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Article

Extended Reality and Special Educational Needs: Evolution, Trends and Pedagogical Perspectives

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Abstract

Extended Reality (XR), which includes augmented, virtual, and mixed reality, is gaining prominence in the field of education as a valuable didactic tool. However, its effective implementation requires consideration of classroom diversity, particularly the presence of students with special educational needs (SEN), who may require tailored adaptations. This article presents a literature review of XR-based educational interventions targeting SEN learners, conducted through structured searches in major scientific databases and applying explicit inclusion and exclusion criteria to select and analyze the most relevant peer-reviewed studies. The review examines the pedagogical approaches, types of XR technologies employed, target populations, educational levels, and the skills or competencies addressed, as well as the reported effects on academic performance and learner motivation. The findings show that most interventions focus on the development of daily living, social, and professional skills, alongside domains such as language learning, natural sciences, and attention. Overall, the evidence suggests that well-designed XR experiences tend to improve both students' academic performance and their attitudes toward learning, highlighting XR's potential as an inclusive educational tool for learners with SEN. At the same time, these results underline that successful implementation depends on careful pedagogical planning, informed technological choices, and a deep understanding of students' individual profiles, needs, and interests to ensure truly effective and inclusive use of XR in special education.

Keywords: extended reality (XR); augmented reality (AR); virtual reality (VR); special educational needs (SEN); inclusive education; educational technology

1. Introduction

In the modern classroom environment, there has been an increasing prevalence of students with particular educational needs that teachers are required to address. In this context, technology set out as a supportive resource that enables more motivating, versatile and inclusive educational practices [1], facilitating access to information, the transmission of content and interaction between students and teachers. Furthermore, technological solutions have been shown to assist in adapting the teaching-learning process to the individual needs of students [2]. A significant body of research has been dedicated to investigating the benefits of Information and Communication Technologies (ICT) in the domain of special education. [3] posit that these tools favor the principle of individualization in the teaching of students with special educational needs (SEN), allowing the sequencing of contents and activities according to their abilities. Another benefit is that they help to reduce the frustration caused by making mistakes and, due to their flexibility, promote motivation for learning [4].

Moreover, using ICT as a teaching tool has facilitated the introduction of other technologies that can benefit the teaching-learning process. Specifically, the integration of Extended Reality (XR), defined as a collection of digital resources that facilitate the convergence of real-world experiences and virtual environments, is gaining prevalence [5]. XR encompasses Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR), the main difference between them being the degree of

immersion of the user in the virtual world. [6] propose a classification system for XR, likening it to the rungs of a ladder. They designate AR as the initial step, representing the incorporation of virtual objects into real-world scenarios [7]. It is a versatile tool that adapts easily to different educational environments thanks to its special characteristics [8,9], which makes it suitable for multiple areas and educational contexts [10].

VR, on the other hand, is the final rung on the ladder, allowing the simulation of real-life scenarios in an entirely virtual world. Although it can be achieved through mobile devices, it is the head-mounted display (HMD) that produces the greatest immersion in this virtual world [11]. In recent years, this technology has undergone the most significant development in the field of education. The central step is constituted by MR, which combines the two previous ones because it introduces real elements into the virtual world and allows interaction with both [12,13]. Nevertheless, the expense of this technology makes its incorporation into educational settings difficult [5].

More and more schools are choosing to implement XR in their classrooms as a didactic resource that can be relied upon to perform the teaching-learning process in a new way [14]. This is confirmed by a recent [15] report, which refers to the rapid increase in the use of these tools in educational centers around the world to improve the quality and accessibility of education, responding to the need to adapt educational methodologies to the characteristics of today's increasingly digitalized society [16].

Studies such as [17] point out that XR provides interactive learning spaces that can be easily combined with more traditional methodologies, leading students to improve their attitudes towards learning and encourage active participation in activities.

