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A Systematic Review of Digital Interventions for Enhancing Social Skills in Children with Autism Spectrum Disorder: The Role of E-Books in EIBI

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Abstract: Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by persistent impairments in social communication and interaction, which significantly affect children's adaptive functioning in daily life. Consequently, the development of social skills remains a critical focus in educational and therapeutic interventions. In recent years, digital technology has been increasingly explored as a complementary approach to support social skill development. This study aims to systematically review and synthesize empirical evidence regarding the use of digital interventions to improve social skills in children with ASD. The review focuses on digital approaches integrating behavioral principles, including Early Intensive Behavioral Intervention (EIBI), gamification, interactive e-books, and multimodal platforms. A Systematic Literature Review (SLR) was conducted in accordance with PRISMA guidelines, with literature searches conducted across Scopus, Web of Science, PubMed, ERIC, and Google Scholar. In addition, a bibliometric analysis using the Bibliometrix package was employed to map research trends and publication patterns in this field. Of the 228 identified articles, 7 studies met the inclusion criteria and were included in the final synthesis. The findings suggest that digital interventions have the potential to improve social interaction, communication, and engagement among children with ASD. However, the evidence varies depending on intervention type, study design, and implementation context. Gamification-based interventions and interactive e-books appear promising in enhancing motivation and participation, while EIBI-based digital approaches support structured skill development. The bibliometric analysis indicates a growing, multidisciplinary research trend, although its contribution is primarily descriptive, mapping the field. In conclusion, digital interventions may serve as a complementary approach to support social skill development in children with ASD. Nevertheless, given the limited number of included studies and their methodological heterogeneity, further rigorous, context-sensitive research is required.

Keywords: Autism Spectrum Disorder; digital intervention; social skills; gamification; interactive e-book.

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by persistent impairments in social communication, social interaction, and restricted patterns of behavior and interests (Oberman & Kaufmann, 2020; Rahmahtrisilvia et al., 2024). One of the most significant challenges experienced by children with ASD lies in social skill deficits, which affect their ability to engage in meaningful interactions across home, school, and community settings (Marchi, 2015; Robinson et al., 2018). Difficulties in understanding social cues, expressing emotions appropriately, initiating interactions, and adapting to social contexts often lead to social isolation and limited participation in collaborative learning environments (Karlina & Sunaengsih, 2019; Ahlers et al., 2017).

Given these challenges, the development of social skills has become a central focus in educational and therapeutic interventions for children with ASD (Mahsud & Masood, 2025; Macevilly et al., 2024). Among various approaches, Early Intensive Behavioral Intervention (EIBI), grounded in Applied Behavior Analysis (ABA), has been widely implemented due to its structured and evidence-based nature (Net et al., 2023; Avula et al., 2025). EIBI emphasizes intensive, repetitive, and systematic instruction to improve cognitive, adaptive, and social functioning. While previous studies have reported positive outcomes, their effectiveness varies depending on implementation quality, duration, and contextual factors (Estes et al., 2019).

Despite its effectiveness, the conventional implementation of EIBI presents several challenges. The approach requires substantial resources, including trained professionals, intensive time commitment, and high financial costs (Richmond et al., 2017). Moreover, its face-to-face format may limit flexibility and scalability, particularly in regions with limited access to specialized services (Manca & Delfino, 2021). These limitations highlight the need for more adaptive, accessible, and sustainable intervention models.

In this context, digital technology has emerged as a promising alternative to complement traditional interventions (Todd, Moon, & Langston, 2016). Digital interventions such as mobile applications, gamified learning environments, interactive e-books, and multimodal platforms offer opportunities to deliver structured and visually supported learning experiences aligned with the characteristics of children with ASD (Basciano & Bisagno, 2025; Sproul, 2019). Several studies suggest that digital-based approaches can enhance motivation, engagement, and opportunities for repeated practice, which are essential for social skill acquisition (Gkora, 2024; Christopoulos, 2023). In particular, interactive e-books integrated with behavioral principles, such as Discrete Trial Training (DTT), have shown potential for supporting gradual, contextually relevant learning of social behaviors (Iswari & Efrina, 2019).

