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Literacy Interventions as Rehabilitation Strategies for Students with Autism Spectrum Disorder: A Systematic Review

Intervenciones de alfabetización como estrategias de rehabilitación para estudiantes con trastorno del espectro autista: una revisión sistemática

Intervenções de alfabetização como estratégias de reabilitação para alunos com transtorno do espectro autista: uma revisão sistemática.

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ABSTRACT

This study systematically reviewed pedagogical and technological approaches to literacy in students with Autism Spectrum Disorder (ASD), with a focus on functional outcomes framed within a biopsychosocial rehabilitation model. Rehabilitation was operationalized as support for functional communication, literacy autonomy, and social participation, rather than solely as clinical remediation. The systematic review was conducted using the Methodi Ordinatio methodology and followed PRISMA 2020 guidelines. Articles published between 2019 and 2025 in SciELO, Scopus, Web of Science, and Science Direct were retrieved. Studies were ranked using the InOrdinatio index, and those scoring >90 were included in the final synthesis. The final synthesis analyzed 23 studies. Findings clustered into three themes: (i) reading and comprehension skills, where letter recognition is often preserved but difficulties persist in vocabulary, phonological awareness, and comprehension; (ii) pedagogical mediation practices, especially shared reading, which improve joint attention and functional communication; and (iii) digital and assistive technologies, including Augmentative and Alternative Communication (AAC) tools, which support functional literacy even for nonspeaking students. The review shows that literacy interventions for students with ASD contribute to academic performance and to rehabilitation-oriented outcomes when they expand communication, autonomy, and social

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participation. It also indicates that expanded research in underrepresented regions is essential to ensure culturally responsive and equitable practices.

Keywords: Autism Spectrum Disorder; Literacy; Assistive Technologies; Rehabilitation; Functional Outcomes; Inclusive Education; Pedagogical Mediation.

RESUMO

Este estudo realizou uma revisão sistemática das abordagens pedagógicas e tecnológicas para o letramento em estudantes com Transtorno do Espectro Autista (TEA), com foco em resultados funcionais compreendidos a partir de um modelo biopsicossocial de reabilitação. A reabilitação foi operacionalizada como apoio à comunicação funcional, à autonomia no letramento e à participação social, e não apenas como remediação clínica. A revisão sistemática foi conduzida utilizando a metodologia Methodi Ordinatio, e seguiu as diretrizes PRISMA 2020. Foram recuperados artigos publicados entre 2019 e 2025 nas bases de dados SciELO, Scopus, Web of Science e Science Direct. Os estudos foram classificados utilizando o índice InOrdinatio, e aqueles com pontuação >90 foram incluídos na síntese final. A síntese final analisou 23 estudos. Os resultados foram agrupados em três temas: (i) habilidades de leitura e compreensão, onde o reconhecimento de letras é frequentemente preservado, mas as dificuldades persistem no vocabulário, na consciência fonológica e na compreensão; (ii) práticas de mediação pedagógica, especialmente a leitura compartilhada, que melhoram a atenção conjunta e a comunicação funcional; e (iii) tecnologias digitais e assistivas, incluindo ferramentas de Comunicação Aumentativa e Alternativa (CAA), que apoiam o letramento funcional mesmo para estudantes não verbais. A análise indica que as intervenções de alfabetização para alunos com TEA contribuem para o desempenho acadêmico e para desfechos orientados à reabilitação quando ampliam comunicação, autonomia e participação social. Demonstra ainda que a expansão da pesquisa em regiões sub-representadas é essencial para garantir práticas culturalmente sensíveis e equitativas.

Palavras-chave: Transtorno do Espectro Autista; Alfabetização; Tecnologias Assistivas; Reabilitação; Resultados Funcionais; Educação Inclusiva; Mediação Pedagógica.

RESUMEN

Este estudio revisó sistemáticamente los enfoques pedagógicos y tecnológicos para la alfabetización en estudiantes con Trastorno del Espectro Autista (TEA), con un enfoque en los resultados funcionales comprendidos desde un modelo biopsicosocial de rehabilitación. La rehabilitación se operacionalizó como apoyo a la comunicación funcional, la autonomía en la alfabetización y la participación social, y no solo como remediación clínica. La revisión sistemática se realizó utilizando la metodología Methodi Ordinatio, y seguió las directrices

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PRISMA 2020. Se recuperaron artículos publicados entre 2019 y 2025 en SciELO, Scopus, Web of Science y Science Direct. Los estudios se clasificaron utilizando el índice InOrdinatio, y aquellos con una puntuación >90 se incluyeron en la síntesis final. La síntesis final analizó 23 estudios. Los hallazgos se agruparon en tres temas: (i) habilidades de lectura y comprensión, donde el reconocimiento de letras a menudo se conserva, pero persisten dificultades en vocabulario, conciencia fonológica y comprensión; (ii) prácticas de mediación pedagógica, especialmente lectura compartida, que mejoran la atención conjunta y la comunicación funcional; y (iii) tecnologías digitales y de asistencia, incluidas las herramientas de Comunicación Aumentativa y Alternativa (CAA), que apoyan la alfabetización funcional incluso para estudiantes que no hablan. El análisis indica que las intervenciones de alfabetización para estudiantes con TEA contribuyen al rendimiento académico y a resultados orientados a la rehabilitación cuando amplían la comunicación, la autonomía y la participación social. También muestra que ampliar la investigación en regiones subrepresentadas es esencial para garantizar prácticas culturalmente sensibles y equitativas.

Palabras clave: Trastorno del Espectro Autista; Alfabetización; Tecnologías de Asistencia; Rehabilitación; Resultados Funcionales; Educación Inclusiva; Mediación Pedagógica.