Within the domain of special education, XR facilitates novel experiences that can be employed in conjunction with traditional pedagogical methods. It offers opportunities to convey curricular contents and cultivate diverse skills, particularly for SEN students. These students often encounter challenges in learning in the real world, due to their ability to perceive specific stimuli, which can result in frustration, uneasiness, and anxiety. In this regard, XR provides a plethora of options to address these circumstances, facilitating the acquisition of independent living skills, the reduction of disruptive behaviors, and the visualization of real-life phenomena that students are otherwise unable to access independently, through the provision of visual, auditory, and tactile information [18]. This approach fosters the development of cognitive processing, psychomotor, and communicative skills, thereby enhancing academic performance [19–21].

Despite these advantages, XR may present certain disadvantages in terms of its integration into educational centers. A significant challenge is its economic cost, which is a barrier for many of them, especially those with low budgets [5]. However, the main obstacle for the integration of these tools is the challenge for teachers to learn how to use them [22–24]. This can be a significant impediment, as misuse can lead to distraction and deviation from the intended learning objectives [5].

In the field of special education, these challenges can be exacerbated due to the necessity of adapting to the diverse needs of students, which precludes the provision of experiences catering to all individuals. The design of complex activities can result in overstimulation, anxiety, and frustration, while their improper use can lead to dizziness and eyestrain [5].

To establish an appropriate, safe, and ethical use of XR, it is imperative to modify the educational paradigm. The primary challenge lies in researching its application in this domain and securing financial support from educational institutions to acquire these technologies and train teachers. This will ensure the selection of the most suitable type of XR and the design of experiences that align with educational objectives and student needs [25].

The objective of this study, conducted by a multidisciplinary team composed of specialists in computer vision and experts in heritage education, is to ascertain the nature of XR initiatives in special education and to examine the students targeted, the technology selected, and the efficacy of the results in enhancing student performance and motivation. Moreover, the study presents a comprehensive table that can serve as a foundational reference for further research, providing a

clearer understanding of the topic based on data drawn from a detailed analysis of the existing literature.

2. Materials and Methods

2.1. Data Collection and Research Questions

To gather the data presented in this study, three literature searches were conducted using the Web of Science and Scopus databases. The results of these searches were then used to extract relevant variables and perform a qualitative analysis, as detailed in the following sections.

As previously stated, the aim of this study is to analyze the use of XR within the context of special education. This objective can also be articulated as an exploration of how XR is being applied to support students with SEN. To address this aim, the following research questions were formulated:

1. Does the use of XR as a didactic resource enhance the academic performance and motivation of students with SEN in school settings?
2. Within the field of special education, which groups of students have been most frequently targeted by XR-based interventions, and what types of technologies have been employed?
3. What kinds of content or skills are these technologies intended to teach or develop?
4. Is there a growing trend in research on the use of XR as an educational tool for students with SEN?

2.2. Search Strategies and Selection Criteria

A preliminary search was conducted on April 2, 2024, in the Scopus and Web of Science using the keywords: “special education”, “virtual reality”, “augmented reality”, “extended reality”, and “mixed reality”. The Boolean operators “AND” and “OR” were employed to refine the search, resulting in the following query: “special education” AND (“virtual reality” OR “augmented reality” OR “extended reality” OR “mixed reality”).

The initial search returned a total of 230 documents (116 in Web Of Science and 114 in Scopus).

A second search, using the same search terms, was conducted on October 30, 2024, resulting in 261 documents (130 from Scopus and 131 from Web of Science).

A third search was performed on November 7, 2024, incorporating the additional keyword “special needs” into the equation. The final search query was as follows: (“virtual reality” OR “augmented reality” OR “extended reality” OR “mixed reality”) AND (“special education” OR “special needs”).

This search yielded a total of 557 documents, with 310 found in Scopus and 247 in Web of Science. All searches were filtered by “Abstract” in both databases to ensure relevance.

The following exclusion criteria were applied during the selection process:

- Duplicate papers.
- Systematic reviews and meta-analyses.
- Books and book chapters.
- Conference proceedings.
- Doctoral theses.
- Articles focused exclusively on teacher training.

Conversely, the inclusion criteria were as follows:

- Peer-reviewed journal articles.
- Publications in any language.
- Open access availability.

After applying these criteria, the initial corpus was reduced to 233 documents. Following abstracts screening, a final sample of 59 articles was selected for in-depth analysis.

