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From Play to Progress: A Structured Narrative Review of Design Characteristics and Reported Developmental Outcomes of Digital Games for Children with Autism Spectrum Disorder

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Abstract. Digital games have increasingly been used to support learning and early intervention for children with autism spectrum disorder (ASD), yet evidence regarding their impact on children's developmental outcomes remains fragmented. Therefore, this study conducted a structured narrative review to examine the design characteristics and reported developmental outcomes of digital games for children with ASD. A total of 27 studies were identified from Web of Science, IEEE Xplore, PubMed, and Google Scholar based on their relevance to children with ASD, digital games, and reported developmental outcomes. The findings indicate that the reviewed studies reported outcomes across five domains: communication and social behavior, emotional regulation, daily living skills, executive functioning and cognition, and learning skills. Therapeutic digital games were more frequently reported in relation to adaptive domains, particularly communication and emotional regulation, whereas educational digital games more frequently target cognitive and learning-related outcomes. The reported outcome patterns also varied by participant age, intervention duration, technology format, and study type. Overall, digital games demonstrate meaningful potential as supportive tools for children with ASD rather than as stand-alone evidence of universal effectiveness. Future research should adopt more rigorous and standardized designs to enhance comparability and clarify the conditions under which digital games may support specific developmental outcomes.

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1. Introduction

The use of digital technologies in educating children with autism spectrum disorder (ASD) has attracted growing attention from scholars over the past decade. A wide range of technologies have been proposed to support learning, communication, and personal skill development for children with ASD. Among these, digital games are viewed as a promising option because they can provide interactive and personalized learning environments (Stasolla et al., 2021). Digital games often combine learning and playing elements, allowing children to engage in clearly structured tasks within an interactive setting. Features such as immediate feedback, controlled repetition, and adjustable difficulty levels are considered well suited to the developmental characteristics of many children with ASD (Tsikinas & Xinogalos, 2020; Wagle et al., 2021). Several studies suggest that digital games may help sustain children's engagement and facilitate favorable conditions for practicing skills in safe and familiar contexts (Cordioli et al., 2024; Gallup et al., 2021).

Although many studies have reported the use of digital games for children with ASD, evidence regarding their reported contributions to specific developmental outcomes remains fragmented. Existing studies differ in the types of games used, intervention goals, activity design, and implementation duration (Costescu et al., 2024; Montero de Espinosa Espino & Perez de la Maza, 2024; Tsikinas et al., 2016). Furthermore, the reported child outcomes are diverse, including communication skills, social interaction, cognition, behavior, and academic or learning skills (Al-Hammadi & Abdelazim, 2015; Malinverni et al., 2017; Miyamoto & Tsuge, 2021; Shams et al., 2020). This situation leads to gaps in current understanding of how digital games are designed and which developmental outcome domains have been reported to support in education and early intervention for children with ASD. For teachers, educational administrators, and researchers, understanding the design characteristics of digital games and the developmental outcomes reported in previous studies is essential to guide further research and support decision-making in educational practice.

Several review studies have already examined digital games or related digital technologies for children with ASD. These reviews have made important contributions by mapping game-based interventions, serious games, or digital technologies for supporting social, emotional, cognitive, and executive development in this population group (Costescu et al., 2024; Derks et al., 2022; Kellidou et al., 2020; Tsikinas et al., 2016). However, existing reviews have paid limited attention to how design-related factors, such as game purpose, technology format, implementation features, and participant characteristics, relate to the developmental outcome domains reported in studies of children with ASD.

To address this gap, the present study conducts a structured narrative review to synthesize evidence on the design characteristics and reported developmental outcomes of digital games for children with ASD. By organizing the existing

evidence in this way, the review aims to clarify what is currently known, highlight how different game characteristics are linked to reported outcome domains, and identify directions for future research on digital game–based education and intervention for children with ASD. The review was guided by the following research questions:
RQ1. What design characteristics are reported in studies on digital games for children with ASD?
RQ2. What developmental outcome domains are reported in studies on digital games for children with ASD?
RQ3. How do reported developmental outcome domains differ between therapeutic and educational digital games?