Introduction

Literacy, defined as the ability to read and write, is not only a fundamental educational goal but also a core element of rehabilitation, enabling functional communication, autonomy, and participation in society. International organizations, including the United Nations (UN) and UNESCO, emphasize inclusive education and rehabilitation as pillars of sustainable development and human rights (UNESCO, 1994; 2020; World Health Organization, 2011). Within rehabilitation frameworks, literacy skills are recognized as essential for enhancing the quality of life, fostering independence, and supporting social inclusion for individuals with disabilities.

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by persistent difficulties in social communication and restricted, repetitive behaviors (American Psychiatric Association, 2013; World Health Organization, 2022). These characteristics can significantly impact the acquisition of literacy skills, affecting not only academic performance but also functional outcomes such as communication, social participation, and adaptive behavior. Research demonstrates that many students with ASD achieve adequate letter recognition but continue to face challenges in vocabulary, phonological awareness, and reading comprehension (Ribeiro et al., 2021; Solari et al., 2022). Addressing these challenges is therefore critical not only for educational achievement but also for rehabilitation-oriented goals.

Global frameworks such as the Salamanca Statement (UNESCO, 1994), the Convention on the Rights of Persons with Disabilities (UN, 2006), and the World Report

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on Disability (World Health Organization, 2011) call for inclusive strategies that link education, health, and rehabilitation. In Brazil, national milestones – including the Federal Constitution of 1988, the National Policy on Special Education (Brazil, 2008), the Berenice Piana Law (2012), and the Brazilian Inclusion Law (2015) – have expanded access to education and rehabilitation services. However, barriers remain, including regional inequalities, insufficient teacher and therapist training, and limited access to assistive technologies (Mantoan, 2003; 2015).

To avoid treating rehabilitation as a generic label, this review adopts a biopsychosocial model aligned with the International Classification of Functioning, Disability and Health (ICF). In this model, rehabilitation is understood as a process that strengthens functioning by reducing activity limitations and participation restrictions through environmental, communicative, pedagogical, and technological supports. Therefore, literacy interventions are interpreted as rehabilitation strategies when they produce or support functional outcomes – communicating needs, following written instructions, making choices, participating in classroom routines, and accessing social interaction – rather than only when they improve isolated academic scores (World Health Organization, 2001; World Health Organization & The World Bank, 2011).

Evidence highlights promising practices. Pedagogical mediation, particularly shared reading, has shown positive effects not only on comprehension but also on functional communication and joint attention (Boyle et al., 2019; Wicks et al., 2020; Fleury et al., 2021). Similarly, digital and assistive technologies – including ABRACADABRA, Headsprout®, and AAC tools – have demonstrated the capacity to enhance functional literacy, promoting autonomy in both verbal and nonspeaking students (Arciuli & Bailey, 2019; Caron et al., 2021; Thompson et al., 2022; Jaswal et al., 2024).

In this context, the present review examines the recent literature (2019–2025) using the Methodi Ordinatio methodology, aiming to identify pedagogical and technological strategies that contribute to literacy and rehabilitation-oriented functional outcomes. The review therefore analyzes not only whether interventions improve reading and writing performance, but also whether they support communication, autonomy, and participation in educational and everyday contexts.

Methods

The registration protocol for this review was maintained on the Open Science Framework (OSF) platform. The initial registration was updated throughout the review process to reflect changes in the research scope and methodological approach. These updates were appropriately documented in the methods section and registered with the OSF, ensuring transparency. The full protocol is available on the OSF registration page, including the methodological outline, implementation timeline, and data extraction spreadsheet template. The registration is publicly accessible under the DOI: https://doi.org/10.17605/OSF.IO/KZ4PR

Design of the review

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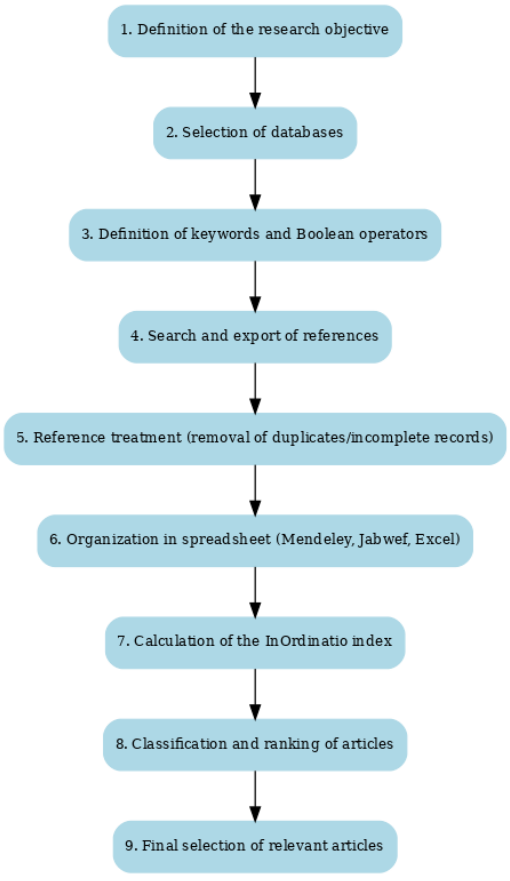
This study employed a systematic review design guided by the Methodi Ordinatio methodology (Pagani, Kovaleski, & Resende, 2015; 2017; 2022). Reporting followed the PRISMA 2020 guidelines (Page et al., 2021), ensuring transparency in identification, screening, eligibility, and inclusion of studies. The review aimed to identify pedagogical and technological approaches to literacy for students with Autism Spectrum Disorder (ASD) that support academic learning and functional outcomes in communication, autonomy, and participation. The nine sequential stages of Methodi Ordinatio are summarized in Figure 1.