However, the effectiveness of digital interventions remains inconclusive. Existing studies show considerable variability in intervention types, research designs, outcome measures, and implementation duration. Furthermore, several critical challenges remain underexplored, including issues of accessibility, digital literacy among teachers and parents, and the digital divide in low-resource or inclusive education settings. Cultural and contextual factors also play an important role in determining whether digital interventions can be effectively implemented in real educational environments.

Given these gaps, there is a need for a systematic and critical synthesis of existing evidence to understand better the role of digital interventions in supporting social skill development in children with ASD. Therefore, this study aims to systematically review empirical research on digital interventions, with a particular focus on approaches that integrate behavioral principles, such as EIBI, gamification, and interactive e-books. In addition, this study incorporates a bibliometric analysis to map research trends and identify potential directions for future research.

METHOD

Research Design

This study employed a Systematic Literature Review (SLR) approach to identify, evaluate, and synthesize empirical evidence regarding the effectiveness of digital interventions in improving social skills in children with Autism Spectrum Disorder (ASD) (Taylor et al., 2025). The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency, rigor, and replicability (Zhang et al., 2020).

In addition to the SLR, a bibliometric analysis was conducted to complement the review by mapping research trends, publication patterns, and thematic developments in the field. In this study, the bibliometric analysis was used as a descriptive analytical tool to support the interpretation of findings rather than as a primary source of evidence.

Data Sources and Search Strategy

A systematic literature search was conducted across five major scientific databases: Scopus, Web of Science, PubMed, ERIC, and Google Scholar. These databases were selected to ensure comprehensive coverage of interdisciplinary research in education, psychology, and health sciences.

The search strategy employed a combination of keywords and Boolean operators aligned with the research objectives, as follows:

> ("digital intervention" OR "digital health intervention" OR "interactive e-book" OR "gamified learning") AND ("autism spectrum disorder" OR "ASD") AND ("social skills" OR "social interaction" OR "social communication").

The search process was conducted iteratively, with keyword refinement to balance sensitivity and specificity.

Inclusion and Exclusion Criteria

Studies were selected based on predefined inclusion and exclusion criteria to ensure relevance and methodological quality.

Inclusion criteria:

1) empirical studies or systematic reviews focusing on digital interventions for children with ASD.
2) studies addressing social skills, social interaction, or communication outcomes.
3) articles published in peer-reviewed journals.
4) publications between 2014 and 2026.
5) full-text articles available in English.

Exclusion criteria:

1) studies not involving children with ASD.
2) studies not using digital technology as a core intervention component.
3) non-empirical publications (e.g., editorials, opinion papers).
4) studies not reporting outcomes related to social skills.

Study Selection Procedure

The study selection process followed the PRISMA flow, consisting of identification, screening, eligibility, and inclusion stages. Duplicate records were removed during the identification stage. Titles and abstracts were screened to assess relevance, followed by full-text evaluation for eligibility. To enhance reliability, the screening and selection process was conducted by two independent reviewers. Any discrepancies were resolved through discussion until consensus was reached.

Data Extraction and Synthesis

Data extraction was conducted using a structured extraction form including: author(s), publication year, study design, participant characteristics, type of intervention, duration, targeted social skills, and key findings.

A narrative and thematic synthesis approach was used to analyze the data, grouping studies by type of digital intervention (e.g., gamification, interactive e-books, multimodal platforms, and EIBI-based approaches). Particular attention was given to identifying similarities, differences, and patterns across studies.

Bibliometric Analysis

Bibliometric analysis was performed using the Bibliometrix package in R to examine publication trends, keyword co-occurrence, author collaboration networks, and source distribution. The purpose of this analysis was to provide a broader overview of research development and to identify emerging themes and gaps in the literature.