For the qualitative analysis, all 59 documents were read in full. Relevant data addressing the research questions were systematically coded. The analysis focused on the extraction of the following variables:

- Title, author(s), and year of publication
- Language of publication
- Implementation of the proposed XR activity (Yes/No)
- Type of XR employed (AR, VR, or MR)
- Nature of the technological tools used (Custom-developed vs. Commercial solutions)
- Type of SEN addressed
- Educational stage and type of institution
- Targeted skills or competencies
- Reported effect on academic performance and motivation (Improved, Unchanged, Decreased, Not reported)

Once extracted, the data were compiled and organized for all documents included in the study. These findings were then interpreted in relation to the research objectives, as discussed in the following sections.

3. Results

To begin this section, it is worth noting that the majority of the interventions described in the reviewed studies, 52 out of 59, were in fact implemented. In contrast, four interventions were not conducted, and three were still in progress at the time the articles were reviewed. Consequently, the variables pertaining to academic performance and student motivation could not be evaluated in these seven cases.

In light of this, and in response to the first research question, “Does the use of XR as a didactic resource improve the academic performance and motivation of students with SEN in school settings?”, the analysis reveals that a large proportion (81.36%) of the studies in which XR experiences were implemented reported positive effects on student performance.

However, some variations in outcomes were observed. For instance, the study by [26] implemented a MR intervention across three different schools. While two of the schools reported significant improvements in student performance, the third did not show any statistically significant changes. The authors suggest that this discrepancy may be due to the relatively short duration of the intervention in that particular school, indicating that a longer implementation period might be necessary to achieve more conclusive results.

When examining the influence of XR tools on student motivation, most of the reviewed studies (59.32%) reported an increase in learner motivation as a result of these interventions. However, a notable exception was observed in a study by [27], which reported an opposite effect. In this particular case, the authors reported no improvement in the motivation of students with special needs, attributing this finding to a lack of adaptation of the XR experience to the specific interest of the students.

In addition, 6.78% of the articles provided no information regarding changes in student performance, and 27.12% omitted any reference to motivation. Furthermore, 11.86% of the documents did not address either variable, as the corresponding XR interventions were either still underway or had not yet been implemented at the time of publication.

Taken together, the findings suggest that the use of XR as a didactic resource tends to improve both academic performance and motivation among students with SEN, with XR-based approaches generally demonstrating greater effectiveness than traditional methods.

Following the findings related to the first research question, the answer to the second question, “Which groups of students have been most frequently targeted by XR-based interventions and what types of XR have been used?”, required an initial step of categorizing and grouping the different student profiles addressed in the reviewed studies. The categories identified are as follows:

- Intellectual Disability (ID)
- Learning Difficulties (LD)
- Developmental Disability (DD)
- Motor Disability (MD)
- Sensory Disability (SD)
- Brain Injury (BI)
- Pediatric Patient (PP)
- Behavioral Disorder (BD)
- Attention-Deficit/Hyperactivity Disorder (ADHD)
- Autism Spectrum Disorder (ASD)
- Anxiety Disorder (AD)

Among these, the majority of XR-based interventions were designed for students with ASD, followed by those targeting individuals with ID. By contrast, pediatric patients were the group least frequently addressed in the reviewed experiences.

In terms of educational settings, most of the activities were conducted in mainstream schools, particularly those with special education classrooms, as well as in special education schools. These experiences primarily involved students in primary and secondary education (ages 6 to 16). By contrast, interventions in hospitals, universities, vocational training centers represented only 4.92% of all reviewed studies. Similarly, activities involving early childhood education students accounted for just 5.19% of the total.

Table 1 presents an analysis of the technologies used for each of the student groups identified above. As shown, AR emerges as the most employed technology (56.92%), followed by VR (40%). Experiences using MR are rare, representing only 3.08%, and only one study refers to XR in general terms, without specifying the exact type of technology used.

Table 1. Technologies used for each category.

