LITERATURE REVIEW

Immersive Virtual Reality in Inclusive and Special Education: A Decade in Review

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Abstract

This systematic review examines immersive virtual reality (VR) applications in inclusive and special education from 2012 to 2023, with a focus on learners with neurodevelopmental conditions and closely related disability groups. Searches of eight electronic databases identified peer-reviewed studies that used head-mounted displays, Cave Automatic Virtual Environments, or comparable immersive systems in educational or training contexts. After duplicate removal, title and abstract screening, and full-text review, 47 studies met the inclusion criteria. The included studies were grouped into five areas: social and communication skills, academic and cognitive skills, life-skills and vocational preparation, educator professional development, and safety skills. The corpus is concentrated in autism spectrum disorder research, especially social-communication interventions. Studies involving attention deficit hyperactivity disorder, intellectual disability, specific learning disabilities, and sensory disabilities were less common. Most studies reported favorable learning or training outcomes, but the evidence base remains limited by small sample sizes, short interventions, incomplete follow-up, and frequent lack of comparison groups. The review identifies practical and ethical issues that should shape future work, including cybersickness, sensory load, physical-space requirements, teacher preparation, and the need to test whether gains transfer beyond the virtual environment.

Keywords — Virtual reality; Inclusive education; Special education; Autism Spectrum Disorder; Neurodevelopmental conditions; Systematic review; Human-Computer Interaction

1 Introduction

Inclusive education depends on teaching practices that can be adapted to learners who differ in communication, attention, cognition, sensory processing, and motor control. In the United States, students ages 3–21 served under the Individuals with Disabilities Education Act increased from 6.4 million in 2012–2013 to 7.5 million in 2022–2023, rising from 13% to 15% of public-school enrollment [1]. Comparable pressures are evident in other education systems, where schools are expected to provide individualized supports while maintaining access to shared curricular and social experiences.

Immersive virtual reality has become more accessible during the same period. Head-mounted displays (HMDs) and room-scale systems can place learners inside controlled, repeatable simulations while preserving a sense of presence. These affordances are relevant to inclusive and special education because they allow students to rehearse situations that are hard to stage safely in ordinary classrooms, such as crossing a street, participating in a job interview, navigating a crowded social setting, or sustaining attention in the presence of controlled distractions. Earlier work on virtual environments for autism and intellectual disability suggested that simulated settings could support practice, engagement, and transfer when tasks were designed around the learner's needs [2–4].

The promise of VR should not be treated as evidence by itself. Learners with autism spectrum disorder (ASD) may experience sensory discomfort in immersive systems [5]; children with attention deficit hyperactivity disorder (ADHD) can be vulnerable to distracting or poorly paced stimuli [6]; and learners with intellectual disability may need simplified interaction design, explicit scaffolding, and repeated practice [4]. Reviews of VR for autistic children and adolescents have therefore emphasized a tension between promising outcomes and uneven methodological quality [7, 8]. Similarly, reviews focusing on HMD-based life-skills interventions report encouraging feasibility but note that the small number of participants and limited controlled evidence prevent strong claims about effectiveness [9, 10]. A useful review must therefore ask not only whether VR interventions produce gains, but also which populations and skills have been studied, how strong the study designs are, and what practical constraints affect classroom use.

This review has three aims. First, it identifies peer-reviewed studies on immersive VR in inclusive and special education published between 2012 and 2023. Second, it summarizes the study populations, educational targets, technologies, and reported outcomes in that corpus. Third, it describes methodological and implementation issues that should guide future work. The review deliberately treats technology as one component of an instructional system: hardware, software design, teacher mediation, learner profile, and transfer activities are considered together rather than as separable factors.

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2 Background

The review centers on neurodevelopmental conditions, including ASD, ADHD, intellectual disability (ID), and specific learning disabilities (SLD), while also including a small number of studies involving closely related disability groups when the intervention was educational and immersive. These populations are not interchangeable. Students with ASD often need support for social communication and flexible behavior [2]. Students with ADHD often need support for sustained attention, response inhibition, and activity regulation [6]. Learners with ID may need concrete instruction, high levels of repetition, and opportunities to generalize skills across settings [4]. Learners with sensory disabilities may benefit from spatial, visual, or embodied representations when the task is designed accessibly [11].