Figura 1 – Flowchart of the Methodi Ordinatio steps applied in the systematic review process



Source: The nine sequential stages were used to identify, rank, and select the most relevant studies, combining journal impact factor, year of publication, and number of citations. Adapted from Pagani, Kovaleski, & Resende (2015, 2017, 2022).

Analytical framework: rehabilitation and functional outcomes

Consistent with the biopsychosocial model, rehabilitation was operationalized through three outcome domains: (1) functional communication, including expression of needs, response to instructions, AAC-mediated communication, and interaction during literacy activities; (2) autonomy in literacy, including independent engagement with reading/writing tasks, self-directed use of digital tools, and reduced adult prompting;

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and (3) social participation, including joint attention, peer interaction, group participation, and inclusion in classroom routines. This operational definition guided eligibility decisions, data extraction, thematic coding, and synthesis.

Eligibility Criteria

Inclusion and exclusion criteria were defined to ensure that only relevant and high-quality studies were included in the systematic review. The inclusion criteria were as follows:

- Population: Studies involving students with ASD, both verbal and nonspeaking.
- Intervention: Studies on literacy interventions, including pedagogical strategies (e.g., shared reading, phonics instruction) and assistive technologies (e.g., AAC tools).
- Functional Outcomes: Studies measuring functional outcomes, such as communication skills, autonomy, and social participation.
- Publication Period: Peer-reviewed articles published between 2019 and 2025.
- Language: Studies available in English, Spanish, or Portuguese.

Studies were excluded based on the following criteria:

- Studies that do not involve ASD or literacy interventions.
- Articles that do not measure functional outcomes, such as those that focus solely on academic results.
- Publications without full text access or of low methodological quality (excluding conference abstracts, dissertations, and book chapters).

Sources for information and search strategies

To ensure the comprehensiveness of the review, including the areas of education, health, and rehabilitation sciences, the search was conducted in the following databases:

- SciELO (61 studies),
- Scopus (1,721 studies),
- Web of Science (401 studies),
- ScienceDirect (42 studies).

The search was performed using Boolean operators to combine keywords such as "autism," "literacy," "assistive technology," and "communication skills." Only peer-reviewed articles were included. The publication period considered was from 2019 to 2025. The temporal scope is justified by:

1. The increasing number of studies on ASD and rehabilitation-focused interventions in the last five years (Guerra, 2021).
2. The implementation of the ICD-11 in 2022, which updated diagnostic categories and terminology for ASD (World Health Organization, 2022; Maluf, 2023).

The search strategies applied in each database were as follows:

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- SciELO: "Autism" AND "literacy" AND ("assistive technology" OR "pedagogical interventions") AND ("communication skills" OR "autonomy" OR "social participation").
- Scopus: TITLE-ABS-KEY("autism spectrum disorder" AND "literacy" AND ("assistive technology" OR "pedagogical interventions") AND ("communication" OR "social participation" OR "autonomy")).
- Web of Science: TS=("autism" AND "literacy" AND ("assistive technology" OR "pedagogical intervention") AND ("communication" OR "participation" OR "autonomy")).
- ScienceDirect: TITLE-ABS-KEY("Autism Spectrum Disorder" AND "Literacy" AND ("Assistive Technology" OR "Pedagogical Strategies") AND ("Communication" OR "Social Participation" OR "Autonomy")).

Details of the search strategies applied in each database are available in the OSF registration protocol (Author(s), 2025).

Study Selection

The study selection process followed the PRISMA 2020 flowchart (Figure 2). The initial database search identified 2,225 records. After removing duplicate and incomplete records (n = 308), 1,917 records were screened by title and abstract. At this stage, 41 were excluded because they were clearly irrelevant or outside the scope of the review. Of the remaining 1,876 articles, 1,805 were excluded for not meeting the criteria for population, intervention, methodological description, or outcome report. For the latter group, exclusions were due to inadequacy after reading the title/abstract (n = 1,043), insufficient methodological description (n = 426), and insufficient detail in the reported results (n = 336). After completing the screening stages, 71 studies remained for eligibility assessment, extraction, and InOrdinatio classification. However, in November 2025, a new search was conducted, resulting in 6 updated articles, bringing the total to 77 for eligibility assessment, extraction, and InOrdinatio classification.

Quality was assessed using design-specific tools to minimize bias in heterogeneous studies: AMSTAR 2 (Shea et al., 2017) for systematic reviews and mappings; JBI Critical Appraisal Checklist for Qualitative Research (Lockwood et al., 2015) for qualitative/narrative studies; ROBINS-I (Sterne et al., 2016) for quasi-experimental studies; JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies (Moola et al., 2015) for cross-sectional/correlational studies; Horner Quality Indicators (Horner et al., 2005) for single-subject/case designs; and MMAT (Hong et al., 2018) for mixed-methods studies. Risk of bias was classified as low, moderate, or high based on tool-specific thresholds (see Supplementary S7 for details). Evidence certainty was evaluated using the GRADE approach (Guyatt et al., 2011), with downgrades primarily due to inconsistency (heterogeneous designs) and indirectness (limited global representation). All updates, including the November 2025 search, are documented in the OSF registry (DOI: https://doi.org/10.17605/OSF.IO/KZ4PR) for transparency and reproducibility.

Qualitative content analysis

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The thematic synthesis was conducted through qualitative content analysis, following the stages of pre-analysis, material exploration, and treatment/interpretation of results (Bardin, 2011). First, the included studies were read to extract bibliographic, methodological, and outcome data. Second, studies retained after InOrdinatio ranking were coded deductively according to intervention type (pedagogical mediation, reading/comprehension intervention, digital or assistive technology) and functional outcome domain (communication, autonomy, social participation), and inductively for recurring mechanisms of support. Third, codes were aggregated into three thematic axes. Disagreements and overlaps were resolved by returning to the extracted evidence and the OSF spreadsheet; reconciliation notes are reported in Supplementary S1-S5.