Reality SEN	AR	VR	MR	Total
Intellectual Disability	19.99%	7.69%	1.54%	29.22%
Learning Difficulties	7.69%	6.15%	0.00%	13.84%
Developmental Disability	3.08%	0.00%	0.00%	3.08%
Motor Disability	3.08%	3.08%	0.00%	6.16%
Sensory Disability	3.08%	1.54%	0.00%	4.62%
Brain Injury	1.54%	0.00%	0.00%	1.54%
Pediatric Patient	1.54%	0.00%	0.00%	1.54%
Behavioral Disorder	0.00%	3.08%	0.00%	3.08%
ADHD	1.54%	1.54%	0.00%	3.08%
ASD	15.38%	15.38%	1.54%	32.30%
Anxiety Disorder	0.00%	1.54%	0.00%	1.54%
Total	56.92%	40.00%	3.08%	100.00%

These results further reveal that AR is most frequently used in interventions targeting students with ASD or ID, whereas VR is the sole technology employed in activities designed for students with behavioral or anxiety disorders.

In addition, the vast majority of studies (72.88%) report on the use of custom-built applications, specifically developed for the purposes of each individual research project.

Turning to the third research question, “What kinds of content or skills are these technologies intended to teach or develop?”, the analysis of the different documents reveals a variety of subjects on which the experiences have been designed. It is noteworthy that the most prevalent experiences pertain to skills essential for daily living, such as life skills, social skills, and professional skills. In

addition to these competencies, efforts have been made to cultivate language skills, natural sciences, and attention and concentration, which, although less frequent, were still represented across several studies. A detailed overview of the types of content and skills targeted by each experience is provided in Table 2.

Examples of activities related to life, social, and professional skills include learning to cross the street, conducting job interviews, using an ATM, serving in restaurants, symbolic play, money education, parts of the house, seasons of the year, board games, and social interaction.

Regarding language skills, activities have been developed that focus on reading, writing, and vocabulary, both in the individuals’ mother tongue and in other languages, as well as sign language, specifically Brazilian Sign Language [28]. Conversely, the domain of natural sciences included knowledge of domestic, wild, and marine animals, endangered animals, climate change, and space, among others.

To a lesser extent, experiences were developed in the areas of mathematical calculation, geometry, music, stress reduction, anxiety and aggressiveness management, and motor skills or physical education.

Finally, in response to the last question, “Is there a growing trend in research on the use of XR as an educational resource for students with SEN?”, Figure 1 shows that publications related to the topic addressed in this paper began in 2009, focusing on AR. Thereafter, there was a decline in publications concerning this technology, accompanied by an increase in publications focusing on VR.

The publication trend exhibited variability over the observed period, with AR reaching its highest peak in 2023, followed by VR in 2019, which then remained constant for the following two years.