Traditional classroom instruction can be difficult to individualize at the level required by these groups. VR can partly address this problem by allowing teachers and researchers to vary the complexity, pacing, sensory load, and feedback structure of an activity. For autistic learners, this adaptability can support graded exposure to social situations, explicit teaching of emotional cues, and repeated practice without the unpredictability of real peer interactions [12–14]. For learners with ADHD, virtual classrooms can separate attentional control from uncontrolled classroom variation by presenting standardized distractors and measuring performance over time [6, 15]. For learners with ID or developmental disability, the strongest rationale is often practice of functional routines, such as shopping, navigation, or vocational preparation, in settings that can be repeated until learners reach fluency [16–18]. At the same time, VR can create new barriers if the hardware is uncomfortable, the task requires fine motor skills that some learners lack, or the simulation overwhelms the user.

Desktop virtual environments have a long history in special education and rehabilitation, but immersive VR differs in the degree to which it surrounds the user and supports embodied interaction. Theoretical accounts of VR learning emphasize situated cognition, embodied learning, affect, and presence [19, 20]. In inclusive education, these features matter because many target skills are situated: social reciprocity depends on context, pedestrian decisions depend on timing and spatial layout, and vocational skills depend on realistic role-play.

Four properties recur in the literature. First, immersive environments can be standardized, allowing each learner to encounter the same scenario while researchers manipulate specific variables [21]. Second, they provide a comparatively safe space for practicing risky or stressful tasks [17, 22]. Third, immersive tasks can increase engagement when they are aligned with the learner's sensory and cognitive profile [23]. Fourth, interaction logs can capture timing, gaze, choices, and errors that are difficult to measure consistently in classroom observation [24, 25]. These affordances are especially important when the educational target requires a situated response rather than recall of factual content. Social reciprocity, pedestrian safety, job interviewing, and classroom attention all require learners to perceive cues, select a response, and adapt behavior under time pressure.

Immersion is not uniformly beneficial, however. Miller and Bugnariu [26] found that the level of immersion can affect assessment and teaching of social skills in ASD, suggesting that design decisions about display type, field of view, embodiment, and perspective can change both performance and interpretation. Work using CAVE-like and third-person role-play approaches further indicates that some learners may benefit from seeing themselves or an avatar in relation to the social scene rather than only viewing the world from a first-person perspective [27]. Thus, immersion should be treated as a manipulable instructional variable rather than a single binary property.

3 Review Methodology

3.1 Search Strategy

The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [28]. Searches were conducted in Google Scholar, IEEE Xplore, ACM Digital Library, Scopus, PubMed, Web of Science, Taylor & Francis Online, and Wiley Online Library. The search period was January 2012 through December 2023.

The search combined immersive-technology terms with education and disability terms: *("virtual reality" OR "virtual environment" OR "immersive simulation" OR "head-mounted display" OR "CAVE")* AND *("special education" OR "inclusive education" OR "autism" OR "ADHD" OR "intellectual disability" OR "learning disability" OR "developmental disability")*. Reference lists of included articles and recent reviews were screened for additional studies.

3.2 Eligibility Criteria

Studies were included when they met five criteria: (a) they appeared in a peer-reviewed journal or conference proceeding; (b) they were available in English; (c) they used an immersive VR system, including HMD, CAVE, or a comparable immersive simulation; (d) they involved learners, trainees, or educators in an educational, life-skills, vocational, safety, or classroom-management context; and (e) they were published between 2012 and 2023. Older studies and reviews were used only as background unless explicitly identified as examples of earlier work.

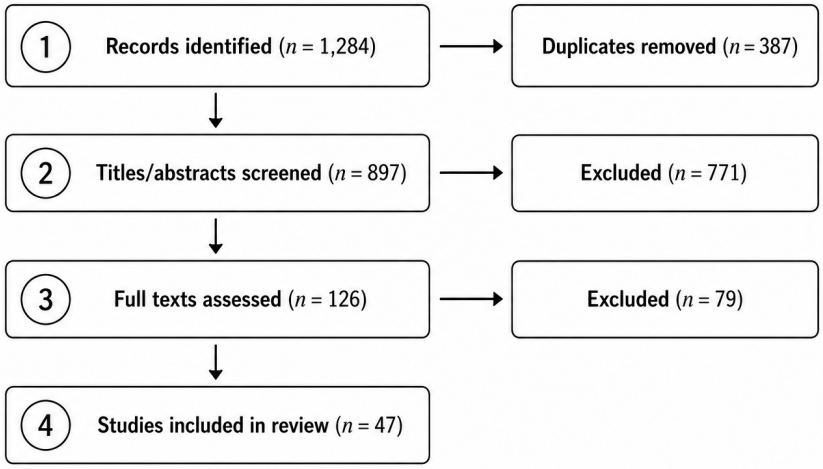

Figure 1: Selection flow for the review corpus.