Validity and Reliability

The validity of this review was supported by transparent procedures that followed PRISMA guidelines, clearly defined inclusion criteria, and systematic data extraction. Reliability was enhanced by involving multiple reviewers in the screening process and using standardized procedures to minimize selection bias.

FINDING AND DISCUSSION

Finding(s)

Study Selection Results

The study selection process in this Systematic Literature Review (SLR) followed the PRISMA framework, including identification, screening, eligibility, and inclusion stages. An initial total of 228 articles was identified and systematically screened based on predefined inclusion and exclusion criteria. After a rigorous selection process, 7 studies were included in the final synthesis. Although the number of included studies is limited, the selection prioritized relevance and alignment with the research objectives.

The initial search results yielded several articles, which were then gradually selected according to established inclusion and exclusion criteria. This process aimed to ensure that the analyzed articles were topically relevant, methodologically sound, and aligned with the research objectives. Based on the overall selection stages, 7 articles were obtained that met all criteria and were subsequently analyzed in depth in this SLR.

Table 1. Results of Article Selection Process Based on PRISMA Characteristics of Selected Studies

PRISMA Stage	Number (n)
Identification	228
After Removing Duplicates	228
Title and Abstract Screening	204 included, 24 excluded
Full-Text Eligibility	29 eligible
Included in Final Synthesis	**7 articles**

The seven selected studies demonstrate substantial heterogeneity in terms of research design, intervention type, and outcome measures. While this diversity reflects the multidisciplinary nature of digital intervention research, it also limits direct comparability across studies. The included studies range from experimental and longitudinal designs to systematic reviews and prototype-based research, each contributing different levels of evidence.

The digital interventions identified in this review can be categorized into four main groups: EIBI-based digital interventions, gamification-based approaches, interactive e-books, and multimodal platforms. Although all studies aim to support social skill development, their approaches and outcome focus vary significantly, indicating a lack of standardization in intervention design and measurement.

Table 2. Summary of Selected Studies (n = 7) Results of Bibliometric Analysis Annual Scientific Production

No	Author & Year	Title	Design	Focus RQ	Key Findings
1	(Reichow et al., 2018)	Early Intensive Behavioral Intervention Program for Children With Autism in Syria	Longitudinal study, pre-test and post-test design, with 67 children ages 1-6 diagnosed with ASD	Evaluate the effectiveness of EIBI in improving skills in children with ASD.	Significant improvements in participants' scores from pre- to post-test, with no significant differences based on age or sex, but notable differences based on diagnoses.
2	(Reichow et al., 2014)	Early Intensive Behavioral Intervention (EIBI) for Young Children with Autism Spectrum Disorders (ASD)	Systematic review and meta-analysis, including 5 studies (RCT and CCT) with a total of 219 children	Assess the effectiveness of EIBI in improving functional behaviors and skills in children with ASD.	EIBI showed positive effects on adaptive behavior and IQ, but no effect on the severity of autism symptoms. Overall evidence quality was low due to methodological issues in the studies.
3	(Ji et al., 2025)	Digital health interventions targeting psychological health in parents of children with autism spectrum disorder: A scoping review	Scoping review of 53 studies from various databases (CINAHL, MEDLINE, Web of Science, etc.)	Evaluate the effectiveness of digital health interventions (DHIs) on the psychological health of parents of children with ASD.	DHIs are effective in improving psychological health, especially in managing stress and enhancing self-efficacy, with long-term benefits confirmed in most studies.
4	(Granato, 2025)	A Proposal for a Multimodal Interactive Platform for Data Collection in Autism Play-Based Therapy Sessions	Prototype design of a multimodal interactive platform integrating cameras, sensors, and data collection tools for autism play therapy	Assess the potential of an interactive platform to collect behavioral data during play-based therapy for children with autism.	The platform improves data collection efficiency and supports enhanced analysis of social participation during therapy sessions, showing promise in therapeutic and diagnostic contexts.
5	(Mounzer & Stenhoff, 2022)	Efficacy of gamified digital health interventions for children and adolescents with autism spectrum disorder: A systematic review and meta-analysis	Systematic review and meta-analysis, 21 RCTs with 1,050 participants	Evaluate the efficacy of gamified digital health interventions in improving emotional, social, executive, and motor skills in children with ASD	Significant improvements in emotional skills, social skills, executive functions, and motor skills, with superior results for sensor-based games. No significant effect on behavioral problems.
6	(Lin & Lu, 2024)	Tangible Interactive Picture Book Design: Combining Discrete Trial	Prototype design of a tangible, interactive picture book integrating DTT methods and	Evaluate the effectiveness of an interactive picture book for improving cognitive and	The interactive picture book significantly improved children's interest in learning and social skills, compared

