Virtual Reality as a solution for Children with Autism Spectrum Disorders: a state of the art systematic review

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ABSTRACT

The evolution of virtual reality (VR) technologies has been notorious, both for leisure activities and for activities related to education. The efficiency of this technology in education leads us to point out several benefits and strengths, for students with specific educational needs (SEN), especially for those with autism spectrum disorders (ASD). In this sense, the growing number of students with ASD requires us to innovate so that we can rehabilitate this group of students, giving them a better quality of life. We can improve their skills: social, behavioural, emotional, cognitive; and even their daily tasks. VR offers a panoply of tools, such as interactive three-dimensional simulations of scenarios that can be used with students with ASD. In this literature review several studies were identified, where they differ in the type of applications developed and the technology used by the students. Although optimism prevails, we need more studies on the use of this technology in educational settings. Thus, this article presents a systematic review of the state of the art on VR perspectives and case studies applied to students with ASD. Case studies are presented where VR technology has been successfully applied and with results that demonstrate the effectiveness of the technology in students with ASD. We are aware that much has to be done still to make the potential of VR an effective reality in the educational context and to allow a better quality of life for students with autism spectrum disorders. Also, we believe that in the next years teachers will be ever more capable of creating specific VR experiences. However, it is essential to have a solid theoretical basis to support the correct use of VR regarding students with ASD. This is our goal with this contribution.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Interaction devices; Displays and imagers; Human computer interaction (HCI); Interaction paradigms; Virtual reality; Interaction design; Interaction design theory, concepts and paradigms.

KEYWORDS

Virtual Reality, Virtual Environment, Autism Spectrum Disorder, Education, Human-Computer Interaction, Multimedia, Interaction Design, Teaching

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1 INTRODUCTION

In the last years, there has been an evolution in the use of technologies related to Virtual Reality (VR), both for leisure activities and for activities related to education [1]. This evolution leads these technologies to be more and more present in the teaching/learning process, propelling education towards new directions [3]. VR is playing a leading role in this area, allowing students to enjoy immersive and interactive experiences in a controlled virtual environment.

Education is seen as a knowledge construction and, in the face of this process, VR is a powerful tool available to all, in the development of new knowledge, allowing its evolution. VR presents some specificities and attributes, which makes it an advisable and applicable tool in several teaching situations. In this sense, it cannot be treated as just another tool to improve learning, but as a powerful tool to support the traditional ways of teaching.

According to [4], VR is described as a support for 21st century learning, providing new skills and new knowledge. A study, in [5], states that students are more involved in their learning activities when they put into practice the theoretical knowledge with the help of VR. Thus, the potential of VR in improving learning becomes evident, leading those involved in the educational process to choose this technology and thus adding a new dimension to the classroom.

The effectiveness of the use of VR, in an educational context, is rather limited by the need for adequate equipment and for teachers who are aware of the potential and weaknesses of the technology. Only after the elimination of some barriers and a very clear definition of the objectives to be achieved with the inclusion of virtual environments, we can take advantage of the technology and add value in the teaching/learning process [2].

VR is used in the treatment of several disorders such as phobias, post-traumatic stress disorders, obsessive-compulsive disorders and Autism Spectrum Disorders (ASD). Autism Spectrum Disorders are

considered a complex behavioural disorder that is characterised by failures in communication, behaviours, motivation and daily activities. According to [6], studies show that 40% to 80% of children with ASD show alterations in sensory processing, which is reflected in their difficulty in responding to sensory stimuli.

In the vast literature, several references are easily found to the benefits that this technology offers, especially to students with Special Educational Needs (SEN). Within the area of Special Education and taking into account the specific characteristics of this type of students, we will address students with ASD.

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder, described by showing failures in communication and social interaction, together with repetitive behaviours, interests and activities, affecting the quality of life [7]. With the growing number of students with ASD, it is necessary to develop rehabilitation programs for this type of students, using technology. The use of VR is just one example among many other technologies in order to develop these programs [8]. The interest and adherence to this technology has been demonstrated by students with ASD in their learning process [9], [10]. Thus, it has become one of the most effective solutions to meet the students' needs. This effectiveness is reported in studies, where different types of VR settings have been tried on students with different levels of disorders [11], [12].

