real- life social settings that respond to their interests, thereby lowering certain stressors and avoiding meltdowns (Pliasa & Fachantidis, 2019a, b, c). Also, as SARs are programmable, they can be designed to be simpler and more predictable than humans, making it easier for children to follow instructions, to engage in group activities, thus making the entire communication process easier (Pliasa & Fachantidis, 2019a, b, c).

From the above, it is concluded that SAR is a significant tool for children with ASD inclusion. HE students in the field of special education are accustomed to the importance of the SAR-mediated interventions, but there is a huge gap between the theoretical knowledge they receive and the opportunity to see the numerous available SAR in action, and to learn how to operate them in order to deliver interventions. According to a research, the end-user perceptions on SAR are crucial because if they do not believe they have the capability and/or expertise to operate the technology, they will never use it (Roldan et al., 2021) However, getting acquainted with SAR is not always easy as the variety of proposed robots is significant. Universities rarely have a sufficient number and plethora of SAR for their HE students' training. In addition, it is pretty demanding work to design and develop software for the wide variety of SARs' educational applications and organize hands-on training. For this reason, in an Erasmus+ project, VR technology was proposed and utilized to present robots and introduce analytical methods on how to use SAR through detailed scenarios, such as the detailed description of the outlined ARRoW method.

VR in Higher Education

Research on VR in education suggests that there is a current opportunity to (1) educate university students on how to program numerous SAR to deliver interventions, and (2) present methods and specially designed scenarios for the implementation of the interventions.

VR could be of great assist for teachers, therapists, and students to learn about the plethora of SAR and their special features, functions, and ways to employ them at their sessions, classrooms in their inclusive practices (Slavova & Mu, 2018). VR has progressed in several ways, becoming increasingly resemblant to the actual world. There are two types of virtual reality: nonimmersive and immersive. The first is a computer-based environment-simulating locations in actual or imagined worlds; the second takes the concept a step further by creating the sensation of being physically present in a nonphysical world (Cherni et al., 2020).

The environment is viewed through the use of a virtual reality headset or helmet. By mimicking as many senses as possible, such as vision, hearing, and touch, it is feasible to create a realistic environment. Three basic principles are fundamental for VR: immersion, interaction, and user involvement with the environment and narrative, and those aspects could be of great potential in education (Freina & Ott, 2015).

Because of its potential for stimulating engagement (Roussou, 2004) and motivation (Ott & Tavella, 2009), VR is frequently employed in the sectors of education and training (Leite et al., 2010). It also provides a perfect way for those who prefer a visual, aural, or kinesthetic learning style to approach, study, and recall new information (Freina & Ott, 2015).

With the introduction of the Metaverse, VR has garnered more attention as an educational tool, and many think that it is destined to affect educational practices. VR is frequently utilized in adult vocational training in all those sectors where the authentic environment or tools and methods cannot be used for practice due to a lack of access, because of the high cost, or sometimes could be extremely risky (Duan et al., 2021).

VR has a lot of benefits for learning: it gives us a direct experience of objects and events that are physically out of our reach, it allows us to train in a safe environment while avoiding real-life dangers, and it increases the learner’s involvement and motivation while expanding the range of learning styles supported thanks to the game approach. (Freina & Ott, 2015).

The potential of VR to change education has been widely discussed in the academic world as it has become more accessible in recent years. For higher education, there are already a variety of instructional activities and training processes based on VR for many disciplines (Hamilton et al., 2021). By offering a learning atmosphere that is difficult to recreate or accessible in real life, using VR as an educational tool enables novel forms and ways of visualization and presentation, motivates students’ learning, and stimulates their interest (Nissim & Weissblueth, 2017).

Scenario on SAR and ASD for HE Students

In order to provide a solution to the difficulty faced by universities to equip themselves with several different robots, and to have the expertise to program them, VR technology was utilized. and a scenario was created, utilizing the Daisy Robot, that it was designed to meet the characteristics of children with ASD. The scenario was addressed to HE students that were studying to become special education teachers. Before the scenario, HE students were given a presentation on SAR and specifically on the benefits interventions with robots have on children with ASD improvement of social skills. Moreover, the ARRoW method was outlined. They were also introduced to the VR technology and how it can be integrated into the learning process to bring significant benefits to teachers and students as well.