No	Author & Year	Title	Design	Focus RQ	Key Findings
		Training methods to improve cognitive and social skills of children with autism	sensors for autism therapy	social skills in children with autism.	to traditional picture books.
7	(Liu et al., 2026)	Gamified Digital Health Interventions for Children and Adolescents with Autism Spectrum Disorder: A Systematic Review	Systematic review and meta-analysis of 21 RCTs, with 1,050 participants	Evaluate the effectiveness of gamified digital health interventions on emotional, social, executive, and motor skills for children with ASD	Significant improvements in emotional, social, executive, and motor skills, with better results from sensor-based games, but no significant change in behavioral problems.

An analysis of annual scientific production shows that publications related to digital interventions for children with Autism Spectrum Disorder have consistently increased since 2020. The peak in publications occurred in the 2024–2025 period, indicating growing global scientific community attention to the use of digital technology to support the development of social skills in children with ASD.

Results of Bibliometric Analysis: Annual Scientific Production

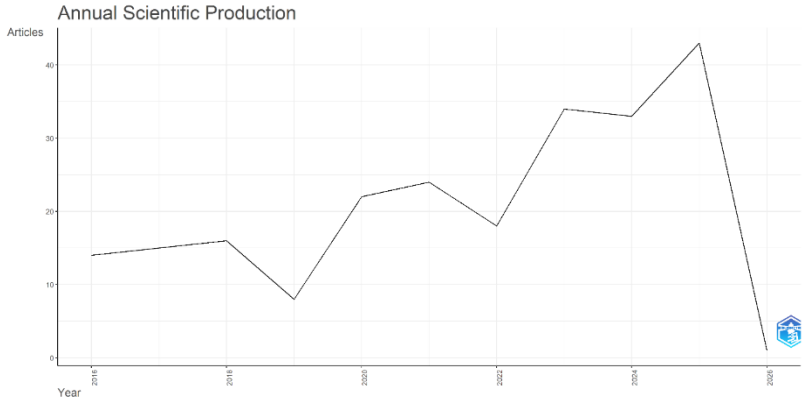

Figure 1. Annual Scientific Production Trends of Digital Interventions for Children with Autism Spectrum Disorder (2016–2026)

Figure 1 shows the annual trend in scientific production related to digital interventions for children with Autism Spectrum Disorder (ASD) during the period 2016–2026. There is a significant increase in the number of publications since 2020, with peak production in the 2024–2025 period. This pattern indicates increasing global attention and research intensity toward the utilization of digital technology in educational and therapeutic interventions for children with autism. The decline over the last year reflects the limitations of public data availability.

Most Productive Journal Sources

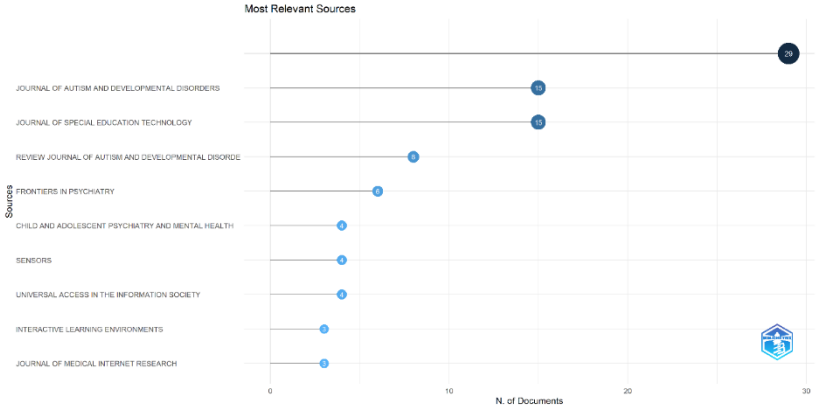

Figure 2. Most Productive Journal Sources in Digital Intervention Research on Autism