Studies were excluded when they focused only on diagnosis, pharmacological treatment, or physical rehabilitation without an educational or training component; used only non-immersive desktop VR, augmented reality, or mixed reality without an immersive VR condition; were editorials, book chapters, dissertations, or non-peer-reviewed reports; or described a system without empirical evaluation.

3.3 Screening, Extraction, and Synthesis

Two reviewers screened titles and abstracts and then assessed full texts. Disagreements were resolved by discussion. Extracted variables included participant population, sample size, study design, VR platform, learning target, outcome measures, comparison condition, follow-up interval, adverse effects, and reported findings. The appendix summarizes selected studies from the extracted corpus; it is not an exhaustive list of all 47 included studies.

Because the included studies varied substantially in population, intervention target, hardware, outcome measurement, and study design, a narrative synthesis was used rather than a meta-analysis. Each study was appraised for five features that are central to educational intervention evidence: clarity of participant description, presence and appropriateness of a comparison condition, use of standardized or externally meaningful outcome measures, reporting of maintenance or transfer, and reporting of adverse effects. Single-case and feasibility studies were not treated as weak by default, but their evidentiary contribution was interpreted according to their design. For example, a multiple-baseline study with direct natural-environment probes can provide stronger evidence of functional change than a small uncontrolled pre-post study with only researcher-created VR-task measures [22]. Conversely, randomized assignment does not by itself establish educational usefulness if the outcome is limited to post-test performance in the simulation and no transfer measure is reported.

The synthesis, therefore, distinguishes between three levels of inference. First, feasibility evidence indicates that the technology can be used by the target population under supervised conditions. Second, learning evidence indicates measurable improvement on a trained or closely related task. Third, implementation evidence indicates that gains can be maintained, generalized, and integrated into school or community routines. Most included studies reached the first or second level; fewer provided strong evidence of implementation.

4 Results

The database search returned 1,284 records. After removal of 387 duplicates, 897 titles and abstracts were screened. Of these, 126 articles were assessed in full text, and 47 met all inclusion criteria. Fourteen review or meta-analysis papers were consulted for context but not counted as primary studies.

4.1 Overview of Included Studies

Table 1 shows the thematic distribution of the 47 included studies. The categories are mutually exclusive in this table. Some interventions could plausibly fit more than one area; for example, a safety-skills intervention may also involve social communication. In such cases, the study was assigned to the dominant stated learning goal. The distribution is consistent with prior ASD-focused reviews, which have found that the largest share of VR work addresses social communication, emotion recognition, social adaptation, and everyday functional skills rather than broad academic achievement [7–9].

Table 1: Classification of included studies by primary educational focus.

Primary educational focus	No. of studies	Representative references
Social and communication skills	21	[12–14, 26, 27, 29, 30]
Academic and cognitive skills	10	[6, 11, 15, 31]
Life-skills and vocational preparation	9	[4, 9, 16–18, 32]
Educator professional development	4	[33, 34]
Safety skills	3	[22, 35]

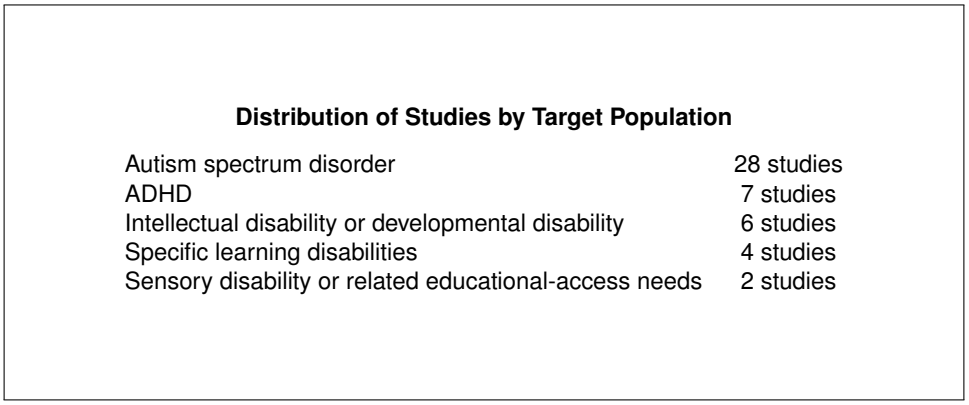

Figure 2: Number of included studies by primary target population. Categories reflect the primary population named by each study.