2. Conceptual framework

Play is widely recognized as an intrinsically motivating activity that supports exploration, learning, and development. Digital games extend this broader concept of play into structured, technology-mediated environments. Digital games combine rules, goals, challenges, and feedback to guide player behavior (Kellidou et al., 2020). They are typically delivered through digital devices such as computers, tablets, and immersive platforms such as virtual reality (Sher et al., 2021). From this perspective, digital games can be understood as interactive, rule-based, and goal-oriented environments facilitated by digital technologies, in which players actively engage with tasks and receive feedback to achieve intended outcomes.

Analytically, the relevance of digital games to children with ASD lies in the way in which play-based engagement is transformed into structured game-based learning activities. Play theory emphasizes intrinsic motivation, exploration, and active participation, while game-based learning translates these qualities into goal-oriented tasks, rules, feedback, repetition, and adaptive challenges. These features are relevant for children with ASD, who often benefit from predictable structures, repeated practice, visual or interactive cues, and safe contexts for practicing communication, emotional regulation, and cognitive skills.

In educational contexts, digital games are not merely tools for entertainment, they are designed to support learning and development through interactive and engaging experiences (Li et al., 2024). Their pedagogical value can be explained through several theoretical perspectives. From a behaviorist perspective, digital games provide immediate feedback, reinforcement, and progressive challenges that support repeated practice and sustained engagement (Li et al., 2024). From a social-cognitive perspective, they create contextualized environments in which learners actively construct knowledge through interaction and guided experience (Li et al., 2024). In addition, features such as immersion, personalization, and continuous challenge enable digital games to support self-regulated learning, motivation, and deeper engagement (Annetta, 2010; Gee, 2003; Kiili, 2005; Kwon & Lee, 2016; McClarty et al., 2012).

Building on their educational role, digital games can be classified in different ways depending on their purpose and design. In educating children with ASD, a

common and meaningful distinction is between therapeutic digital games and educational digital games. Therapeutic digital games are primarily designed to support intervention goals, such as improving communication, emotional regulation, and adaptive behavior (Calderón & Ruiz, 2015). In contrast, educational digital games focus on promoting learning outcomes, including cognitive development, executive functioning, and academic skills (Djaouti et al., 2011; Prensky, 2001). In addition, digital games can also be categorized by genre, such as action, simulation, role-playing, and puzzle games, as well as by their technological features, including screen-based, motion-based, and immersive environments (Cheng et al., 2015; Erhel & Jamet, 2013; Prensky, 2001; Sher et al., 2021). In this study, the distinction between therapeutic and educational digital games provides a conceptual basis for examining differences in the developmental outcome domains reported across the reviewed studies.

This conceptual framework is used as an analytical lens rather than as a causal model. The theoretical perspectives discussed above explain why digital games may support children with ASD through feedback, repetition, interaction, engagement, and personalization. These features may be reflected differently in therapeutic and educational digital games. However, the two categories are not treated as mutually exclusive, because developmental outcomes may overlap depending on game design and implementation.

3. Methodology

This study employed a structured narrative review design, with qualitative content analysis used to synthesize published studies on digital games for children with autism spectrum disorder. This approach was considered appropriate because the purpose of the study was not to estimate pooled effect sizes or determine causal effectiveness through meta-analysis, but to identify, categorize, and interpret patterns in design characteristics and reported developmental outcome domains across heterogeneous studies. Therefore, the structured narrative review provides a content-based synthesis of reported evidence rather than a full systematic review. The PRISMA-style procedure was used to enhance transparency in study identification and screening.

The literature search was conducted on September 15, 2025, across four databases: Web of Science, IEEE Xplore, PubMed, and Google Scholar. The search strategy used the following keyword string: (“Autistic children” OR “children with autism” OR “ASD” OR “autism spectrum disorder”) AND (“educational game*” OR “digital game*” OR “online game*”). No publication-year restrictions were applied. Only studies written in English were considered. Eligible document types included journal articles, conference papers, and book chapters that reported or discussed digital games or game-based interventions for children with ASD. Backward and forward citation searching was not performed. Google Scholar was used only to identify additional relevant records beyond the three main academic databases.

Studies included if they focused on children with ASD, examined digital games or game-based interventions, were conducted within an early education or

intervention context, and reported relevant information on game characteristics and/or child developmental outcomes. Studies were excluded if they did not focus on children with ASD, did not involve digital games or game-based interventions, were conducted outside an early education or intervention context, or did not provide sufficient information for data extraction.