Since VR is a human-machine interface, where computer graphics is used, it leads us to multidimensional environments, with multiple sensory channels, where students can explore the virtual environment in an autonomous way. The interaction may be performed through visual, auditory, tactile and olfactory perception, thus providing an interactive and immersive experience for the student [13]. A VR system could be available such as Head Mounted Displays (HMD), head and body tracking devices and CAVE (Cave Automatic Virtual Environment), creating the feeling of immersion in a virtual world [14]. On the other hand, Augmented Reality (AR) can be understood as another form of VR, being a way to visualize in real time, a real world that is overlaid by virtual objects [15], i.e., mixed reality.

The research that has been carried out to understand the factors that contribute to a greater effectiveness of hardware devices is notorious [17], [18]. These factors include age and gender differentiation, one of the most studied factors by researchers. In [20], it is pointed out that women are more likely to have a bad feeling due to the use of virtual environments, such as nausea symptoms. It will be essential to analyse the case studies presented, where VR was successfully implemented and what results were obtained, in order to draw well-founded conclusions on the subject.

There are several reasons to justify this review, one of which is to have an up-to-date assessment of this topic, due to the increase in relevant publications and to establish relationships with previous reviews. Another reason is the evolution of technology, teaching techniques and methods and the increase in the number of cases of students with ASD in education. Furthermore, in contrast to previous reviews, the pedagogical usefulness and graphical quality of virtual environments is increasingly evident in recent reviews.

However, there may be reasons for some resistance in applying VR to students with ASD. In this article we will point out the reasons why virtual environments may be an added value for this type of students and understand the current state of research in this area of education. We also intend to highlight the key factors for the development of virtual scenarios, thus allowing us to break down barriers and anticipate dangers so that the use of VR is not considered a setback in the development of skills.

2 METHODOLOGY

This systematic review includes several publications, from which were identified specific databases such as PubMed, ERIC, Web of Science, PsycINFO, Google Scholar, Sage and IEEE xplore. The databases used present a general variety, social science and technology literature. We use a comprehensive search strategy, drawing on terms such as virtual reality, augmented reality, computer-simulated reality, artificial reality, virtual environment, virtual world, computer-simulated environment, and autism spectrum disorder. Each search strategy will be tailored to each database.

The literature inclusion for this review took into account the literature published between 2011 and 2022. This last criterion allowed us to verify the increase in the level of interest in virtual environments using VR. The launch of the Oculus Rift Development Kit 1 (DK-1), in 2013, was pointed out as the factor that contributed to the increase of this same interest, especially in education [19].

Regarding the technical issues, as in [21], we considered analysing several case studies, in order to add new design knowledge. Moreover, in [22], it is suggested that a complete description of the contexts, the objectives, the artefacts, and the design processes should be carried out, in order to gain even more knowledge about our problem to be investigated. According to the same authors, they suggest that all the knowledge needed for the development of the artefact will be an accumulation of experiences over time. Lukyanenko et al. [23], adds that the possibility of considering multiple artefacts, as well as detail of the description and its development process, reveals the reliability and validity of the knowledge about the design process in the artefact development.

Each reference found could be included in this review, obeying criteria such as: students with ASD in education, who had or not a control group, although it was not a priority condition; groups that had been exposed to VR experiences and studies that revealed the achievement of valid results, which allowed to evaluate the effectiveness of the experience. After an analysis, we propose a set of case studies, which allow us to observe the learning outcomes. Each study was analysed and included, according to the theme addressed by us and where its experience was based on the use of VR technology.

It was found that, in some studies, the ages of the participants are not identified or only the average age of the analysed group is indicated. Thus, we analysed the studies where the topic of VR in students with ASD was addressed and where the ages were expressly stated.

After the literature review, we felt the need to incorporate the articles where the development of an artefact had occurred, as in [27], where the author proposes for the development of an artefact, the "Design Cycle" and for the acquisition of technical-scientific knowledge, he proposes a "Knowledge Cycle".

3 LITERATURE REVIEW AND PREVENTIVE REVIEWS

According to [24], for students with ASD it is sometimes difficult to interact with technology and, especially, to simulate situations that could improve emotional and social skills. They suggest that the solution is based on VR, where each situation will take the student to an immersive environment. The results obtained, by the authors, suggest that with VR we will obtain satisfactory results both in learning and in the acquisition of social skills. Other studies, with similar results, are found in research, as in [25], [26].

According to S. Parsons [29], the use of VR in education has essentially focused on two areas: in the investigation of social interactions and in the educational methodological process. For the author, the use of environments will serve fundamentally to investigate social interactions, in which he believes they provide experiences that are very close to reality and that reflect the reactions and behaviour of students in the real world. Sometimes the two worlds may function differently or even in parallel. These arguments will serve for the use of VR in various areas, such as education. Gega et al. [30], adds that VR could be included in areas where the experience allows the treatment of phobias, anxiety and even physical rehabilitation.