Subsequently, they were shown the scenario, which had five steps as its design was based on the ARRoW method. ARRoW method is a prototype method that combines the two inclusive strategies of prompting and peer-mediation interventions, with the aim of assisting children to improve their social skills toward their inclusion.

The "Daisy Robot" (Fig. 1) is a robotic flower (a flower-like robot) with anthropomorphic characteristics, created to assist children that face difficulties in communication and cooperation due to social skills and language deficiencies, such as children with ASD, attention deficit hyperactivity disorder (ADHD), etc.

It is a tool suitable for usage at schools, treatment centers, and at home, helping children develop the ability to understand verbal and nonverbal cues of communication, express themselves, and also improve their social relations with peers and other family members. The robot speaks phrases, moves its petals in different motives, makes sounds, and performs facial expressions (Pliasa & Fachantidis, 2019a, b, c).

The following elements are incorporated into the robot and the majority of them were demonstrated through the VR scenario. Pedagogical-educational aspects

- Verbal and nonverbal communication (face expression, body movements)
- Functions that allow a teacher to interact with children through the robot and achieve personalized learning.

Fig. 1 Daisy Robot

- Personalized learning and treatment, since the teacher/carer can incorporate its own material (robot's vocabulary, expressions, exercises, etc.) based on each child needs and characteristics
- Child-friendly robot
- User-friendly interface for teacher/carer/parents.
- Multi-modal interactivity
- Ease of updating and adding content (texting or dictating)
- Multimedia content
- Multiple users' support
- Holds the learner's interest
- Proper for dyadic, triadic, and other types of cooperative approaches Social aspects

- Implementation of socially assistive robotics' principles
- Flower-like robot with anthropomorphic characteristics and functions
- Huggable (proper dimension and material)
- Face expressions
- Body (body language)
- Work in a personal manner, without educator/trainer presence intervene the "safe zone" of the child (eye contact, tone of voice, dressing style, smell, body dimensions, etc.)
- Increase children's motivation
- Huge impact on individual's, relatives', and community's life
- Technological aspects
- Implementation of robotic technologies
- Interchangeable skin (proper for special needs)

• Interaction with the environment (presence detection, proper face direction, stem and petals motion, tactile sensing, voice sensing, etc.)
• Text to speech
• Speech to text (speech recognition)
• Remote communication
• Wireless communication (Bluetooth, WiFi)
• Internet of things
• Mobile technologies
• Open architecture
• Light and transferable
• Long-life operation

Before the activity, HE students were introduced to the five steps ARRoW method (Fig. 2) which consists of the following five steps (Pliasa & Fachantidis, 2019a, b, c).

Subsequently students were delivered VR headsets and were presented with the intervention that was delivered with the ARRoW method. They were to observe the features of Daisy Robot, its movements, facial expressions, and sounds that were produced, also to pay attention to the five steps of the method, and overall to the outcome of the intervention.

Scenario

In the script of five steps that was incorporated in the VR, an elementary school classroom was presented, with the Daisy Robot placed on a classroom desk. During the first step, George a child with ASD – Level 1, attending the third grade of elementary school, entered the room. We watch him approach and observe the robot until he stands in front of Daisy and starts talking to it. The robot starts asking questions to the child and we notice that the child gradually trusts the robot and enjoys the interaction. The robot then asks George to play some games, guiding the child's actions on a tablet. During the game, Daisy Robot provides George with prompts and reminds him of the game rules. When the game is finished the first step of the intervention is also completed.

In the second step a teacher accompanies the child-robot team to form a triad during the interactions. The robot sets the instructions of the games and promotes

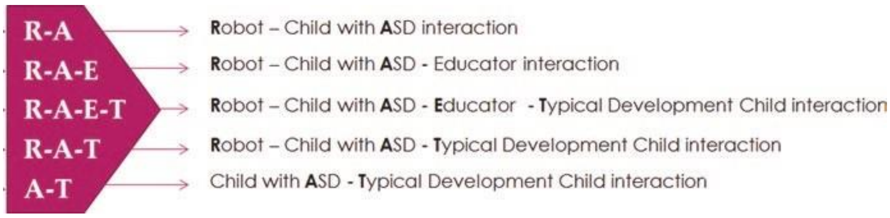

Fig. 2 ARRoW method

the dialogue as in step 1. After the conversation, George and his teacher proceed in playing the game, during which all instructions, reminders, guidance, and prompts to both are given exclusively by the robot. The robot takes on the role of educator- instructor and the teacher the role of a team mate.