The study identification, screening, eligibility assessment, and inclusion process are summarized in Figure 1. The initial search identified 114 records. Specifically, 69 records were retrieved from Web of Science, 27 from IEEE Xplore, 12 from PubMed, and six additional records were identified through Google Scholar. After 13 duplicate records were removed, 101 records remained for title and abstract screening. At this stage, 72 records were excluded because they did not focus on children with ASD, were not related to digital games or game-based interventions, were not concerned with the educational use of digital games for young children with ASD or were outside the scope of education or early intervention for children with ASD.

The remaining 29 reports were sought for retrieval, and all were successfully retrieved. These 29 reports were then assessed for eligibility. Two reports were excluded at the full-text screening stage because they were not related to education or early intervention for young children with ASD. Finally, 27 studies met all inclusion criteria and were included in the final synthesis.

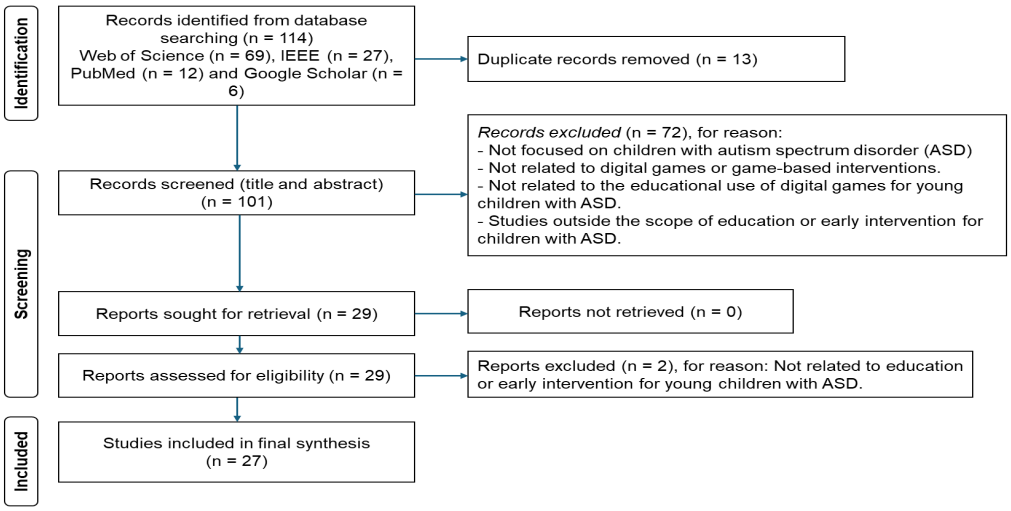

Figure 1: PRISMA flow diagram of the study selection process

The study selection, data extraction, and content coding processes were conducted collaboratively by a four-member research team. Given the heterogeneity of the included studies, methodological quality was assessed descriptively rather than through a single scoring tool. The research team considered the clarity of the study objectives, participant descriptions, game or intervention design, duration, results reporting, and the fit between the study design and reported conclusions. Before coding, the team developed a codebook based on the research questions and the extraction framework. The codebook included definitions and coding rules for study characteristics, game type,

technology format, implementation duration, participant age range, and reported developmental outcome domains. The team worked through five consensus meetings, each lasting approximately four hours. During these meetings, the authors jointly reviewed the search results, discussed inclusion and exclusion decisions, refined the codebook, and agreed on the final coding of design characteristics and developmental outcome domains. Disagreements were resolved through discussion until consensus was reached. Inter-coder agreement was not calculated statistically because the coding process was consensus-based rather than independently scored for reliability estimation. This collaborative procedure was used to enhance consistency, reduce individual interpretation bias, and strengthen the credibility of the qualitative content analysis.

Data was systematically extracted from the selected studies using a predefined framework aligned with the research questions. The extracted information covered four main areas: study characteristics (author, year of publication, and study design); design characteristics (game type, game title, technology form, and implementation duration); participant characteristics, particularly age range; and reported developmental outcome domains. For game types, the distinction between therapeutic and educational digital games was based primarily on the stated purpose and design orientation of each game in the original study. Games were classified as therapeutic when they were designed mainly for therapy, rehabilitation, or adaptive functioning support. Games were classified as educational when they were designed mainly for instruction, learning, academic development, or cognitive skill development. When a game combined both orientations, the dominant purpose described by the original authors was used.

