

Artificial Intelligence and Extended Reality in Special Education: A Scoping Review of Current Evidence, Emerging Trends, and Future Research

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ABSTRACT:

Digital technologies are transforming instruction and generating new ways to support students with disabilities. Extended reality (XR) technologies, including virtual reality (VR), augmented reality (AR), and mixed reality (MR), along with advances in artificial intelligence (AI), provide immersive, interactive, and increasingly customized learning experiences.

This scoping review analyzes scholarly and gray literature regarding the application of AI and XR technologies in special education. Using established scoping review methodologies, literature published between the timeframe of 2010 and 2026 was examined to identify current applications, instructional outcomes, emerging trends, implementation challenges, and future directions for research and practice. Included were peer-reviewed studies, conference proceedings, policy documents, professional reports, and practitioner resources.

The overall findings uncover an expanding body of evidence supporting the use of XR technologies to increase student engagement, academic achievement, vocational preparation, community navigation, and independent living skills. This review further underscores the emerging integration of AI, enabling adaptive instruction, individualized feedback, and responsive learning experiences for students with special needs. Additional themes include the broadening of XR applications across diverse disability populations, the role of immersive technologies as assistive and accessibility tools, and the growing integration of XR and AI into educator preparation and professional development.

Keywords: Artificial Intelligence, Virtual Reality, Mixed Reality, Special Education, Transition

Introduction

Digital technologies are transforming educational practice and creating new opportunities to support diverse learners. Extended reality (XR) technologies, which include virtual reality (VR), augmented reality (AR), and mixed reality (MR), enable users to interface with digital environments and experiences, to strengthen

learning and skill development. Recent advances in education-related artificial intelligence (AI) tools have further enhanced instructional design through adaptive learning systems, customized feedback, and responsive instructional support. Current research suggests the potential of digital environments to increase engagement, promote skill acquisition, and nurture the development of

independent living skills within the safety of the classroom. These instructional innovations may provide safe, controlled, and repeatable learning experiences across learning domains.

As researchers, practitioners, and policymakers make instructional decisions, understanding current evidence, emerging trends, and implementation challenges regarding the educational impact of AI and XR is essential. Both peer-reviewed and gray literature on the topic is growing. Yet existing reviews have often focused on specific technologies, disability groups, or educational outcomes, leaving a need for a more extensive synthesis of recent developments across the field.

To address this need, this scoping review examines the current state of research and practice related to AI and XR technologies in special education. This review synthesizes scholarly and gray literature to identify key themes, educational applications, reported outcomes, and challenges. By mapping the current landscape of AI and XR in special education, this review intends to inform future research, policy, and practice, and to highlight opportunities to leverage innovative technologies to improve instructional experiences and outcomes for students with disabilities.

Statement of the Problem

Innovative XR technologies are being explored as tools to support learning, skill development, and generalization among students with disabilities. Advances in AI create new opportunities for customized and flexible XR learning experiences. Exploring the impact of technology on learning, researchers, educators, and decision-makers would benefit from an in-depth understanding of current evidence, trends, challenges, and knowledge gaps. A synthesis of recent literature is needed to map the current scope of emerging technology applications in special education and identify priorities for future research and practice.

Purpose of the Review

The purpose of this scoping review was to examine and synthesize recent scholarly and gray

literature concerning the use of emerging digital XR technologies in special education. This review sought to identify technology applications, examine educational outcomes for students with disabilities, explore AI integration, and identify challenges, limitations, and future directions for research and practice.

Objectives / Research Questions of the Review

- What is the recent body of literature related to AI and XR technologies in special education?
- What are the themes and key findings represented in AI and XR research and practice?
- What educational outcomes have been associated with AI and XR use?
- What does AI and XR research suggest as to the implications for the field of special education??
- What barriers, limitations, and research gaps exist in the current evidence base?
- What are potential recommendations for future research, policy, and educational practice regarding the use of AI and XR technologies in special education?

Methodology

Design

A scoping review methodology was used to examine the current state of research and practice of AI and XR technologies in special education. Scoping reviews are useful for exploring emerging and rapidly evolving fields by charting the range, identifying key concepts, and highlighting gaps that require additional research (Arksey & O'Malley, 2005; Munn et al., 2018). This scoping review design was informed by the methodological framework proposed by Arksey and O'Malley (2005) and Levac et al. (2010). Reporting was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR; Tricco et al., 2018).

Search Strategy

A search of scholarly and gray literature identified publications addressing the use of AI and XR

technologies in special education over the past 16 years. Search terms included combinations of keywords related to innovative and emerging technologies and special education, including "artificial intelligence," "extended reality," "virtual reality," "augmented reality," "mixed reality," "special education," "disability," "inclusive education," "autism," "intellectual disability," and "assistive technology." Scholarly sources were identified through searches of major education, psychology, and interdisciplinary databases, including: ERIC, APA PsycINFO, JSTOR, Web of Science, Education Source, Google Scholar, IEEE Xplore, ACM Digital Library, and the Michigan eLibrary (MEL).