It is a fact that students with ASD show socioemotional weaknesses, experienced in the real world, and it is urgent to adapt the educational contexts in order to help students overcome their weaknesses. Despite the evolution of technology, we still have many challenges in developing environments that make a difference in traditional classrooms. Thus, it is necessary that the benefits of VR allow students with ASD to develop social and mainly life skills [31], [32]. For Gega et al. [30], students will be able to interact and improve the characteristics of their behaviour in a virtual environment considered realistic, where it has been developed with the aim of reducing sensory and social aspects.

To date, it is known that teachers can use VR environments to develop various skills, due to the relaxation shown by students with autism, when using tools of this kind [33], [34]. For these authors and to date, VR presents a huge range of opportunities in the education of students with learning, social, cognitive or even physical difficulties. On the other hand, we find reasons for the non-applicability of VR in the education of students with ASD.

The potential of VR has always raised discussions about its potential in education, allowing teachers to simulate activities in a controlled way, which in reality might not be possible. Students using a wheelchair could visit, for example, a museum, where they would have access to a virtual tour, but above all, have the perspective of what it is like to see reality on their feet [35]. It was therefore imperative to develop virtual environments capable of stimulating and providing experiences in controlled environments for students with ASD. According to [36], VR technology has numerous benefits when applied as a learning resource. Due to the ease of use and the motivation of students in handling the technology, it allows the customization of virtual environments and adapting, thus, to the individual needs of each student. Still, according to [36], VR offers numerous advantages, the main one being the possibility of providing safe access to realistic virtual environments, which would be considered dangerous for students. It also provides a greater flexibility and control of the task to be developed, as well as its complexity and receive feedback, either visual or even auditory, in real time, of their effort in the course of the task [37], [38].

In recent years, several state-of-the-art reviews have appeared on the use of VR for autistic students [29], [31]. VR has allowed demonstrating the improvements in this type of students, as well as showing that it is motivating in the learning process. There is evidence in the literature, that using virtual scenarios in different contexts have made it possible to improve social and learning skills, using the repetition of activities [31], [39], [40].

Despite some evidence of the use of VR in students with ASD, there is a gap in the studies carried out, as they do not make any reference and differentiation to the use of this technology in different age groups [31], [41]. In general, the literature mentions concerns about the use of VR, such as social isolation and the high cost of the technology for schools. Although in recent times this cost has been mitigated by developments in new VR technologies, some of which are low cost.

Lately, several systematic reviews have been carried out to evaluate the application of this technology in teaching different skills, such as communication and social skills [42], [43], academic skills [44] or even information processing [45]. Only Mesa-Gresa et al. [46], focused their systematic review on evaluating the effectiveness of VR applicability in students with ASD, but without presenting a statistical analysis and limited to children and adolescents. In the literature, studies were found, where a meta-analysis on VR technology, applied in children with autism is performed [46], [48]. In Grynszpan et al. [47], the meta-analysis performed is very comprehensive and the technology used in the study was based on computer game software. Since then, the number of studies has increased and in Karami et al. [48], a meta-analysis is performed, although comprehensive, but focused on VR technology and aiming to help students with ASD. Thus, systematic research of evaluation studies in students with autism were conducted and in this way the effectiveness of VR learning in improving social and communication, emotional, daily tasks and cognitive skills was evaluated. It was also evaluated and compared in which of the aforementioned skills, VR had more influence on their improvement

3.1 Definition of key terms

It is essential to define the key terms used, due to the transversality of VR research in education. In education, where all actors aim to make it effective, it is intended to have a wide knowledge in new technologies, to attract and stimulate students throughout the teaching and learning process [49]. In the various pedagogical theories VR is seen as a solution that enables participation and contributes to the interaction and involvement of students. We may find two forms of VR technology provision, namely Immersive Virtual Reality (IVR) and Desktop Virtual Reality (DVR). The two differ in the way they are used, RVD uses traditional hardware, such as keyboard and mouse, while RVI uses more specific hardware, such as HMDs. Currently, there is a wide range of equipment available that enables students to immerse themselves well. They may range from more advanced hardware such as the HTZ Vive, to lower cost hardware such as Google Cardboard [50].