Meanwhile, the five developmental outcome domains were defined as follows: Communication and social behavior referred to outcomes related to social interaction, communication attempts, joint attention, cooperation, and social participation; Emotional regulation included outcomes related to emotion recognition, emotional expression, behavioral regulation, engagement, and reduced agitation or inattention; Daily living skills referred to functional or adaptive skills relevant to everyday independence, including movement, object control, and self-management; Executive functioning and cognition included attention, memory, cognitive control, visual perception, problem-solving, and information processing; Learning skills referred to academic outcomes, such as vocabulary, reading, symbol recognition, numeracy, concept learning, and subject-matter knowledge.

The extracted data are summarized in Table 1. Then, qualitative content analysis was used to identify and synthesize recurring patterns across the included studies. The extracted information was reviewed and compared iteratively to categorize design characteristics and reported developmental outcomes. Through repeated discussion among the research team, the studies were grouped according to game type, technology form, participant characteristics, and outcome domains. The synthesized patterns were then used to examine how design characteristics and reported developmental outcomes varied across therapeutic and educational digital games for children with ASD.

Table 1: Data extraction summary of the 27 included studies

Source	Study design	Type of game	Technology format	Game title	Intervention duration	Age Range	Adaptive behavior			Intellectual functioning	
							CSB	ER	DLS	EF	LS
(Guerra & Furtado, 2013)	Empirical intervention	Therapeutic	Motion-based	Kinect Mobile (WP7)	Not reported	Not reported		✓		✓	
(Uzuegbunam et al., 2015)	Empirical intervention	Therapeutic	Motion-based	MEBook	12 days	7-12	✓				
(Malinverni et al., 2017)	Empirical intervention	Therapeutic	Motion-based	Pico's Adventures	30 min × 4 sessions/week × 1 month	4-6	✓	✓			
(Qidwai & Connor, 2018)	Empirical intervention	Therapeutic	Motion-based	Arduino MEGA platform	Not reported	Not reported		✓		✓	
(Nawahdah & Ihmouda, 2019)	Empirical intervention	Therapeutic	Augmented / virtual reality	Not reported	30 min × 2 sessions/week × 6 weeks	Not reported	✓	✓			
(Shams et al., 2020)	Empirical intervention	Therapeutic	Screen-based	EmoGalaxy	Not reported	7-12		✓			
(Najeeb et al., 2020)	Empirical intervention	Therapeutic	Motion-based	Aliza	Not reported	5-12	✓				✓
(Hassan et al., 2021)	Theoretical analysis	Therapeutic	Not reported	40 serious games	Not reported	<10				✓	
(Elhaddadi et al., 2021)	Empirical intervention	Therapeutic	Screen-based	JESTIMULE	1h/session × 2×/week × 4 weeks	6-14	✓	✓			
(Derks et al., 2022)	Theoretical analysis	Therapeutic	Not reported	Not reported	Not reported	4-11	✓		✓	✓	
(Cordioli et al., 2024)	Empirical intervention	Therapeutic	Not reported	Not reported	4 months	4-7	✓		✓		
(Wu et al., 2025)	Empirical intervention	Therapeutic	Virtual reality	Mobile app	12 weeks	6-12			✓		
(Hassan et al., 2025)	Empirical intervention	Therapeutic	Screen-based	Zirkus Empathico (ZE) 2.0	120 min/week × 8 weeks	5-11	✓	✓			