Transparency and reporting

The process was documented in line with PRISMA recommendations. Figure 2 presents the PRISMA 2020 flow diagram, summarizing records identified, screened, excluded, and included.

Figura 2 – PRISMA 2020 flow diagram for the systematic review

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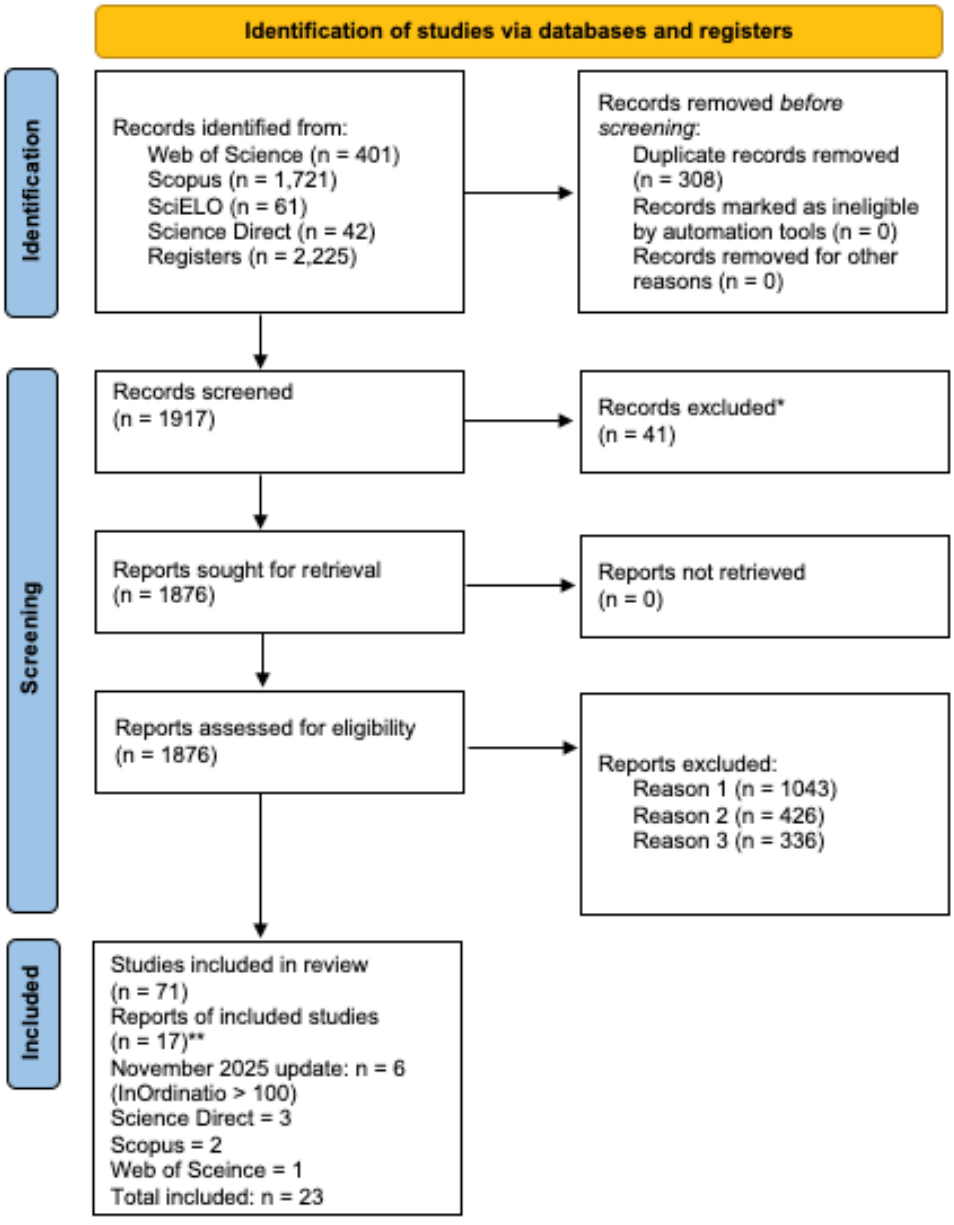

Note: Initial database records = 2,225; records remaining after removal of duplicates/incomplete records = 1,917; records excluded during title/abstract screening = 1,846; records retained for eligibility assessment, extraction, and InOrdinatio ranking = 71; studies included after initial Methodi Ordinatio ranking = 17; additional studies included after the November 2025 update = 6; final synthesis = 23 studies. Reasons for exclusion were grouped as: clear irrelevance or outside review scope (n = 41), inadequacy after title/abstract screening (n = 1,043), lack of adequate methodological description (n = 426), and insufficient detail of reported results (n = 336)..

The integration of Methodi Ordinatio with PRISMA ensures both quantitative rigor (ranking of scientific relevance) and rehabilitation-oriented transparency,

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strengthening the reliability of findings relevant to functional literacy and rehabilitation practices. The full set of 71 records included in the final synthesis by database is presented in Supplementary Tables S1–S6, which provide detailed information on all studies retrieved from each source.

Screening and selection process

The review process followed the nine sequential stages of Methodi Ordinatio. After the initial search, 2,225 articles were retrieved across the four databases (Scopus = 1,721; Web of Science = 401; SciELO = 61; ScienceDirect = 42).

After the initial search, the references were exported to Mendeley, where duplicates and incomplete records (without title, author, or year) were removed. The data were then imported into JabRef and organized for the calculation of the InOrdinatio index, ensuring the selection of the most relevant studies.