Gray literature was located through searches of government agencies, international organizations, professional associations, educational technology publications, and other relevant practitioner-oriented sources, including UNESCO, CEC, Zarrow Institute, U.S. Department of Education, and educational organizations.

Eligibility Criteria

Sources were selected for their emphasis on the application, implementation, effectiveness, or impact of technologies for individuals with disabilities in school settings and included peer-reviewed journal articles, conference proceedings, reports, policy documents, and other relevant gray literature.

Studies that addressed only technical development without educational application, were unrelated to disability or education, or lacked sufficient information regarding their objectives and findings were excluded. Only research published from 2010 forward was considered.

Study Selection and Data Extraction

Titles and abstracts were screened to determine relevance. Full-text articles were reviewed to identify sources that met the preliminary

inclusion criteria. Data extracted from each source included publication type, target population, technology assessed, educational context, study design, primary outcomes, and principal findings.

Data Synthesis

Using scoping review methodology, the findings were synthesized using a narrative thematic approach rather than quantitative aggregation (Arksey & O'Malley, 2005). Recurring patterns, key areas of inquiry, and recurring challenges within the literature were noted. The analysis uncovered the following themes: life skills development, learner engagement, AI Integration, assistive technology, educator growth and innovation, inclusive support tool, application to a wider range of disability populations, and barriers related to access and cost.

This systematic approach provided insight into the current application of innovative digital technologies in special education settings and highlighted directions for future research and instructional practice.

Results

The literature reviewed for this study reveals an evolving body of research examining the use of XR and AI technologies in special education. Across scholarly and gray literature, researchers and practitioners increasingly recognize the potential of these emerging technologies to enhance student engagement, support skill development, and create more accessible learning opportunities for students with disabilities.

At the same time, the literature highlights the growing application of life-skills instruction, expansion to diverse disability populations, and ongoing concerns related to accessibility, implementation, and research quality. Table 1 provides a summary of the major themes, key findings, educational implications, and representative sources.

Table 1. : Themes, Key Findings, Implications, and Representative Sources from Recent Literature on Extended Reality & Artificial Intelligence Technologies in Special Education

Theme	Key Findings	Implications for Special Education	Representative Sources
Life Skills Development	Growing evidence supports the use of XR applications to develop practical life skills, vocational skills, navigation, and independent living competencies.	Expands XR use beyond traditional social-emotional interventions toward functional outcomes that support transition and independence.	Maher (2019); Mathewson (2019); Castelo (2020); Zitter (2020); Cheung, J. C.-W., et al. (2022); Demir (2022); Meccawy, (2022); Silva et al. (2022); Skjoldborg, N. M., et al. (2022); Michalski et al. (2023); Carreon,, Smith., et al. (2023) Jakubow, L., et al. (2024). Wang et al. (2024); Bouck, E., et al. (2025); Norwine & Bouck (2025); Voultsiou & Moussiades (2025); Tao & Fu (2025); Dordio et al. (2026)
Learner Engagement	Studies have shown that XR technologies help students become more engaged, motivated, and actively involved in learning while supporting the development of important academic and functional skills, regardless of disability status.	Immersive learning experiences promote active learning, knowledge retention, and authentic skill practice, supporting improved academic, functional, and social outcomes for eligible students with disabilities.	Gullen & Zimmerman (2013). Gullen & Thomas (2014); Buzio et al. (2017); Maher (2019); Zitter (2020); Demir (2022); Carreon et al. (2023); Huang & Tseng (2025); Rullyana & Triandari (2025); Dordio et al. (2026)
AI Integration	AI-enhanced XR environments are emerging as a new area of research and practice. AI may provide adaptive, personalized learning experiences through real-time feedback and responsiveness.	Offers opportunities for individualized instruction and intervention; additional empirical research is needed.	Marino, M. T. (2023). Willmore, J. (2023); Sapizon (2024); Barbu et al. (2025); Evdokia, V., (2025); Fitas, R. (2025); Harkins-Brown, A. R. et al. (2025); Kumari, R. K. (2025); Mohamed et al. (2025); Voultsiou & Moussiades (2025)
Assistive Technology	Gray literature provides practical guidance for educators and families implementing XR	Supports translation of research into practice and highlights XR's role	Bowser et al. (2014). Bowser & Reed (2018); Maher (2019); Bowser et al. (2020); UNESCO (2024); Gullen et