During Step 3, students through the VR witness a child of typical development joining the team of the previous step. Both children and the teacher interact under the guidance and prompts of the robot as in the previous steps, George needs to adapt to the new requirements – a dialogue and a game with three people requires upgraded skills in cooperation, learning sequence and communication. As in Step 2, the robot is the coordinator; it is the one that has set the rules and reminds the players of them, the one that determines the turn of the players, and gives reinforcements and rewards.

In Step 4, the person of reference for the child with ASD (the teacher) is not present. What is interesting for this step, is for the students to see whether the cooperation and communication skills that George achieved in Steps 1, 2, and 3 are maintained, but with the minimal supportive presence, and if not, how the robot intervenes.

In Step 5, the robot waives the lead role. It retires, declares that it is tired, and remains as a simple observer of the interaction between the two children. Students are asked to note whether the skills acquired by the child with ASD in Steps 1–4 can be applied and managed in a context of equal coexistence, without guidance from a significant other, but simply through communication and cooperation with the team mate, and thus whether the whole intervention was successful.

Students' Experience

After the presentation, students were asked to describe the scenario and answered questions on the potential benefits of SAR and VR technology. Students were first asked on the script's content to determine their level of comprehension of both the robot's operation and functioning and of the method that structured the intervention. They were also asked if they believed that the VR technology had provided them with adequate data on the goal of the intervention, on the characteristics of the child with ASD, and on the role that the teacher and the child development took on.

The HE students described the specific characteristics of the Daisy Robot and justified why those are suitable for ASD. They also described the ARRoW method and the sequence of its five steps, and if they believed that VR technology efficiently assisted them to understand the capabilities of the robot, the reasoning behind the ARRoW, and whether they felt confident enough to utilize them.

The majority of the HE students admitted that VR was an effective way to demonstrate how the robot operates, its functionalities, and how it interacts with children. They indicated that they felt like they were a part of the process and that the only thing they wished for was physical contact with the robot, which virtual reality did not deliver. All of the HE students reported that they comprehended the intervention's content and that it fulfilled the steps of the ARRoW method.

They noted that they were given the opportunity to see the script's steps multiple times in order to properly understand its various features, each time from a different perspective. They felt as if they could wander around the classroom, and be present while observing the expressions of every participant. Most of the HE students said that this whole experience made them feel confident that they themselves can now carry out their own interventions utilizing Daisy.

The degree of understanding of the robot, its functionality, or how to utilize it with the ARRoW method was notably similar to that of HE students who had previously been exposed to the intervention, but with a physical demonstration of the robot, a detailed description of the method and examples of interventions.

HE students stated that they were able to identify the two inclusive strategies of prompting and peer-mediated that ARRoW combines, and agreed that it determined the role of Daisy as a mediator, facilitating the child's attachment to it, which assisted in the improvement of George's social skills toward inclusion.

All the students express their wish for more scenarios to be produced, but with more detailed descriptions of how to program the robots.

Conclusion

To summarize, with the delivered scenario, VR as a technology has proven to be successful in engaging HE students to observe Daisy's intervention with great anticipation. It is deemed necessary to incorporate examples of SAR utilization and operation into virtual reality technology and present them to each of those HE students who would later carry out interventions in the ASD population. SAR has shown its value in improving the social skills of children with ASD, and it has been portrayed as a technology capable of assisting in the inclusion of children.

Since it is pretty demanding work to develop software for the wide variety of SARs', to design educational applications and to organize hands-on training, virtual reality seems a proper tool to help institutions that lack resources and tech labs, by demonstrating the various SARs, executing actions that employ methodologies and strategies for the successful inclusion of children with ASD.

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