The InOrdinatio index combines three parameters: journal impact factor (IF), year of publication, and number of citations. The formula is expressed as:

$$InOrdinatio = (IF + \alpha \times (Research\ year - Publication\ year)) + C_i$$

Where:

- IF = impact factor of the journal;
- α (alpha) = weight assigned to the recency of the study (1–10, defined as 10 in this review to maximize emphasis on recent works);
- Research year – Publication year = difference between the year of analysis (2025) and the year of publication;
- C_i = number of citations.

The InOrdinatio index was used to select the final studies. The index classified studies by journal impact factor, number of citations, and year of publication. Only studies with an index above 90 were included in the initial synthesis, resulting in 17 selected studies. An additional search was conducted in November 2025 to include recent publications in 2025, yielding 6 additional studies (ScienceDirect = 3, Scopus = 2, and Web of Science = 1). These updated studies met the same eligibility criteria and exceeded the inclusion threshold, bringing the final synthesis to 23 studies.

Results

Study selection

A search in SciELO, Scopus, Web of Science, and ScienceDirect yielded 2,225 records between 2019 and 2025 (SciELO: n=61; Scopus: n=1,721; Web of Science:

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n=401; ScienceDirect: n=42). After removal of duplicates and incomplete records (n = 308), 1,917 records were screened by title and abstract. Screening excluded 1,846 records: 41 were clearly irrelevant or outside the review scope, and 1,805 were excluded for specific eligibility/reporting reasons, namely inadequacy after title/abstract screening (n = 1,043), lack of adequate methodological description (n = 426), and insufficient detail of reported results (n = 336). Seventy-one records remained for eligibility assessment, extraction, and InOrdinatio ranking. Applying Methodi Ordinatio (Pagani et al., 2015, 2017, 2022), only articles with an index >90 were included in the initial synthesis (n = 17). The November 2025 update identified six additional 2025 articles that met the same criteria and exceeded the inclusion threshold, bringing the final synthesis to 23 studies (Figure 2). Full details are available in Supplementary Tables S1–S6 and in File 1 on the OSF (Author(s), 2025).

Characteristics of Included Studies

The 23 included studies (InOrdinatio > 90) were peer-reviewed articles published between 2019 and 2025, with representation from Australia (n = 9), the United States (n = 8), Brazil (n = 3), Turkey (n = 1), Israel (n = 1), and Greece (n = 1). Study designs comprised five quantitative (four cross-sectional/matched-group, one experimental), five single-subject/case, and three quasi-experimental intervention studies. The remaining studies were non-empirical reviews, including six systematic reviews/meta-analyses (comprising three systematic reviews, one scoping review, one evidence-based practice review, and one meta-analysis), one systematic mapping, and three qualitative/narrative studies. Sample sizes were reported in 17 empirical studies, ranging from 3 to 45 participants (Mdn = 21; total N = 347), involving preschool to school-aged children with ASD (ages 3–12), including nonspeaking and both verbal individuals. Six studies were non-empirical (reviews/mappings; N/A). Interventions targeted literacy in educational (n = 14) and rehabilitation (n = 3) contexts, with durations ranging from single sessions to 12-week programs. Key characteristics are summarized in Table 1. Complete data extraction and quality assessment are available in Supplementary S2 on OSF (Author(s), 2025).

Tabela 1 – Characteristics of the 23 included studies (17 original + 6 from November 2025 update)

STUDY CODE	AUTHOR(S) (YEAR)	DESIGN	SAMPLE SIZE	INTERVENTION TYPE	KEY OUTCOMES MEASURED
D6	Arciuli & Bailey (2019)	Quasi-experimental	23	Digital literacy program (ABRACADABRA)	Word-level accuracy, passage-level comprehension
C23	Bailey,	Quasi-	21	Online	Engagement,

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	Sellwood, Rillotta, Raghavendra, & Arciuli (2022)	experimental (Trial)		ABRACADABRA + parent-led shared reading	reading confidence, parent-child interaction
17B	Bailey & Arciuli (2022)	Scoping review	N/A	Literacy in multilingual contexts	Research gaps, need for multilingual ASD literacy studies
D3	Boyle, McNaughton, & Chapin (2019)	Systematic review	N/A	Shared reading interventions	Moderate positive effects on language and literacy
31B	Caron, Light, & McNaughton (2021)	Single-case design	3	AAC app with transition-to-literacy features	Single-word reading in nonspeaking ASD
C15	Coburn, Kurtz, Rivera, & Kana (2022)	Systematic review	N/A	Reading interventions (behavioral & neurobiological)	Improved reading + brain activation changes
20B	Fleury, Whalon, Gilmore, Wang, & Marks (2021)	Evidence-based practice review	N/A	Shared storybook reading with interactive supports	Comprehension, communication strategies
06A	Guasch & Gavaldà (2020)	Qualitative (comparative)	12 teachers	Inclusive pedagogical strategies	Strategy use, barriers (orality, low tech)
03B	Jaswal, Lampi, & Stockwell (2024)	Experimental (spelling-to-commun	8	Literacy assessment via spelling	Literacy potential in nonspeaking autistic