The application of these hardware devices in students with ASD, will always be a challenge, due to their specific characteristics. The proof of the effectiveness of using VR for these students has yet to have more concrete results in improving their social and emotional skills. Furthermore, it is essential to think about the type of VR to be applied (immersive or non-immersive) and the type of interactions (individual or collaborative) they will have, the latter depending on the type of virtual environment. When developing virtual scenarios, all conditions must be considered, according to the characteristics of a student with ASD.

3.2 Virtual Reality and Autism

Autism spectrum disorders are characterised by deficits in areas such as social interaction, communication, and behaviour. It is essential to develop techniques that help improve the quality of life of these students and provide tools to help teachers provide the necessary care.

In this sense, virtual environments offer students with ASD an individualized, predictable experience and a safe and controlled space [51]. In this way, students will be able to improve their skills as well as their behaviour by interacting in a virtual environment with a quality very close to reality. In these environments, we will be able to reduce sensory levels, making them feel safe. In the literature, there is evidence that the repetition of social scenarios contributes to improve the same skills, allowing their adequate preparation for the real world [8], [39], [40].

As previously mentioned, we may find two means of making VR technology available, where both, present different ways in helping students with ASD. According to [52], [53], VR offers a great level of immersion and a greater realism. Whereas in the use of RVD, student interaction is more limited, in that the immersion level of realism and interaction are not present, as in RVI systems. The higher the level of immersion, the better we will assess the real-time sensory needs of the learners [54].

There has been a huge interest in the use of HMDs by these students [55], [56]. These devices allow increasing the sense of immersion in virtual environments. According to [56], the use of this type of devices has been increasing along with the development of computer graphics. Thus, students will be able to access very realistic VR content. It is important to recognize the full potential of the HMDs technology, but it will be even more important to reflect on the sensory problems adjacent to it, especially regarding sensory issues. There has been concern to carefully investigate the use of HMDs in these types of learners. In [57], some high levels of distress in the use of this technology are reported.

For Tian et al. [58], Cybersickness is a great challenge since the student is exposed to different levels of discomfort and may interrupt the immersion experience at any time. It is therefore important to find the reasons and possible solutions to face Cybersickness, so that this discomfort is tolerable.

However, it is becoming increasingly clear that the use of VR in students with ASD is a reality in education. Judging by the studies published, we found several benefits of technology when applied to this type of students, in the most diverse contexts.

4 ANALYSIS

The results of the systematic review provided evidence that there is significant improvement in students with ASD following the use of VR technology. To improve their quality of life and group integration, we should adopt intervention strategies considering their characteristics. The different approaches implemented proved to be feasible in view of the results evidenced.

In the literature review, we identified some case studies, of which we highlighted the most relevant ones (Table 1). We highlight the studies [59 - 61], due to the fact that they present statistically significant results on the topic. In general, in these studies, the results show a very high heterogeneity, which does not make it possible to analyse them.

The population studied with ASD was varied in all the studies presented, as well as the VR technology used in each study. We believe that the results presented reflect the potential that VR has in improving the skills of students with ASD [46], [48], [60 - 62].

In Berenguer et al. [63], the aim is to highlight the impact of AR in the social, cognitive and behavioural domains in students with autism. The results suggest that AR may be a way to promote students' well-being.

In Amaral et al. [62], it was analysed how virtual environments could enable the development of social competences. The main results, fully justify our previous statement. According to the authors, there was an improvement in the characteristic traits of ASD (34% in sociability; 37% in sensory/cognitive awareness; 29% in health/physical/behavioural).

As mentioned earlier, Cybersickness, for Tian et al. [58], is a major stimulus in research, to understand the reactions of students with ASD. Although several investigations have published results, these are still inconsistent about the factors that contribute to this state and possible solutions to reduce Cybersickness. Also, in [58], the main causes of Cybersickness were pointed out as being content, interaction, the human factor, hardware technology and experimental factors. The authors highlight the importance of this last factor. They also point out that, with the evolution of hardware technology, this has become the point of least concern for researchers, although it has a huge impact with regard to content factors. On the other hand, concerns are directed towards gender differentiation. Finally, for Tian et al. [58], although in the available studies several factors of Cybersickness are pointed out, as well as a great variety, it is not possible to draw valid conclusions from the literature.

5 DISCUSSION

The studies, where VR technology was applied, referenced in this review, reveal the potentialities in the learning process and in its assessment, in students with ASD. Some of the barriers identified, such as the use of VR-HMD and immersion time, show that they have been overcome. Despite the recent emergence of studies on the topic we have addressed, we believe that these could reveal even more about the potential of this emerging technology in Education.