4.2 Social and Communication Skills

Social and communication skills were the most common focus, accounting for 21 of the 47 included studies. Most targeted learners with ASD. Kandalaft et al. [12] evaluated virtual reality social cognition training for young adults with high-functioning autism. Eight participants completed ten sessions in a collaborative virtual environment, and the authors reported gains in emotion recognition, social attribution, and theory of mind. Didehbani et al. [13] extended this approach to children with high-functioning autism and reported improvements in emotion recognition and social attribution following the intervention.

Lorenzo et al. [29] designed an immersive VR system for emotional skills training for children with ASD. Ip et al. [14] evaluated a larger school-based program in Hong Kong and reported improvements in emotional and social adaptation skills. Cheng et al. [30] used a three-dimensional immersive virtual environment to support social understanding and social skills. Miller and Bugnariu [26] showed that the level of immersion itself may shape how social skills are assessed and taught, while Tsai et al. [27] used CAVE-like role play with a third-person perspective to support social reciprocity. These studies illustrate the main strength of the ASD-focused VR literature: interventions often target clearly defined social situations that can be practiced repeatedly.

The social-skills studies also reveal substantial variation in instructional theory. Some interventions rely on repeated role-play with virtual agents, aiming to increase fluency in recognizing emotions, interpreting intentions, and responding appropriately [12, 13]. Others emphasize psychoeducation and scenario-based practice, embedding explicit teaching before and after the immersive activity [14, 36]. A third group uses adaptive or gaze-contingent systems to personalize stimulus presentation and difficulty [24, 25]. This variation is important because it means that "VR social-skills training" is not a single intervention. The active ingredients may include immersion, repetition, feedback, therapist or teacher mediation, avatar behavior, peer involvement, or structured reflection after the session.

The positive pattern should be interpreted cautiously. Many social-skills studies had small samples, short intervention periods, and limited follow-up. Parsons [21] argued that claims about authenticity and intervention effects in autism-related VR research require careful attention to transfer, ecological validity, and outcome measurement. Evidence-based reviews similarly conclude that VR interventions for autistic children and adolescents are promising, but that heterogeneity in technologies, dosage, participants, and outcomes makes it difficult to isolate which design features are responsible for improvement [7, 8]. That caution applies directly to this review corpus.

4.3 Academic and Cognitive Skills

Ten studies addressed academic or cognitive skills. For ADHD, the virtual-classroom paradigm remains influential. Rizzo et al. [15] described a classroom simulation designed to assess and train attention under controlled distractor conditions. Bioulac et al. [6] used a virtual classroom to examine time-on-task effects in children with

Table 2: Selected studies on social and communication skills.

Reference	VR system	Population	N	Reported outcome
Kandalaft et al. [12]	Collaborative virtual environment	ASD, young adults	8	Gains in social-cognition measures
Didehbani et al. [13]	Collaborative virtual environment	ASD, children	30	Improved emotion recognition and social attribution
Lorenzo et al. [29]	Immersive VR system	ASD, children	20	Improved emotional-skills measures
Ip et al. [14]	VR-enabled school program	ASD, children	94	Improved emotional and social adaptation outcomes
Cheng et al. [30]	3D immersive virtual environment	ASD, children	16	Improved social understanding and social skills

Table 3: Selected studies on academic and cognitive skills.

Reference	VR system	Population	N	Reported outcome
Rizzo et al. [15]	Virtual classroom, HMD	ADHD-related attention assessment	Review/design report	Controlled assessment of attention in classroom-like conditions
Bioulac et al. [6]	Virtual classroom	ADHD	24	Time-on-task effects on attention performance
Shema-Shiratzky et al. [31]	VR motor-cognitive training	ADHD	14	Feasible intervention with improvements in selected behavioral and cognitive outcomes
Passig and Eden [11]	Immersive VR activities	Deaf and hard-of-hearing children	44	Improved inductive reasoning, including follow-up maintenance

ADHD and found that performance changed as task demands increased over time.