Figure 2 shows the most productive journals for publishing research on digital interventions for children with autism. These journals are dominated by the fields of autism, child and adolescent psychiatry, and educational technology, indicating that digital intervention research is multidisciplinary and integrates clinical, psychological, and pedagogical perspectives.

Distribution of Country of Correspondence Author

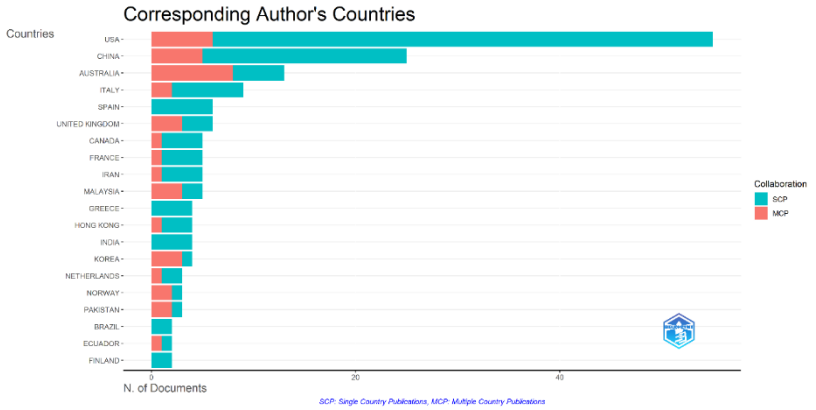

Figure 3. Distribution of Countries of Corresponding Authors in Autism Digital Intervention Research

Figure 3 shows the distribution of countries among the corresponding authors of digital intervention publications for children with autism. Most publications originate from the United States, followed by China, Australia, and several European countries. This distribution reflects the dominance of developed countries in the development, testing, and publication of technology-based digital interventions for children with Autism Spectrum Disorder.

Keyword Co-occurrence Patterns

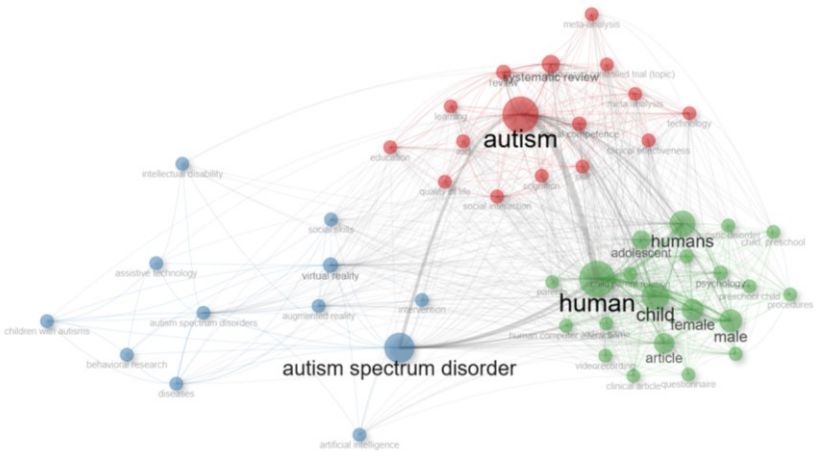

Figure 4. Co-occurrence Map of Keywords in Digital Intervention Research and Autism

Figure 4 shows a keyword co-occurrence map indicating that the terms "autism" and "autism spectrum disorder" are at the center of the research network. Both terms are closely connected to other keywords such as digital intervention, social skills, assistive technology, and artificial intelligence, indicating the main research focus on utilizing technology to support the development of social interaction and participation in children with autism.