Thus, we consider that the results obtained in the various studies limit our understanding of the relationship between the way virtual environments are implemented and the benefits achieved for students in terms of their skills. Only two studies have been presented in this area, [72] and [58]. It should be noted that only

Table 1: Studies' Analysis

Study Title	Authors
A Feasibility Clinical Trial to Improve Social Attention in Autistic Spectrum Disorder (ASD) Using a Brain Computer Interface.	Amaral et al. [62]
Using Virtual Interactive Training Agents (ViTA) with Adults with Autism and Other Developmental Disabilities	Burke et al. [59]
Innovative use of virtual reality in autism spectrum disorder: A case-study.	de Luca et al.[64]
Understanding the Psycho-Physiological Implications of Interaction With a Virtual Reality-Based System in Adolescents With Autism: A Feasibility Study.	Kuriakose & Lahiri, [65]
Virtual Travel Training for Autism Spectrum Disorder: Proof-of-Concept Interventional Study.	Simões et al. [60]
Brain responses to biological motion predict treatment outcome in young adults with autism receiving Virtual Reality Social Cognition Training: Preliminary findings.	Yang et al. [61]
Can Youth with Autism Spectrum Disorder Use Virtual Reality Driving Simulation Training to Evaluate and Improve Driving Performance? An Exploratory Study	Cox et al. [67]
Measuring the attitudes of novice drivers with autism spectrum disorder as an indication of apprehensive driving: Going beyond basic abilities	Ross et al. [68]
Brief Report: Vocational Outcomes for Young Adults with Autism Spectrum Disorders at Six Months After Virtual Reality Job Interview Training	Smith et al. [69]
Psychosocial and Computer-Assisted Intervention for College Students with Autism Spectrum Disorder: Preliminary Support for Feasibility	White et al. [70]
Psychosocial and Computer-Assisted Intervention for College Students with Autism Spectrum Disorder: Preliminary Support for Feasibility	Meindl et al. [75]
Exploring the Impact of Augmented Reality in Children and Adolescents with Autism Spectrum Disorder: A Systematic Review	Berenguer et al.[63]
Effectiveness of Virtual/Augmented Reality–Based Therapeutic Interventions on Individuals With Autism Spectrum Disorder: A Comprehensive Meta-Analysis	Karami et al. [48]
Virtual reality in autism: state of the art	Bellani et al. [12]
Autism and virtual reality head-mounted displays: a state of the art systematic review	Bradley & Newbutt, [56]
Virtual and Augmented Reality in Social Skills Interventions for Individuals with Autism Spectrum Disorder: A Scoping Review	Dechsling et al. [71]
The application of immersive virtual reality for students with ASD: A review between 1990–2017	Lorenzo et al. [52]
Effectiveness of Virtual Reality for Children and Adolescents with Autism Spectrum Disorder: An Evidence-Based Systematic Review	Mesa-Gresa et al. [46]

Adjorlu et al. [58] assessed whether the skills acquired during the experience were reflected in their daily lives.

It is essential to obtain feedback from the participants in the experiment, so that we can improve its sustainability in the reinforcement of educational interventions using virtual environments. Only in [58], [73] was the request of the participants revealed.

Throughout the experiences, in the studies presented, quantitative data were collected that reveal the interventions, preponderant of students with autism. We believe that it would be important to have qualitative data, data resulting from the interviews or even records made about the students' behaviours, so that we could assess the process of technology implementation. It is evident in all studies the success resulting from the implementation of VR in educational practice [72] and in [73] recommendations are made based on the findings.

There are several constraints that may influence the results and the understanding of them. The combination of technologies, such as HDMs, the degree of realism presented in virtual environments and the characteristics of students with autism, that is to say, the level of autism diagnosed may influence the results and the conclusions to be drawn from them [29]. In this sense, the heterogeneity of the results leads us to think about the possibility that further research is still needed, since they may not be applied to all students with ASD. In Bozgeyikli et al. [73], it is observed that students revealed their degree of immersion and that they were aware that they were immersed in an environment that was not real. This point could be indicative of the quality of the graphic realism of that same virtual environment.

Based on the results analysed in [65], it is shown that students easily adapted and accepted the use of VR, due to the innovative and originality aspects of the approaches presented. It was also notable that the approaches generated motivation in the developed activities, because they were related to daily tasks, where this type of students feel less comfortable. It should also be noted that in [60], the anxiety levels of each student were monitored, where it was found a reduction in the anxiety level in the simulation of a specific task, using VR. With lower levels of anxiety, the student is

able to obtain better results in learning, due to the regular use of technology.