Source	Study design	Type of game	Technology format	Game title	Intervention duration	Age Range	Adaptive behavior			Intellectual functioning	
							CSB	ER	DLS	EF	LS
(Florou et al., 2009)	Empirical intervention	Educational	Screen-based	Up To Ten, Poisson Rouge, Minisebran	Total 7 hours	<6	✓				
(Hetzroni & Ne'eman, 2013)	Empirical intervention	Educational	Screen-based	Graphic-symbol	15 min/session × 25 sessions	<6					✓
(Christinaki et al., 2014)	Empirical intervention	Educational	Virtual reality	Not reported	1 month	< 6	✓	✓			
(Al-Hammadi & Abdelazim, 2015)	Empirical intervention	Educational	Screen-based	Miss.Fly	Not reported	6-7				✓	
(Pistoljevic & Hulusic, 2017)	Empirical intervention	Educational	Screen-based	E-book	Not reported	4-7					✓
(Bossavit & Parsons, 2018)	Empirical intervention	Educational	Not reported	Serious game	5 sessions	9-15					✓
(Vukicevic et al., 2019)	Empirical intervention	Educational	Motion-based	Kinect	1 session/week × 5 weeks	9-13		✓			
(Gobbo et al., 2021)	Empirical intervention	Educational	Screen-based	ACA	Not reported	2-15					✓
(Chien-Sing & YATIM, 2021)	Empirical intervention	Educational	Screen-based	Puzzle game	Not reported	Not reported				✓	
(Macoun et al., 2021)	Empirical intervention	Educational	Screen-based	Caribbean Quest	12 hours (8–12 weeks)	6-12	✓	✓		✓	
(Rodriguez et al., 2022)	Empirical intervention	Educational	Augmented Reality	Balloon Pop	Not reported	Not reported	✓				✓
(Adochiei et al., 2024)	Empirical intervention	Educational	Screen-based	Memory Maze	Not reported	6-12		✓		✓	
(Sloan, 2024)	Survey	Educational	Screen-based	Box Island and Peg Plus Cat – Music Maker	Not reported	5-11				✓	
(Junaidi et al., 2025)	Empirical intervention	Educational	Screen-based	Moral Awareness Game	12 sessions (3 weeks)	7-18				✓	

Notes: CSB = Communication & social behavior; ER = Emotional regulation; DLS = Daily living skills; EF = Executive functioning & Cognition; LS = Learning skills

4. Results

4.1. Methodological characteristics of the included studies

As shown in Table 1, the included studies varied in methodological design, although most were empirical intervention studies involving the implementation or evaluation of digital games with children with ASD (88.9%). These studies typically involved structured game-based activities or intervention procedures, allowing researchers to report changes in children's communication, emotional regulation, cognitive skills, or learning-related outcomes following exposure to digital games (Adochiei et al., 2024; Gobbo et al., 2021; Malinverni et al., 2017; Najeeb et al., 2020; Nawahdah & Ihmouda, 2019; Qidwai & Connor, 2018; Rodriguez et al., 2022; Uzuegbunam et al., 2015; Wu et al., 2025).

Only one study (3.7%) was classified as a survey study, focusing on the reported relationship between educational digital games and children's cognitive abilities (Sloan, 2024). Two studies (7.4%) were classified as theoretical/design analyses because they discussed the potential of digital games to support developmental domains without collecting primary empirical outcome data from participants (Derks et al., 2022; Hassan et al., 2021). Overall, the predominance of empirical intervention studies provides a useful basis for interpreting the reported developmental outcomes, although the strength of evidence varied across studies.

4.2. Age-related patterns in reported developmental outcomes

The findings suggest that reported developmental outcomes appeared to vary across age groups. As shown in Table 1, studies involving younger children, particularly those under 6 years old primarily focus on foundational domains such as communication, social interaction, and early language or cognitive skills. For example, game-based activities for children aged 4–6 often aim to support language development and social communication through structured and simulated contexts (Christinaki et al., 2014; Hetzroni & Ne'eman, 2013). In contrast, studies involving children aged 6–12 show a broader focus across adaptive and cognitive domains. This group represents the largest proportion of participants and is often associated with more structured interventions.

Digital games such as MEBook and EmoGalaxy have been used to improve communication and emotional regulation (Shams et al., 2020; Uzuegbunam et al., 2015), while educational digital games such as ACA support literacy development (Gobbo et al., 2021). For older participants, especially adolescents, outcomes shift toward higher-order cognitive and social domains. For instance, the Moral Awareness Game (MAG) targets moral reasoning and abstract thinking (Junaidi et al., 2025). Overall, these findings suggest a possible age-related pattern, where studies involving younger children tended to report on basic adaptive skills, while studies involving older children more often reported on cognitive and learning-related outcomes. However, incomplete reporting in several studies (Chien-Sing & YATIM, 2021; Guerra & Furtado, 2013; Nawahdah & Ihmouda, 2019; Qidwai & Connor, 2018) limits firm conclusions.