	technologies. XR is increasingly framed as a form of assistive technology.	in accessibility and individualized support.	al. (2025); Olivares et al. (2025); Rullyana & Triandari (2025); Dordio et al. (2026)
Educator Growth & Innovation	Research is expanding to examine how XR and AI technologies support pre-service teacher preparation, instructional technology development, and professional growth.	Findings suggest that immersive technology training enhances educator readiness, instructional effectiveness, and innovation while strengthening the evidence base for technology integration in teacher education.	Gullen et al. (2024); Morris et al. (2025); Cumming et al. (2025); Crogman et al. (2025); Alqarni (2026); Reichel et al. (2026); Gullen et al. (in press); Vaughan-Hussain et al. (in press).
Technology as an Inclusive Support Tool	XR is frequently promoted as a tool for inclusion; however, scholars caution that many applications focus on adapting individuals to existing environments rather than making environments universally accessible.	Suggests the need for Universal Design for Learning (UDL) and accessibility-focused approaches in XR development and implementation.	Gullen & Sheldon (2014). Maher (2019); Peterson-Ahmad, M. B et al. (2023); UNESCO (2024); Barbu et al (2025); Olivares et al. (2025); Rullyana & Triandari (2025); Dordio et al. (2026); Tan et al. (2026)
Application to a wider range of Disability Populations	Research is expanding beyond Autism Spectrum Disorder (ASD) to include students with intellectual, developmental, and physical disabilities.	Broadens the applicability of XR interventions and increases understanding of diverse learner needs.	Maran et al. (2022). American SPCC (2023); Wagner et al. (2025); Cerdán-Chacón et al. (2025); Demir et al. (2025); Sun et al. (2025); Tao & Fu (2025)
Access & Cost Barriers	Schools continue to face financial and technological barriers to XR adoption, including hardware costs and unequal access to technology.	Equity and sustainability considerations remain important for implementation and future research.	Maher (2019); Wagner et al. (2025)

Discussion

The body of literature of XR technologies reflects the growing interest in innovative approaches to facilitate teaching, learning, and skill

generalization for students with disabilities. Both peer-reviewed and gray literature suggest XR as a promising educational tool capable for strengthening engagement, supporting skill

acquisition, and fostering more accessible learning experiences for students with disabilities (Gullen & Zimmerman, 2013; Gullen & Thomas, 2014; Buzio et al., 2017; Maher, 2019; Zitter, 2020; Demir, 2022; Huang & Tseng, 2025; Rullyana & Triandari, 2025; Dordio et al., 2026; and Public Policy Associates, 2026).

There has been a growth of XR research in special education for the past decade, which demonstrates the growing interest of researchers, educators, and technology developers in exploring digital resources for students with disabilities. (Zhang, M. et al., 2022; Demir et al., 2025; and Gullen et al., 2025). Researchers are moving beyond initial explorations of cost and engagement and are now examining questions related to implementation, effectiveness, and long-term educational outcomes.

One of the significant developments in special education instructional resources is the integration of AI with XR technologies. Recent studies examine AI-enhanced XR environments for their ability to provide customized learning experiences through real-time adaptation, intelligent feedback, and individualized instructional supports (Sapizon, 2024; Voultsiou & Moussiades, 2025; Mohamed et al., 2025; Barbu et al., 2025). Although in their early stages, researchers have identified potential for AI-powered XR systems to tackle the diverse learning needs of students receiving special education services, research on this topic is limited and is in need for further exploration.

Another important key finding is the increasing emphasis on life-skills development. Earlier XR research frequently focused on social and emotional learning, particularly among students with autism spectrum disorder (ASD). More recent studies have expanded this focus to include practical life skills, vocational preparation, community navigation, and independent living competencies (Maher, 2019; Mathewson, 2019; Castelo, 2020; Zitter, 2020; Demir, 2022; Silva et al., 2022; Norwine & Bouck, 2025; Voultsiou & Moussiades, 2025; Tao & Fu, 2025; Dordio et al., 2026). This suggests a recognition of XR technologies as tools that can

support meaningful functional outcomes and facilitate positive transitions to adulthood for individuals with disabilities.

Although XR technologies have been integrated into many academic settings, their inclusion in special education environments remains limited due to access constraints related to specific disabilities (e.g., sensor impairments) (Maher, 2019). Schools have encountered difficulties in incorporating XR technologies due to the high costs of acquiring and maintaining hardware, software licenses, and supporting web access infrastructure. Also, initial investments, ongoing expenditures for staff professional training, technical support, device replacement and liability, and software updates are challenges to the long-term sustainability of XR in many classroom settings.