Bibliometric Statistical Summary

Figure 5. Bibliometric Statistical Summary of Digital Intervention Research on Autism (2016–2026)

Figure 5 presents a bibliometric statistical summary covering the publication period 2016-2026, with a total of 228 documents, 980 authors, and a relatively high international collaboration rate. The average number of citations per document and the age of the documents indicate that research in this field is active and relevant, with topic development dynamics continually increasing.

When integrated with the bibliometric findings, the results suggest that although research on digital interventions for children with ASD is rapidly increasing, the empirical evidence base remains uneven. The dominance of publications from developed countries and the variability in research designs indicate that current findings may not yet be fully generalizable across different educational and cultural contexts.

Summary of Bibliometric Results

Overall, the results of the bibliometric analysis indicate that research on digital interventions for children with Autism Spectrum Disorder is an active, growing, and multidisciplinary field. The increasing trend in publications, the dominance of reputable journals, international collaboration, and the strong keyword connection between autism and digital technology indicate that digital approaches are increasingly recognized as a potential strategy for supporting the development of social skills in children with autism.

Cross-Study Analysis

A cross-study comparison reveals several important patterns. Gamification-based interventions tend to enhance motivation and engagement, which are essential for social learning. EIBI-based digital interventions provide structured, consistent learning environments that support gradual skill acquisition. Meanwhile, interactive e-books facilitate understanding of social situations through visual and narrative elements.

However, not all studies directly measure children's social skills; some focus on indirect outcomes, such as parental well-being or system usability. This inconsistency highlights the need for more standardized and comparable outcome measures in future research.

Discussion

Effectiveness of Digital Interventions in Improving Social Skills of Children with Autism Spectrum Disorder

The findings of this Systematic Literature Review (SLR) indicate that digital interventions show promising potential in supporting the development of social skills in children with Autism Spectrum Disorder (ASD). However, the strength of evidence varies across studies due to differences in research design, intervention types, and implementation contexts. Therefore, the interpretation of these findings should be approached with caution.

The integration of digital technology into EIBI-based approaches appears to provide structured, consistent learning environments that may support social skill development. Nevertheless, the effectiveness of such approaches remains dependent on factors such as implementation fidelity, intervention duration, and the level of support provided by educators or caregivers. This suggests that digital adaptation alone is insufficient without considering contextual and instructional quality.

The Role of Gamification and Interactive Media in Children's Social Engagement

The findings of this SLR also indicate that gamification-based digital interventions significantly improve children with GSA's social and emotional skills. Game elements, such as staged challenges, immediate feedback, and visual reinforcement, were effective in increasing children's motivation and engagement during the intervention process. This higher engagement contributes to increased social responsiveness, shared attention, and the child's active participation in digitally simulated social situations.

Additionally, interactive e-books that integrate the principles of Discrete Trial Training (DTT) offer advantages over conventional learning media. Interactive e-books present social material in concrete visual forms, simple narratives, and direct interaction, making it easier for children to understand social contexts gradually. This finding supports the view that digital media specifically designed and grounded in behavioral intervention principles has great potential to support the development of social skills in children with GSA. However, while gamification enhances engagement, its long-term impact on the

transfer of social skills to real-life interactions remains unclear and requires further investigation.

Digital Interventions as a Support for Social Environment and Parental Involvement

Some of the studies analyzed in this SLR also highlight the role of digital interventions in indirectly supporting parental involvement and the child's social environment. Digital health interventions not only impact children but also improve parents' understanding, readiness, and involvement in supporting their children's social skill development. Parental involvement is an important factor in the success of the intervention, as the social skills of children with GSA need to be consistently reinforced in the home and community environment.