More recent intervention work has moved from assessment toward training. Shema-Shiratzky et al. [31] evaluated a combined motor-cognitive VR training program for school-aged children with ADHD. Participants trained while negotiating virtual obstacles, and the authors reported feasibility and improvements in selected behavioral and cognitive measures. For learners with hearing impairments, Passig and Eden [11] reported that VR-based activities improved inductive reasoning performance, with effects maintained at follow-up.

The cognitive-skills literature is narrower and more heterogeneous than the ASD social-skills literature. In ADHD studies, VR is often used because it can approximate a classroom while keeping distractors, timing, and task demands experimentally controlled. This makes it useful for assessment and attentional training, but it also raises a transfer question: improved performance in a simulated classroom does not automatically imply improved organization, persistence, or inhibition in a real classroom. In sensory-disability- and SLD-related studies, the rationale differs. VR is used to make abstract or spatial relationships more concrete, to provide multimodal feedback, or to support repeated practice without the stigma sometimes associated with remedial instruction. Across these studies, stronger designs paired VR-task performance with independent measures, follow-up assessments, or teacher/parent reports; weaker designs relied solely on immediate post-test gains.

4.4 Life-Skills and Vocational Preparation

Nine studies examined everyday living skills or vocational preparation. Smith et al. [17] developed virtual-reality job-interview training for adults with ASD. Participants who received VR-based practice performed better on role-play interview measures than participants in the comparison condition. This line of work is notable because it links the simulation to a concrete transition outcome.

Adjorlu and Serafin [16] developed an HMD-based money-skills training application for adolescents with ASD. The study was small, but it addressed a practical target: making purchases and handling money in a controlled shopping scenario. Related work has used collaborative supermarket simulations to teach shopping routines, extending the life-skills rationale from individual practice to supported interaction with another person [37]. Standen and Brown [4] reviewed prior work on practical skills training for people with intellectual disabilities and emphasized that transfer depends on task fidelity, learner support, and opportunities to practice outside VR. Wuang et al. [18] evaluated Wii-based virtual reality with children with Down syndrome and reported improvements in sensorimotor and visual-integrative abilities compared with standard occupational therapy.

Vocational preparation is one of the more convincing use cases because simulated interviews and workplace situations can be standardized without exposing learners to repeated high-stakes failure. Smith et al. [17] reported improved role-play interview performance after VR job-interview training, and a six-month follow-up report

Table 4: Selected studies on life-skills and vocational preparation.

Reference	VR system	Population	N	Reported outcome
Smith et al. [17]	VR job-interview training	ASD, adults	26	Better role-play interview performance than comparison condition
Adjorlu and Serafin [16]	HMD-based shopping simulation	ASD, adolescents	5	Improved money-skills performance in a small feasibility study
Standen and Brown [4]	Virtual environments	Intellectual disability	Review	Practical-skills transfer reported, but not uniformly
Wuang et al. [18]	Wii-based VR	Down syndrome	105	Sensorimotor and visual-integrative gains relative to standard occupational therapy

linked the intervention to vocational outcomes for young adults with ASD [32]. The practical value of this line of work lies in the match between the training context and a real transition barrier: job interviews require social judgment, emotion regulation, verbal fluency, and adaptive responses to unexpected questions. The limitation is that employment outcomes are influenced by many external factors, including local labor markets, family support, transportation, disclosure decisions, and employer accommodations. VR should therefore be understood as one component of transition support, not a stand-alone employment intervention.

4.5 Educator Professional Development

Only four studies in the corpus focused primarily on educators. Ke et al. [33] examined teacher training in a mixed-reality integrated learning environment and reported improvements in self-efficacy following repeated practice. Bailenson et al. [34] is an adjacent learning-sciences study rather than a special-education intervention, but it is relevant because it examined how immersive VR can transform teachers', students', and social contexts in learning. Work on mixed-reality simulation in special education teacher preparation also suggests that simulated classrooms can provide repeated practice with behavior management, instructional prompting, and feedback before preservice teachers work with students in high-stakes settings [38–40]. Together, the educator-facing studies show that VR can support rehearsal and reflection, but this area remains much less developed than learner-facing intervention research.