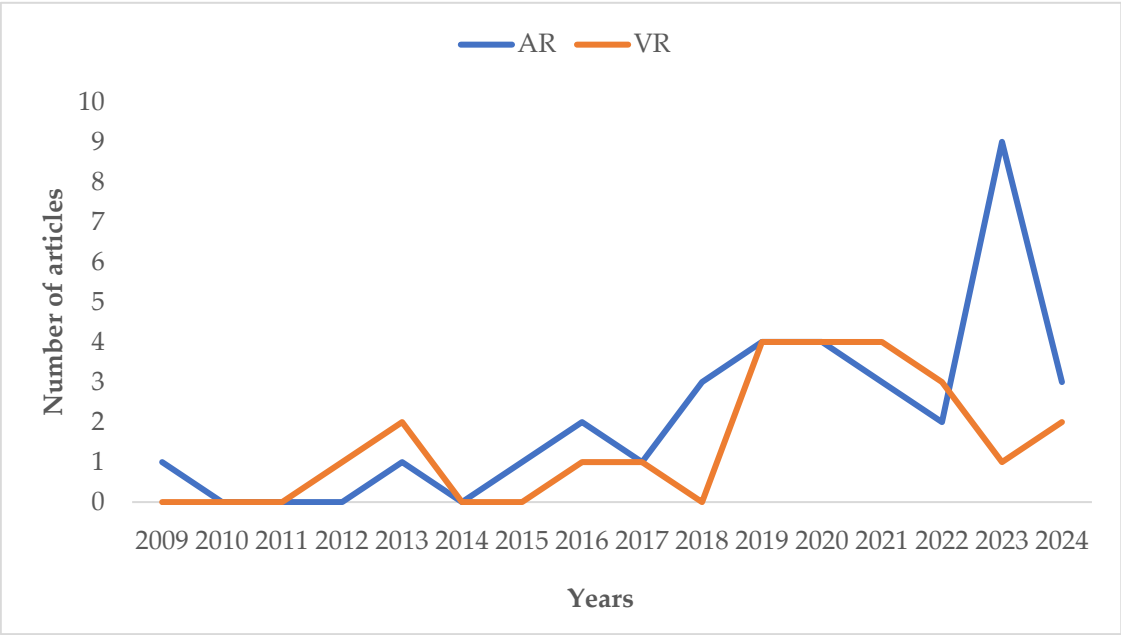


Figure 1. Evolution of articles published on the use of XR in special education (2009-2024).

This observation suggests a discernible trend in research focusing on the utilization of XR in special education, as evidenced by the increasing number of publications on this subject, as depicted in Figure 1. Notably, within the past seven years, AR has emerged as the most extensively researched area, signifying a notable shift in research focus.

It is important to note that the year 2024 cannot be evaluated at the same level as subsequent years, as the analysis was conducted using documents published up to November of the same year.

Noteworthy is the growing significance of the subject matter within South Korea, as evidenced by the predominance of the Korean language in these documents, second only to English.

To conclude this analysis, Table 2 presents a synthesis of the data extracted from each of the articles reviewed, all of which are listed in the Appendix. The table includes the reference for each study, the type of SEN addressed, the specific type of XR technology employed, the targeted skills, and whether the study reports improvements in academic performance and/or motivation. Improvements are indicated with a ✓, declines with a ✗, and “NR” denotes information not reported. This table offers a comprehensive overview of the variables defined in the study and serves as a resource for further exploration by researchers interested in this field.

Table 2. Comprehensive table of documents analyzed.

Reference*	SEN	XR technology	Targeted skills	Performance	Motivation
Abdullah et al., 2024.	ASD	AR	Concentration, attention and identification	✓	NR
Afrianto et al., 2019.	ID	AR	Linguistic skills	✓	✓
Alahmari et al., 2023.	LD	AR	Sciences	✓	✓
Alqarni, 2021.	LD	AR	Natural Sciences	✓	✓
Arvanitis et al., 2009.	MD	AR	Perception	✓	✗
Bossenbroek et al., 2020.	AD	VR	To calm anxiety	✓	✓
Bratu et al., 2024.	SD	VR	Natural Sciences	✓	NR
Cakir & Korkmaz, 2019.	ASD, MD, ID	AR	Daily life	✓	✓
Carvalho & Manzini, 2017.	SD	AR	Linguistic skills	✓	NR
Chae & Kim, 2022.	ID	AR	Maths	✓	✓
Choi, 2015.	ID	AR	NR	NR	NR
Choi et al., 2013.	DD	AR	Social skills	✓	✓
Cox et al., 2024.	ASD	AR	Maths	✓	NR
Da Silva & Romanovitch, 2016.	MD	VR	Mobility	✓	✓
Degli Innocenti et al., 2019.	LD	VR	Music	✓	✓
De Oliveira Malaquias et al., 2013.	ID	VR	Maths	✓	✓
De Vasconcelos et al., 2020.	ID	VR	Linguistic skills	✓	✓
Ha & Park, 2024.	ID, ASD, ADHD	VR	Professional skills	✓	✓
Hu & Han, 2019.	ASD	VR	Linguistic skills	✓	✓
Hyun et al., 2020.	ID	AR	Life skills	✓	NR