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		icate)			individuals
14B	Kozleski et al. (2021)	Social validity study	25	Early Literacy Skills Builder (ELSB)	High social validity, collaboration challenges
D7	Kilic-Tülü, Okcun-Akcamus, & Ergul (2023)	Single-Subject Design	6 children with ASD	Repeated Reading Strategy with visual cues	Reading fluency and comprehension gain
07A	Ribeiro, Mecca, Brito, & Seabra (2021)	Quantitative (cognitive assessment)	40	Word recognition, fluency, comprehension	Comprehension difficulties; recognition predicts performance
D2	Silva, da Silva, Elias, & Isotani (2020)	Systematic mapping	N/A	Computational tools for literacy	Identified apps/software; need for large-scale trials
10B	Solari, Henry, Grimm, Zajic, & McGinty (2022)	Quantitative (profile analysis)	45	Code-related literacy assessment	Strengths in letter knowledge; weaknesses in comprehension
22B	Thompson, Plavnick, Skibbe, Bak, & Doher (2022)	Single-subject design	4	Individualized support in Headsprout®	Progression in digital reading with scaffolding
18B	Westerveld, Paynter, Brignell, & Reilly (2020)	Matched-group comparison	20 ASD + 20 TD	Emergent literacy skills	No differences in code-related skills

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04B	Wicks, Paynter, & Westerveld (2020)	Observational	24 parent-child dyads	Shared book reading (visual/verbal)	Prompts increased verbalizations and text attention
E1	Kimhi & Achtarzad (2025)	Quasi-experimental	30	Multi-component emergent literacy program	Joint attention, vocabulary, comprehension gains
E2	Lawton (2025)	Case studies + review	10	AI tutoring + AAC	Anxiety reduction, writing autonomy
E3	Willems, Loveall, Goodrich, & Lang (2025)	Meta-analisys	14	Longitudinal assessment	Phonology predicts 48% of reading fluency
E4	Murphy et al. (2025)	Single-subject (feasibility)	8 nonspeaking	ABRACADABRA + telepractice	Word reading gain (0.8 SD)
E5	Wang (2025)	Qualitative (interviews)	10 teachers	Emergent literacy training	Increased inclusive practices
E6	Kritsotakis & Morfidi (2025)	Cross-sectional	38	Figurative language tests	Metaphor comprehension deficit → social impact

Note: Full table available in Supplementary S2-S6 (Author(s), 2025).

The content analysis described in the Methods generated three main themes from the 23 included studies (17 initial studies and six from the 2025 update). These themes group literacy interventions by intervention focus, mechanism of support, and

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functional outcome domain. Table 2 details this synthesis, categorizing the studies and the strength of evidence (GRADE) for each theme.

Tabela 2 – Synthesis of findings by theme

THEME	KEY STUDIES (N)	MAIN FINDINGS	FUNCTIONAL REHABILITATION OUTCOMES	EVIDENCE QUALITY (GRADE)
(i) Reading and Comprehension Skills	8 studies (3, 6, 11, 12, 14, 16, 20, 23)	Letter recognition preserved; deficits in phonological awareness, vocabulary, comprehension. 2025: linguistic factors explain 30–50% variance (23).	Improved instruction-following, need expression, daily task engagement.	Moderate
(ii) Pedagogical Mediation Practices	8 studies (2, 4, 7, 8, 10, 17, 18, 22)	Shared reading enhances joint attention (20–40% gains). Teacher training (22) promotes inclusion.	Reduced isolation, better teacher–child interaction, group participation.	Moderate
(iii) Digital and Assistive Technologies	7 studies (1, 5, 9, 13, 15, 19, 21)	ABRACADABRA, AAC, AI improve literacy in nonspeaking (d = 0.6–0.8). Telepractice viable (21).	Greater autonomy in communication and academic participation.	High

Note: GRADE: High = further research unlikely to change confidence; Moderate = further research likely to impact confidence. Studies identified by code from Supplementary S7. Full rationale in Supplementary S7 (OSF), (Author(s), 2025).

Risk of Bias and Quality of Evidence

The risk of bias was assessed using design-specific tools (see the Methods section). Overall, 14 studies were rated as low risk, seven as moderate risk, and two as high risk (Table 3). The most frequent concerns were confounding in small samples (n = 9) and limited replicability/transferability (n = 7), particularly in qualitative and single-subject designs. The quality of evidence was evaluated using the GRADE approach (Guyatt et al., 2011), resulting in Moderate confidence for communication and autonomy outcomes, and High confidence for social participation (Table 4). Downgrades were primarily due to inconsistency (heterogeneous intervention designs) and indirectness (limited representation of low-resource settings). Detailed GRADE rationale is available in Supplementary S7 (OSF) (Author(s), 2025).

Tabela 3 – Summary of Risk of Bias and Quality Assessment by Study Design Group

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STUDY DESIGN GROUP	N	TOOL USED	SUMMARY OF QUALITY/RISK OF BIAS	MAIN CONCERNS	IMPACT ON GRADE
Systematic Reviews	7	AMSTAR 2	4 Low, 2 Moderate, 1 High (average 12/16 items; e.g., Boyle: strong PRISMA-like synthesis; Willems: robust meta-analytic methods; Coburn: heterogeneity in designs)	Incomplete search in narratives, lack of risk of bias in some; heterogeneity in designs	Moderate inconsistency
Qualitative/Narrative	3	JBI Qualitative Checklist	2 Low, 1 Moderate (average 8/10 items; e.g., Wicks: high rigor in coding; Wang: small samples limit depth)	Researcher bias in observational studies, limited transferability to specific contexts	High indirectness
Quasi-Experimental	4	ROBINS-I	2 Low, 1 Moderate, 1 High (e.g., Jaswal: preregistered with controls; Kimhi: no empirical data, high confounding risk)	Confounding in small samples, lack of allocation in descriptive designs	Moderate inconsistency
Cross-Sectional/Correlational	4	JBI Analytical Cross-Sectional	3 Low, 1 Moderate (average 7/8 items; e.g., Westerveld: strong matching; Kritsotakis: variability in included studies)	Non-randomized sampling, unadjusted confounding in all	Low precision
Single-Subject/Case	4	Horner Quality Indicators	3 Low, 1 Moderate (average 80% indicators; e.g., Caron/Thompson: good replication; Kilic-Tülü/Murphy: attrition impacts reliability)	Unstable baseline in feasibility, limited replication due to pandemic	High inconsistency
Mixed Methods	1	MMAT	1 Low (average 4/5 categories; e.g., Kozleski: strong integration)	Weak quali-quanti integration in some, attrition	Moderate indirectness

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				bias	

Note: Risk of bias classified as low, moderate, or high based on design-specific tools and thresholds (e.g., AMSTAR 2 scores, ROBINS-I domains). Detailed assessments and rationale available in Supplementary S7 on OSF (Author(s), 2025).