The gap matters for implementation. Classroom use depends on teachers who can operate equipment, select appropriate scenarios, monitor adverse effects, and connect VR practice to curriculum and individualized education goals. Teachers also need to decide when a learner should stop a session, how to debrief after an immersive experience, and how to translate VR performance into next-step instruction. Without teacher preparation, promising interventions are unlikely to move beyond research settings. Future educator-facing studies should therefore measure not only teacher self-efficacy but also fidelity of implementation, quality of prompting, learner outcomes, and sustainability after the research team leaves.

4.6 Safety Skills

Three studies targeted safety-related skills. Dixon et al. [22] evaluated immersive VR safety training for pedestrian decision-making among children with ASD. After modifications to the training environment, all participants met mastery criteria in both VR and natural-environment settings. Mitchell et al. [35] used virtual environments to teach social understanding to adolescents with ASD, including situations relevant to safety and community participation. Driving and community-mobility work provides an adjacent example of the same logic: gaze-contingent and adaptive driving simulations can vary traffic demands and collect visual-attention data while avoiding real-world risk [25, 41].

Safety-skills studies show why immersive VR is attractive in special education: the method can approximate risky settings while reducing immediate danger. They also show why transfer must be measured directly. A learner's success inside a simulation is educationally meaningful only if it supports safer behavior in real environments. For this reason, the strongest safety studies include naturalistic probes or staged real-world assessments. A VR-only outcome is useful for documenting acquisition inside the program, but it should be interpreted as preliminary until the learner demonstrates safer behavior at an actual street crossing, bus stop, workplace, or school setting.

4.7 Hardware and Design Trends

HMDs were the most common hardware type in the 47 studies, followed by CAVE systems and hybrid configurations. Earlier studies often used laboratory systems or tethered HMDs; later studies used more portable devices. The shift matters for schools because setup time, supervision requirements, and available physical space affect whether an intervention can be used in ordinary classrooms.

Table 5: Selected studies across review categories.

Reference	Focus	Design	N	VR platform	Reported outcome
Kandalaft et al. [12]	Social skills	Pre–post	8	Collaborative VR	Social-cognition gains
Didehbani et al. [13]	Social skills	Pre–post	30	Collaborative VR	Improved emotion recognition and social attribution
Lorenzo et al. [29]	Social skills	Quasi-experimental	20	Immersive VR	Improved emotional-skills measures
Ip et al. [14]	Social adaptation	Mixed methods	94	VR-enabled program	Improved emotional and social adaptation outcomes
Smith et al. [17]	Vocational	Randomized trial	26	VR-JIT	Better interview role-play performance
Shema-Shiratzky et al. [31]	Cognitive/behavioral	Pre–post	14	VR motor-cognitive training	Feasible intervention with selected cognitive and behavioral improvements
Dixon et al. [22]	Safety	Multiple-baseline/single-case	3	Immersive VR	Mastery in VR and natural-environment settings
Wuang et al. [18]	Sensorimotor/life skills	Randomized trial	105	Wii-based VR	Sensorimotor and visual-integrative gains
Ke et al. [33]	Educator training	Within-subjects	37	Mixed-reality learning environment	Improved teacher self-efficacy ratings
Passig and Eden [11]	Cognitive	Experimental	44	Immersive VR activities	Improved inductive reasoning with follow-up maintenance

Across studies, effective designs tended to reduce extraneous stimuli, gradually increase task complexity, provide immediate feedback, and involve educators or learners in iterative design. These practices align with recommendations in autism-focused design research [42] and adaptive VR work [24]. They should be treated as minimum design requirements rather than optional refinements.

The hardware trend also changes the implementation problem. CAVE and laboratory systems can support precise control, full-body interaction, and group observation, but they are expensive and difficult to reproduce in schools. Standalone HMDs are more scalable, but they introduce concerns about fit, hygiene, battery life, content management, guardian consent, and supervision. Reviews of HMD use in autism emphasize that tolerance and feasibility cannot be assumed even when most participants complete sessions successfully [5,9,10]. For schools, the practical question is not only whether a device produces presence, but whether it can be used reliably by teachers with diverse learners during ordinary instructional time.

Table 5 provides selected examples from the review corpus. The table is illustrative rather than exhaustive.

5 Discussion

The clearest pattern is the concentration of research on ASD. Twenty-eight of the 47 studies targeted this population, and most of those addressed social or communication skills. This emphasis is understandable because social interaction can be simulated, repeated, and scaffolded in VR. It also reflects a long-standing expectation that virtual environments may be useful for autistic learners because they can make social situations more predictable and controllable [2, 21]. However, the concentration also leaves gaps. ADHD, ID, SLD, and sensory-disability populations appeared less often, even though these learners may benefit from controlled, embodied, and repeatable practice. The imbalance makes it difficult to draw inclusive-education conclusions beyond ASD, and it risks treating findings from one diagnostic group as if they generalize to all learners with disabilities.