Iatraki & Mikropoulos, 2022.	ID	AR	Natural Sciences	✓	✓
Kan'an et al., 2023.	LD	AR	Sciences	✓	NR
Kanellos et al., 2018.	ADHD	AR	Cognitive skills	NR	NR
Kang & Chang, 2020.	ID	AR	Life skills	✓	NR
Ke & Im, 2013.	ASD	VR	Social skills	✓	NR
Khoirunnisa et al., 2023.	ASD	AR	Linguistic skills	✓	✓
Kim, 2020.	BI	AR	Mobility	✓	✓
Kim & Lee, 2016.	ID	AR	Natural Sciences	✓	✓
Kim & Han, 2019.	ID, MD	VR	Life skills	✓	✓
Kim et al., 2020.	ID	AR	Linguistic skills	✓	NR
Klein et al., 2022.	BD	VR	Control of aggression	NR	NR
Lee & Kim, 2017.	ID	VR	Natural Sciences	✓	✓
Lin et al., 2016.	LD	AR	Maths	✓	✓
López-Bouzas et al., 2023.	ASD	AR	Linguistic and socioemotional skills	✓	✓
Newbutt & Bradley, 2022.	ASD	VR	Usage of VR glasses	NR	NR
Nuguri et al., 2021.	ASD	VR	Social skills	NR	✓
Rapti et al., 2023.	ID	AR	English	✓	✓
Ravindran et al., 2019.	ASD	VR	Attention	✓	✓
Restrepo et al., 2024.	SD	XR	Natural Sciences	✓	✓
Savitha & Renumol, 2019.	ID	AR	Natural Sciences	✓	✓
Smith et al., 2021.	ASD	VR	Professional skills	✓	NR
Smith et al., 2021.	LD	VR	Professional skills	✓	NR
Syahputra et al., 2018.	ASD	AR	Attention	NR	NR
Takahashi et al., 2018.	ASD	AR	Mobility	✓	✓
Tan et al., 2022.	ASD	VR	Life skills	✓	✓
Tan et al., 2024.	ASD, ID	MR	Life skills	✓	✓
Thevin et al., 2021.	SD	AR	Games	NR	NR
Vanneste et al., 2023.	ID	AR	NR	✓	NR

Vaquero-Blasco et al., 2020.	LD	VR	To calm stress	NR	NR
Vera et al., 2012.	ASD	VR	Life skills	✓	✓
Verhoef et al., 2021.	BD	VR	Control of aggression	✓	✓
Vidal-Balea et al., 2021.	PP	AR	To calm anxiety	NR	NR
Widyaningsihet et al., 2023.	LD	AR	Physical Education	NR	NR
Wong et al., 2019.	ASD	AR	Life skills	✓	✓
Wong et al., 2023.	ASD	AR	Professional skills	✓	✓
Wu & Tsai, 2024.	ID, DD	AR	Life skills	✓	✓
Wu et al., 2023.	LD	VR	Anxiety	NR	NR
Yue et al., 2023.	ASD	AR	Social skills and attention	✓	✓
Zhai et al., 2021.	ASD	VR	Memory	✓	NR

** The articles in this table follow the order shown in the “Appendix” at the end of the references section.*

4. Discussion

This study highlights the effectiveness of XR tools in improving academic performance and motivation among students with special educational needs (SEN). While the majority of studies reviewed support this conclusion, some present divergent findings. In those cases, the authors attribute the lack of positive outcomes to XR experiences that were not well-designed or insufficiently adapted to the specific interests of the student population, thereby limiting their educational impact [27]. Notably, several articles emphasize the positive influence of XR on learners’ self-efficacy, particularly in VR and AR environments, suggesting that these technologies may enhance learning more effectively than traditional pedagogical methods. However, [29] report that combining VR with conventional teaching strategies produced better results than using VR in isolation.

The most frequently studied populations were students with ASD and intellectual disabilities. This may be attributed to the significant challenges these groups face in abstract thinking and social interaction, skills that XR can help develop by simulating realistic, immersive environments [18]. Additionally, the increased prevalence of autism in Europe, with current estimates indicating a rate of 1 in 100 [30], has likely prompted a corresponding rise in research focused on this population. According to the World Health Organization, approximately 0.76% of children worldwide are affected by autism [31]. Furthermore, as noted by [32], changes in diagnostic criteria, along with increased awareness and societal understanding of Autism Spectrum Disorder (ASD), have played a significant role in the growing number of reported cases.