It is also important to highlight the phobias, in [74], little relevant results are revealed, but above all these show how VR can be beneficial to dissipate them. In the same sense, [75], [76], corroborated these same benefits and the viability of using VR in the dissipation of some types of phobias, mentioning that some are difficult to dissipate, but the technology shows to be able to overcome some of them.

The challenge lies in designing virtual environments that are useful, which offer a high degree of realism and which fit the specificity of students with autism. We should think about how we can develop and adapt the contents, what the virtual environment should look like and how it should be arranged so that it is attractive for the student. In this way, we will have a VR technology to support the learning process, motivating students in the various tasks to be performed daily.

Limitations were found in studies, due to the non-inclusion of control groups, which may compromise the valuation of the results obtained. Only in [60],[67 - 71], the results were compared using control groups. Despite some limitations in the studies presented, all the results achieved demonstrate evidence of the benefits of using VR in various daily activities in students with ASD.

Finally, as previously mentioned, there are some dangers in using VR in students with ASD, as exposure to this type of environment may cause a setback in their learning and skills already acquired. From the review carried out, we found that a small percentage of students reported discomfort when using VR technology. Even so, as a future work, we will have to develop techniques to approach these situations. As also previously mentioned, there are sensory concerns with these students, as they may motivate different reactions to the stimuli caused by the virtual environment [77].

6 CONCLUSION AND FUTURES DIRECTIONS

The growing trend of Autism Spectrum Disorders requires efforts in terms of technology innovation and effective assessment techniques to improve students' skills [49].

At the stage of life, in which students with ASD find themselves, reveals by itself, some sensitivity in the relationship that the teacher will have to establish with them. The aim is to develop ways, with the help of VR technology, to improve their quality of life in the near future. In [78], a study is reported where it is mentioned that 20% of young people up to the age of 18 will have suffered some kind of emotional disturbance, with implications for their daily life. It is essential that students with ASD are accompanied and develop activities that allow them to mitigate their daily suffering.

In the literature, we find results that indicate the effectiveness of VR in education applied to students with ASD. There are also improvements in the various skills that students should acquire when using VR technology. That said, the approaches undertaken using VR have been shown to be viable and have been well received. Although there have been a considerable number of publications on this topic, there is still a lot of work to be done, especially in the field of evaluating the effectiveness of VR in students with ASD [79]. Such evaluation should focus on different skills, for example social and communication skills, emotional, daily tasks and cognitive skills. We should address the impact of technology and which approaches will be most appropriate for each autistic student in order to improve their quality of life [80].

When developing virtual environments, we should consider how they will be presented, taking into account the characteristics of the students. The colour, the luminosity, the arrangement of the objects in the scenario, among other aspects, will have to be considered, so that the student can obtain the best possible experience.

The research methodology should ensure that the results of the experiments are recorded, so that a systematic analysis of the data can be made. The methodology will be an important factor in involving the learner in the development of a model and ensuring that the model fits the learner's needs.

In future research, it will also be important to ensure the analysis of a Cybersickness profile, although we believe, as in [58], that characterizing a group of students will be a sensitive problem, as there will always be a variation of susceptibility among students and difficulties in measuring that susceptibility that vary according to the content of the virtual environment. It will be essential to screen students by ASD level and individual susceptibility level. In this way, we will need to develop techniques and validate the results that measure the degree of susceptibility, such as interviews, questionnaires or even recording reactions during interaction in a virtual environment. There will be a need to standardise methods to assess whether a virtual environment is a potential focus of Cybersickness. Following this proposal, it will be convenient to have a standardised database so that researchers can make comparisons between studies. The development of virtual environments should be flexible, in the sense that they will have to allow the manipulation of several factors, such as contents and different levels of control, such as movements.

Although it is difficult to access, we will need to use the technology of magnetic resonance imaging (MRI) for functional imaging (fMRI) and positron emission tomography (PET), where we can visualize brain activity during the use of VR [81], [82].

We are convinced that in the next years, with the evolution of technology, the development of attractive and creative contents, with teachers more and more capable of creating specific VR experiences, will contribute to increase the potential of VR in Education. Thus, it is essential to have a solid theoretical basis and experimentation, which will support the use of VR correctly in students with ASD.

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