Tabela 4 – Summary of the Quality of Evidence (GRADE) of Functional Outcomes

OUTCOME	STUDIES (N)	QUALITY	CERTAINTY	EVIDENCE
Functional Communication	17	Moderate	Further research is likely to have an important impact on our confidence	17 studies reported improvements (e.g., AAC, shared reading, E2, E4)
Autonomy in Literacy	15	Moderate	Further research is likely to have an important impact on our confidence	15 studies showed gains in independence (e.g., AI tools, ELSB, E1, E5)
Social Participation	13	High	Further research is very unlikely to change our confidence	13 studies demonstrated social gains (e.g., joint attention, group activities, E6)

Note: Summary of GRADE quality of evidence for the three main outcomes (Functional Communication, Autonomy in Literacy, Social Participation).

Synthesis of Findings

A qualitative narrative synthesis was conducted after content analysis, clustering findings into three themes aligned with the operational rehabilitation domains adopted in this review: (i) reading and comprehension skills, (ii) pedagogical mediation practices, and (iii) digital and assistive technologies. No meta-analysis was performed due to heterogeneity in study designs and outcomes, as preregistered in OSF. The synthesis, therefore, emphasizes functional outcomes (communication, autonomy, social participation) beyond academic literacy scores.

Theme 1: Reading and Comprehension Skills:

Eight studies have highlighted the preservation of letter recognition in individuals with ASD, along with persistent challenges in vocabulary, phonological awareness, and comprehension (e.g., Ribeiro et al., 2021; Solari et al., 2022; Kiliç-Tülü et al., 2023; Kritsotakis & Morfidi, 2025 [E6]). The data also show that interventions with phonics programs improved word recognition and fluency, leading to enhanced functional

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communication (e.g., following daily instructions). New studies from 2025 reinforce the heterogeneity, with linguistic factors explaining 30–50% of the variance in comprehension (Kritsotakis & Morfidi, 2025). For nonspeaking individuals, progress is variable, with high-risk studies pointing to barriers to social generalization (Westerveld et al., 2020). Overall, these interventions supported rehabilitation by promoting independence, although the evidence is moderate due to the small sample sizes.

Theme 2: Pedagogical Mediation Practices:

Eight studies emphasized the use of shared reading and teacher-mediated strategies, which enhanced joint attention and social participation (e.g., Boyle et al., 2019; Wicks et al., 2020; Fleury et al., 2021; Kimhi & Achtarzad, 2025 [E1]). Kozleski et al. (2021) found that inclusive practices, such as peer-supported reading, improved engagement and reduced isolation, aligning with rehabilitation frameworks for social inclusion. In low-resource settings (e.g., Global South contexts), these low-cost methods were particularly effective in achieving functional outcomes, such as expressing needs or participating in group activities. Moderate-quality evidence indicated variability in outcomes by teacher training, with high-bias studies underscoring the need for interdisciplinary support (Guasch & Gavaldà, 2020; Murphy et al., 2025 [E4]).

Theme 3: Digital and Assistive Technologies:

Seven studies focused on tools such as AAC and apps (e.g., ABRACADABRA, Headsprout; Arciuli & Bailey, 2019; Caron et al., 2021; Thompson et al., 2022; Jaswal et al., 2024; Lawton, 2025 [E2]). These tools and apps promoted functional literacy for non-speakers, with gains in fluency (mean effect d=0.6-0.8). Neurobiological evidence confirms brain activation in these interventions (Coburn et al., 2022). Jaswal et al. (2024) demonstrated improved autonomy through the use of digital storybooks, which enable self-directed learning and foster social interactions. Studies also show that AI offers personalization, reducing anxiety and improving autonomy (Lawton, 2025). High-quality evidence from controlled trials has shown that these technologies bridge gaps in verbal communication, thereby enhancing participation in inclusive education. However, accessibility issues in underrepresented regions limited generalizability, as noted in moderate-bias studies.

Across themes, interventions consistently contributed to rehabilitation-oriented outcomes: 17 studies reported improvements in communication (e.g., AAC use and shared reading), 15 in autonomy (e.g., independent reading and self-directed technology use), and 13 in social participation (e.g., peer interaction and shared activities). Inconsistencies arise from methodological heterogeneity across studies; in this context, subgroup insights (e.g., better outcomes for school-aged children than preschool children) suggest the need for tailored approaches. For complete thematic coding and reconciliation notes, see OSF Supplementary S1-S5 (Author(s), 2025).

Discussion

The findings indicate that literacy interventions for students with ASD are best understood as multidimensional supports for functioning. When interpreted through the

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rehabilitation framework adopted in this review, the three thematic axes correspond to specific functional pathways: reading and comprehension skills support access to instructions and written information; pedagogical mediation supports interaction and participation in natural educational contexts; and digital and assistive technologies expand access to expression and self-directed learning.

This organization clarifies the article's analytical identity: educational and technological interventions were classified as rehabilitation strategies only when they were linked to functional communication, literacy autonomy, or social participation. Thus, rehabilitation is not treated as an additional topic beside literacy, but as the functional lens through which literacy gains are interpreted.