In contrast, limited research has examined the use of XR in early childhood education. This may be due to ongoing debate regarding its appropriateness and effectiveness at such developmental stages. Some authors argue that XR activities are too complex for younger learners and should instead be aligned more closely with their immediate interests and developmental needs [33]. Others, however, advocate for the use of AR at this level, citing its potential to facilitate meaningful learning experiences [34].

Among the XR technologies analyzed, AR emerged as the most widely used, likely due to its accessibility and ease of integration into educational settings. [8] supports this perspective, highlighting AR’s unique characteristics that support its pedagogical implementation. Cost and technical complexity are key barriers to the broader adoption of VR, as noted by [35], who argue that

immersive VR experiences require expensive equipment and present usability challenges. Furthermore, the use of VR with students with SEN remains contentious: while [36] report instances of dizziness and discomfort associated with VR goggles, necessitating hybrid approaches, [37] observed a high level of competence and engagement among participants.

In terms of content focus, XR interventions have primarily targeted practical domains such as daily living skills, social, and professional competencies. Nonetheless, other areas, including language acquisition, natural sciences, and attention and concentration, have also received attention, reflecting the versatility of XR in addressing diverse educational needs.

5. Conclusions

XR is gaining increasing relevance in the educational domain and, when implemented appropriately, holds the potential to enhance the acquisition of knowledge among students with SEN.

This study has presented a qualitative analysis of the academic literature published in this field since 2009, leading to the conclusion that the use of XR technologies with SEN students generally supports their learning processes and fosters more positive attitudes towards education. However, the effectiveness of these interventions depends significantly on the careful planning of activities and the active involvement of educators.

For such initiatives to succeed, it is essential that teachers receive adequate training in the use of XR tools. Educators must be aware of the wide range of didactic possibilities these technologies offer, the various types of XR available, and the specific student populations to which they may be most effectively applied. In addition, attention must be paid to the interests and capabilities of participating students, ensuring that the selected XR modality aligns with the learning goals, the skills to be developed, and the characteristics of the target group.

Future research should explore teachers’ perceptions and practices regarding XR, identifying both effective and ineffective uses, as inappropriate implementation can undermine its value as an innovative and motivating educational resource. Furthermore, studies should address the pedagogical design, accessibility, and adaptability of XR tools for SEN students, as well as the selection of appropriate applications. Such efforts are crucial for advancing the meaningful integration of XR technologies in the field of Special Education.

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Abbreviations

The following abbreviations are used in this manuscript:

XR	Extended Reality
VR	Virtual Reality

AR	Augmented Reality
MR	Mixed Reality
SEN	Special Educational Needs
ID	Intellectual Disability
LD	Learning Difficulties
DD	Developmental Disability
MD	Motor Disability
SD	Sensory Disability
BI	Brain Injury
PP	Pediatric Patient
BD	Behavioral Disorder
ADHD	Attention-Deficit/Hyperactivity Disorder
ASD	Autism Spectrum Disorder
AD	Anxiety Disorder
NR	Not Reported

Appendix A

Appendix A.1. Documents Analyzed.

Abdullah, A. S.; Karthikeyan, J.; Gomathi, V.; Parkavi, R.; Rajarajeswari, P. Enabling Technology Integrated Learning for Autistic Children Using Augmented Reality Based Cognitive Rehabilitation. *SN Computer Science* **2024**, 5(151), pp. 1-11. <http://dx.doi.org/10.1007/s42979-023-02495-5>

Afrianto, I.; Faris, A. F.; Atin, S. Hijaiyah Letter Interactive Learning for Mild Mental Retardation Children using Gillingham Method and Augmented Reality. *International Journal of Advanced Computer Science and Applications* **2019**, 10(6), pp.334-341. <http://dx.doi.org/10.14569/IJACSA.2019.0100643>

Alahmari, M.; Jdaitawi, M.; Alzahrani, M.; Kholif, M.; Ghanem, R.; Nasr, N. Promoting Self-efficacy for Students with Special Needs through Augmented Reality. *International Journal of Information and Education Technology* **2023**, 13(7), pp. 1021-1026. <https://goo.su/GDaHGr>

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