Supporting the unique needs of learners, XR is often framed as a form of assistive technology that can enhance accessibility, participation, and individualized instruction (Bowser et al., 2014; Bowser & Reed, 2018; Maher, 2019; Bowser et al., 2020; UNESCO, 2024; Gullen et al., 2025; Olivares et al., 2025; Rullyana & Triandari, 2025; and Dordio et al., 2026). As a resource for inclusive education, some research suggests that XR applications focus primarily on helping students with disabilities adapt to existing educational environments rather than transforming those environments to be more universally accessible (Gullen & Sheldon, 2014; Maher, 2019; UNESCO, 2024; Olivares et al., 2025; Rullyana & Triandari, 2025; Dordio et al., 2026; and Tan et al., 2026).

The population that XR might support is also becoming more diverse. While students with ASD continue to receive significant attention within the literature, researchers are increasingly examining the use of XR technologies with students who have intellectual, developmental, and physical disabilities (American SPCC, 2023; Wagner et al., 2025; Cerdán-Chacón et al., 2025; Demir et al., 2025; Sun et al., 2025; and Tao & Fu, 2025). This broadens the application of XR and supports a greater understanding of how

immersive technologies can support diverse learner needs.

With the increased exploration of diverse learners with disabilities accessing XR interventions, there is a need for professional development for their special education practitioners (Morris et al., 2022; Cumming et al., 2025). Morris et al. (2022) found that when teachers are trained to integrate video modeling with explicit instruction, augmented reality significantly improved mathematics skill acquisition for their learners with disabilities, in addition to supporting the teacher's ability to design lessons that support long-term maintenance and generalization of learning to authentic problem-solving tasks (Morris et al., 2022). Cumming et al. (2025) found that mixed-augmented simulations, such as TeachLivE and Mursion, provide preservice teacher candidates with realistic, low-risk environments to practice inclusive classroom management, behavior support, and de-escalation strategies. When given the opportunity for repeated rehearsal of these skills, they showed increased teacher self-efficacy and competence for inclusive schoolroom settings. Mixed-reality simulations additionally strengthened preservice teachers' readiness to design inclusive classrooms by providing authentic practice opportunities with neurodiverse learners in safe, immersive environments. These experiences enhanced the teacher's ability to create productive classroom experiences, developed self-confidence and self-efficacy, thereby increasing preparedness to support diverse learners through immersive, practice-based experiences (Cumming et al., 2025).

This literature review identifies XR as a rapidly evolving and increasingly influential area of special education research and practice. Research supports its potential to enhance engagement, skill development, and accessibility while opening new opportunities for personalized learning and life-skills instruction. Continued research is needed to address questions related to effectiveness, accessibility, implementation, and equitable access as XR technologies become more widely adopted in educational settings.

Limitations

The purpose of this scoping review was to map current research and practice, rather than to evaluate the quality or effectiveness of individual studies. In following scoping review methodology, no formal appraisal of study quality or risk of bias was performed. Therefore, the findings should be regarded as an overview of existing evidence, not as a determination of intervention effectiveness. Both peer-reviewed and gray literature sources were included. While the inclusion of gray literature enhanced understanding of emerging practices and their implementation, several studies lacked detailed descriptions of research methods, participant characteristics, and outcome measures which hindered comparisons across studies and the generalizability of findings.

Although there is increasing interest in diverse populations, the literature remains focused on ASD. As a result, evidence concerning the effectiveness of XR interventions for students with other disabilities, such as physical, sensory, and intellectual disabilities, is comparatively limited.

Several publications and search-related limitations are acknowledged. Despite reviewing multiple scholarly databases and gray literature sources, some relevant studies may not have been identified due to variations in terminology, publication practices, indexing procedures, or language restrictions. As with all literature reviews, the findings reflect the evidence available at the time of the search.

Conclusion

Emerging technologies are transforming instruction and generating new ways to support students with disabilities. Extended reality (XR) technologies, including virtual reality (VR), augmented reality (AR), and mixed reality (MR), in conjunction with advances in artificial intelligence (AI), provide immersive, interactive, and increasingly customized learning experiences.

This scoping review analyzed scholarly and gray literature regarding the application of AI and XR

technologies in special education. Using established scoping review methodologies and literature published between the timeframe of 2010 and 2026, key findings emerged: life skills development, learner engagement, AI Integration, assistive technology, educator growth and innovation, inclusive support tool, application to a wider range of disability populations, and barriers related to access and cost. The overall findings uncover an expanding

body of evidence supporting the use of XR technologies to increase student engagement, academic achievement, vocational preparation, community navigation, and independent living skills. This review further underscores the emerging integration of AI into XR environments, enabling adaptive instruction, individualized feedback, and responsive learning experiences for students with special needs.

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As this review examines the emerging roles of artificial intelligence and extended reality in education, we recognize that technology alone does not transform lives; it serves only a supporting role. The real influential impact occurs through educators who plan and implement these tools to help their students engage in new learning experiences in the safe environment of the classroom.

Author Declaration

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