4.3. Implementation duration and reported developmental outcomes

Intervention duration may be related to differences in reported outcomes, although this pattern should be interpreted cautiously because duration was not consistently reported across studies. Short-term interventions, such as the three-week implementation of the Moral Awareness Game (MAG), often focus on immediate outcomes such as engagement and attention (Junaidi et al., 2025). Most studies implemented interventions over four to six weeks (Christinaki et al., 2014; Elhaddadi et al., 2021; Malinverni et al., 2017; Nawahdah & Ihmouda, 2019; Uzuegbunam et al., 2015; Vukicevic et al., 2019). These medium-term interventions commonly reported outcomes across both adaptive and cognitive domains, including communication, emotional regulation, and attention (Elhaddadi et al., 2021; Malinverni et al., 2017; Nawahdah & Ihmouda, 2019).

Longer interventions (8–12 weeks or more) were reported in some studies alongside broader developmental outcome domains. For example, the Caribbean Quest game, implemented over 12 weeks, supported both cognitive and adaptive outcomes (Macoun et al., 2021). However, inconsistent reporting of duration across several studies (Adochiei et al., 2024; Al-Hammadi & Abdelazim, 2015; Chien-Sing & YATIM, 2021; Gobbo et al., 2021; Pistoljevic & Hulusic, 2017; Sloan, 2024) limits the ability to draw clear conclusions about how intervention duration relates to reported outcomes.

4.4. Technology format and outcome emphasis

The findings also show that reported outcome emphasis varied across technology formats, based on the frequency and focus of outcomes reported in the included studies. As shown in Table 1, the reviewed interventions include screen-based games such as EmoGalaxy (Shams et al., 2020), motion-based systems such as Kinect (Vukicevic et al., 2019), and immersive or extended-reality formats such as augmented reality in Balloon Pop (Rodriguez et al., 2022) and virtual reality in VR-based serious games (Wu et al., 2025).

Screen-based games, which were the most represented format, were more frequently reported in studies addressing cognitive and learning-related outcomes. For example, Miss.Fly was linked to executive functioning and cognition (Al-Hammadi & Abdelazim, 2015), ACA supported image recognition, vocabulary, and reading (Gobbo et al., 2021), Memory Maze was associated with attention and memory (Adochiei et al., 2024), EmoGalaxy supported emotional regulation (Shams et al., 2020), and MAG (Moral Awareness Game) targeted higher-order moral awareness (Junaidi et al., 2025).

Similarly, educational interventions without a named commercial title, such as the interactive e-book study (Pistoljevic & Hulusic, 2017) and the graphic-symbol learning study (Hetzroni & Ne'eman, 2013), also focused on learning skills and cognitive development. Additional screen-based educational games, such as Up to Ten, Poisson Rouge, and Minisebran (Florou et al., 2009), were associated with communication and social behavior in younger children, while the Puzzle game study (Chien-Sing & YATIM, 2021) emphasized executive functioning and cognition. Box Island and Peg Plus Cat – Music Maker (Sloan, 2024) also contributed to executive functioning and cognition. These findings suggest that, in the reviewed studies, screen-based games may

be particularly aligned with structured tasks involving literacy, concept learning, memory, and academic skill development.

By contrast, motion-based and immersive technologies were more frequently reported in studies that address adaptive, behavioral, and embodied outcomes. MEBook, a Kinect-based intervention, was designed to improve communication-related behavior (Uzuegbunam et al., 2015), while the educational Kinect study reported gains in emotional regulation and motor-related performance (Vukicevic et al., 2019). Similarly, VR-based serious games were associated with improvements in movement skills and object control relevant to daily functioning (Wu et al., 2025).

Balloon Pop, as an augmented reality game, also supported concentration, interaction, and the learning of abstract concepts (Rodriguez et al., 2022). Other motion-based therapeutic systems, such as Kinect Mobile (WP7) (Guerra & Furtado, 2013), Pico's Adventures (Malinverni et al., 2017), Arduino MEGA platform (Qidwai & Connor, 2018), and Aliza (Najeeb et al., 2020), were likewise associated with emotional regulation, communication, adaptive behavior, or early learning engagement. These formats often involve real-time physical engagement and may provide opportunities for practicing social, behavioral, and functional skills in more interactive contexts.