The median sample size across the corpus was 22. Eleven studies used a randomized controlled design, while the rest relied on quasi-experimental, single-case, case-study, qualitative, or mixed-methods designs. Small samples are common in special-education research, but they reduce the precision of effect estimates and make subgroup analysis difficult. The limited use of follow-up assessments is another problem. Only nine studies measured maintenance for four or more weeks after the intervention. Without maintenance and data transfer, positive post-test results remain provisional.

Outcome measures were also inconsistent. Some studies used standardized instruments, while others used researcher-created tasks tied closely to the VR scenario. Scenario-specific measures are useful for detecting

learning inside the intervention, but they can overstate practical impact when not paired with measures of transfer to real classrooms, homes, workplaces, or community settings.

Three methodological issues deserve particular attention. First, many studies confound novelty, engagement, and instruction. Learners may improve because VR is motivating, because they receive more individualized adult support, because they practice more often, or because immersion itself supports learning. Second, adverse effects are inconsistently reported. The absence of a discussion of cybersickness should not be read as evidence that no discomfort occurred. Third, few studies report enough detail to support replication, including session length, number of trials, prompting procedures, feedback rules, headset model, field of view, frame rate, or criteria for terminating a session. Stronger reporting would make the evidence base more cumulative and would help schools judge whether an intervention is feasible in ordinary classrooms.

Cybersickness, discomfort, and sensory overload require explicit attention. Cobb et al. [43] described virtual reality-induced symptoms and effects, and Newbutt et al. [5] showed that most autistic participants in their pilot study tolerated an HMD, though some users still experienced discomfort. Screening, short initial sessions, opt-out procedures, and alternatives to HMD use are therefore necessary.

Schools also face practical barriers. CAVE systems require dedicated rooms. HMDs require clear physical space, supervision, hygiene procedures, and technical support. Costs have decreased, but hardware is only part of the expense. Schools also need accessible content, staff training, maintenance, and procedures for documenting how VR sessions relate to individualized educational objectives.

Equity is another implementation issue. If VR is available only to well-resourced schools or specialized laboratories, it may widen rather than reduce access gaps. Accessible design must therefore include adjustable sensory intensity, alternatives to HMD use, seated and standing modes, captioning or visual supports when appropriate, simplified controllers, and options for teacher control. Consent and assent are also important: learners should be able to stop a session without penalty, and adults should avoid interpreting reluctance to use VR as noncompliance when it may reflect sensory discomfort, anxiety, or motion sensitivity.

Good VR interventions for inclusive education require expertise in education, clinical, technical, and user experience. The reviewed studies were strongest when they connected a specific learning target to an accessible simulation and an appropriate outcome measure. Future projects should involve learners, families, teachers, clinicians, and developers early in the design process. This is especially important for sensory load, language demands, motor requirements, and cultural relevance.

6 Conclusions and Future Directions

The reviewed literature indicates that immersive VR can support social, cognitive, life-skills, vocational, and safety-related learning in inclusive and special education. The strongest concentration of work is in ASD-focused social-skills training. Smaller bodies of work address ADHD, intellectual disability, specific learning disabilities, sensory disability, educator preparation, and safety skills.

The main conclusion is not that immersive VR should be adopted broadly without qualification. Rather, the evidence supports careful, targeted use when the learning goal benefits from controlled practice, the simulation is accessible to the learner, and outcomes are measured beyond the VR task itself. Future research should prioritize larger controlled studies, pre-registered protocols, longer follow-up, direct transfer measures, and clearer reporting of adverse effects. Educator training should be studied as a core part of implementation rather than as a secondary concern.

A mature research agenda should also compare VR against credible alternatives. In some cases, video modeling, live role-play, community-based instruction, or desktop simulations may be cheaper and equally effective. VR is most justified when immersion adds something that other methods cannot provide safely or efficiently: controllable risk, embodied perspective-taking, adaptive real-time measurement, repeated practice of rare events, or realistic rehearsal of stressful situations. The next decade of research should therefore move from asking whether VR can work to asking when, for whom, at what cost, and under what implementation conditions it improves inclusive education.

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