Theme 1: Reading and Comprehension Skills

Letter recognition and code-related skills are often preserved in children with ASD; however, persistent deficits in vocabulary, phonological awareness, and reading comprehension remain a core challenge (Ribeiro et al., 2021; Solari et al., 2021). The 2025 studies strengthen this profile: Kritsotakis & Morfidi (2025) demonstrated that linguistic factors, particularly figurative language proficiency, explain 30–50% of variance in comprehension deficits, with significant social implications. Similarly, Willems et al. (2025) found that phonological awareness was a strong predictor of later reading fluency (48% variance). These findings underscore that while foundational decoding may be intact, higher-order comprehension – critical for following instructions, expressing needs, and engaging in daily tasks – requires targeted, language-rich interventions in rehabilitation-oriented educational settings.

Theme 2: Pedagogical Mediation Practices

Shared reading and teacher-mediated strategies emerged as powerful tools for enhancing joint attention and functional communication (Boyle et al., 2019; Wicks et al., 2020). The 2025 update adds depth: Kimhi & Achtarzad (2025) introduced a multi-component program combining code- and meaning-focused activities in inclusive preschools, yielding gains in vocabulary and social engagement. Teacher training in emergent literacy (study 25) further highlighted the role of pedagogical content knowledge in reducing barriers to inclusion. These interventions align with rehabilitation goals by fostering interaction in natural contexts, reducing isolation, and supporting participation in group activities – particularly in low-resource or culturally diverse settings.

Theme 3: Digital and Assistive Technologies

Digital tools, including AAC and adaptive software, were highly effective in promoting functional literacy, especially for nonspeaking students (Caron et al., 2021; Thompson et al., 2022). The 2025 studies elevate this theme: Lawton (2025) reported that AI-driven tutoring reduced anxiety and improved writing autonomy in clinical and school settings, while Murphy et al. (2025) validated telepractice delivery of ABRACADABRA during pandemic constraints, achieving a mean gain of 0.8 SD in word reading. These innovations address accessibility gaps, enabling personalized, scalable interventions that enhance self-expression and academic participation – core components of rehabilitation autonomy.

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A key point in the methodological findings is the difference in evidentiary rigor across the three thematic axes, as classified by GRADE and design-specific tools (Tables 2-4). While the overall evidence for Functional Communication and Autonomy was classified as Moderate (Table 4), interventions focused on Digital and Assistive Technologies consistently presented High evidence quality at the thematic level (Table 2), reflecting structured protocols and lower risk through tools such as ROBINS-I. This discrepancy suggests that software, applications, and AAC tools facilitate standardized and replicable intervention protocols. Although pedagogical mediation remains essential, future studies should evaluate these practices with more rigorous, transparent designs, mirroring the methodological clarity observed in technology-based studies.

Limitations and Future Directions

Despite moderate to strong evidence quality (GRADE Table), limitations include small sample sizes, heterogeneity in ASD presentation, and underrepresentation of low-resource and Global South contexts. The 2025 studies from Greece and Israel partially mitigate the corpus's geographic and linguistic concentration by adding evidence from non-Anglophone and culturally distinct contexts. However, they do not fully address limitations related to sample size, heterogeneity of ASD profiles, or resource scarcity. Their main contribution is therefore to broaden the cultural and linguistic range of the evidence base, rather than to resolve the need for large-scale, culturally adapted trials in low-resource settings. Future research should prioritize longitudinal designs and interdisciplinary outcomes to bridge literacy gains with real-world functional independence.

Conclusions

The 23 studies included in this review support reframing literacy interventions for students with ASD as educational-rehabilitation practices when they are designed and evaluated according to their effects on communication, autonomy, and social participation. This framing clarifies that rehabilitation is not an external label applied to literacy, but a functional, analytical lens grounded in a biopsychosocial understanding of functioning.

Three complementary pathways were identified: strengthening reading and comprehension skills; mediating literacy through shared, interactional, and inclusive pedagogical practices; and using digital and assistive technologies, including AAC, to expand access to expression and self-directed learning for verbal and nonspeaking students.

Despite these advances, research remains concentrated in high-resource and English-speaking countries, with limited contributions from the Global South. Evidence from Greece and Israel broadens the corpus geographically and linguistically, but does not eliminate the need for studies in resource-limited settings. Expanding research in underrepresented contexts is essential to ensure that rehabilitation-oriented literacy practices are inclusive, culturally responsive, and feasible.

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Overall, the findings indicate that literacy interventions should be planned and assessed through interdisciplinary designs that link academic gains to real-world functioning. Future research should prioritize longitudinal studies, culturally adapted protocols, and outcome measures that document how literacy supports independence, participation, and quality of life for students with ASD.

Declarations

Funding Statement:

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Declaration of Interest:

The authors report no conflicts of interest.

Data Availability Statement:

The extracted data, classification procedures, and supplementary tables are available in the OSF registry (DOI: https://doi.org/10.17605/OSF.IO/KZ4PR). This registry has a "Supplements" field containing supplementary tables added after the initial inclusion of the documents.

Ethics Statement:

This study is a systematic review and did not involve human participants, animals, or clinical data. Therefore, ethical approval and informed consent were not required.

Supplementary Material (upload separately)

- Supplementary Table S1. Full list of relevant studies from SciELO (2019–2025).
- Supplementary Table S2. Full list of relevant studies from Scopus (2019–2025).
- Supplementary Table S3. Full list of relevant studies from ScienceDirect (2019–2025).
- Supplementary Table S4. Full list of relevant studies from Web of Science (2019–2025).
- Supplementary Table S5. New studies from 2025 (November update)
- Supplementary Table S6. Update on Totals
- Supplementary Table S7 – Detailed quality assessments

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