Thus, digital interventions not only serve as therapeutic or learning tools but also as a means of collaboration between children, parents, educators, and professionals. This approach aligns with the ecological intervention paradigm, which emphasizes integrating individuals and their environment into the developmental process. Despite these advantages, empirical evidence supporting the effectiveness of interactive e-books remains limited, often relying on small-scale or prototype studies, underscoring the need for more rigorous experimental validation.

Contextual and Implementation Challenges

Despite the potential benefits of digital interventions, several contextual challenges must be considered. One major issue is the digital divide, particularly in low-resource or inclusive education settings where access to technology may be limited. In addition, the successful implementation of digital interventions depends heavily on teachers' and parents' digital literacy and readiness. Without adequate training and support, the effectiveness of these interventions may be significantly reduced.

Cultural and contextual factors also influence the adoption and use of digital interventions. Most existing studies are conducted in developed countries, which may limit the applicability of findings to different educational systems and socio-cultural environments. Therefore, future research should emphasize context-sensitive approaches that consider local needs and constraints.

Implications of Bibliometric Findings for Research Directions

The results of the bibliometric analysis support the findings of the SLR, showing that research on digital interventions for children with GSA is an active, continually developing field. The increase in publications since 2020 indicates a shift in research focus toward the use of digital technology as an innovative solution in autism interventions. The dominance of developed countries in scientific publications indicates that the development and evaluation of digital interventions are still concentrated in specific contexts, highlighting the need for further research in developing countries and diverse special education settings. While bibliometric findings provide useful insights into research trends, they do not directly indicate the effectiveness of interventions and should be interpreted as complementary information.

The co-occurrence patterns of keywords that place autism and autism spectrum disorder at the center of the network, as well as their connection to digital technology and social skills, indicate that research in this field is increasingly focused on developing interventions that are not only clinical but also educational and technology-based. This finding indicates a significant opportunity to develop digital media that are more adaptive, contextual, and oriented toward the real needs of children with GSA.

Study Limitations and Research Gaps

This study acknowledges several important limitations to consider when interpreting the findings. Although the SLR results indicate promising potential for digital interventions, some limitations warrant consideration. First, most of the studies analyzed still used research designs with considerable methodological variations, making it difficult to generalize the results. Second, the focus of interventions was often still limited to the short term, with little research evaluating the long-term sustainability of digital intervention impacts on children's social skills.

Additionally, research on adapting digital interventions to children with GSA's individual characteristics, such as functional level, age, and cultural context, remains limited. This indicates a research gap that needs to be addressed through the development and evaluation of more personalized, inclusive, and contextual digital interventions, particularly in special and inclusive educational settings.

Synthesis of Discussion

Overall, this discussion confirms that digital interventions have significant potential as a supportive approach to improving the social skills of children with Autism Spectrum Disorder. Integrating behavioral intervention principles with digital technology, such as EIBI, gamification, and interactive e-books, provides opportunities to create interventions that are more flexible, engaging, and sustainable. However, to ensure the effectiveness and sustainability of interventions, further research is needed that is more contextual, collaborative, and based on the real needs of children with ASD.

CONCLUSION

This Systematic Literature Review (SLR) indicates that digital interventions have the potential to support the development of social skills in children with Autism Spectrum Disorder (ASD). The findings suggest that approaches integrating behavioral principles, such as Early Intensive Behavioral Intervention (EIBI), gamification, and interactive e-books, may contribute to improvements in social interaction, communication, and engagement.

However, the strength of evidence remains limited due to the small number of included studies and the variability in research designs, intervention types, and outcome measures. Therefore, the results of this review should be interpreted with caution. Digital interventions should be considered as complementary tools rather than replacements for established behavioral approaches.

This review also highlights important gaps in the existing literature, including the lack of long-term evaluations, limited attention to individual differences, and insufficient consideration of contextual factors such as accessibility, digital literacy, and cultural relevance.

Future research is recommended to focus on longitudinal designs, standardized outcome measures, and the development of context-sensitive digital interventions that can be effectively implemented across diverse educational settings. Strengthening collaboration between researchers, educators, and families is also essential to ensure the sustainability and real-world applicability of digital intervention practices.

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