However, the relationship between technology form and outcomes is not a rigid, isolated boundary. Some screen-based games, such as Caribbean Quest, supported both emotional regulation and executive functioning (Macoun et al., 2021), while multiplayer mobile environments such as Zirkus Empathico 2.0 promoted communication and cooperation (Hassan et al., 2025). Overall, the findings suggest that reported outcomes varied across technology formats, but this pattern should not be interpreted as evidence that technology format independently determines outcomes.

4.5. Game type and reported developmental outcome domains

The reviewed studies reported outcomes in five developmental domains: communication and social behavior, emotional regulation, daily living skills, executive functioning and cognition, and learning skills. Because one study could report more than one domain, these five domains produced 42 coded outcome-domain reports across the 27 included studies. Figure 2 compares how these domains were distributed across therapeutic and educational digital games.

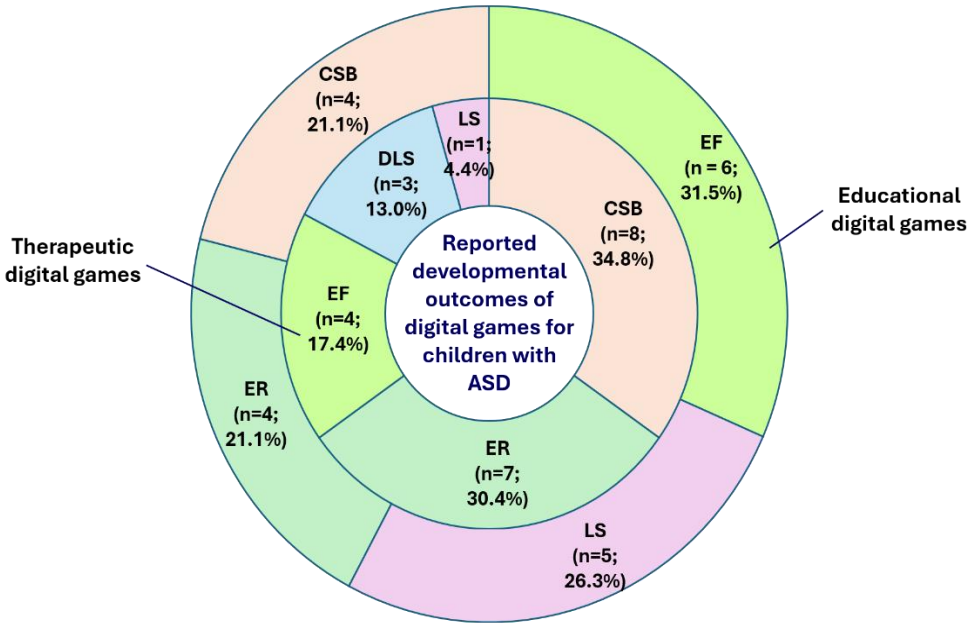

Figure 2: Comparative distribution of reported outcome domains across therapeutic and educational digital games

*(**Note:** CSB = Communication & social behavior; ER = Emotional regulation; DLS = Daily living skills; EF = Executive functioning & Cognition; LS = Learning skills. Percentages represent the distribution of coded outcome-domain reports.)*

For therapeutic digital games, as shown in the second circle from the inside in Figure 2, The reported distribution of outcomes suggests a stronger emphasis on foundational functional skills. Communication and social behavior were the most frequently targeted domains (n = 8; 34.8%), followed by emotional regulation (n = 7; 30.4%). Although less frequently reported, executive functioning and cognitive skills (n = 4; 17.4%), daily living skills (n = 3; 13.0%), and learning skills (n = 1; 4.4%) were also addressed. Despite their lower representation, these domains remain essential for building adaptive functioning and social interaction abilities in children with ASD.

For educational digital games, in the outermost circle of Figure 2, the primary research emphasis shifts toward higher-level cognitive and academic abilities, with executive functioning and cognition (n = 6; 31.5%) and learning skills (n = 5; 26.3%). Communication and social behavior skills, and emotional regulation received slightly less attention, with both domains reported in an equal proportion of studies (n = 4; 21.1%). No studies using educational digital games reported outcomes related to daily living skills. The overall distribution of reported outcome domains across the included studies is shown in Figure 3.

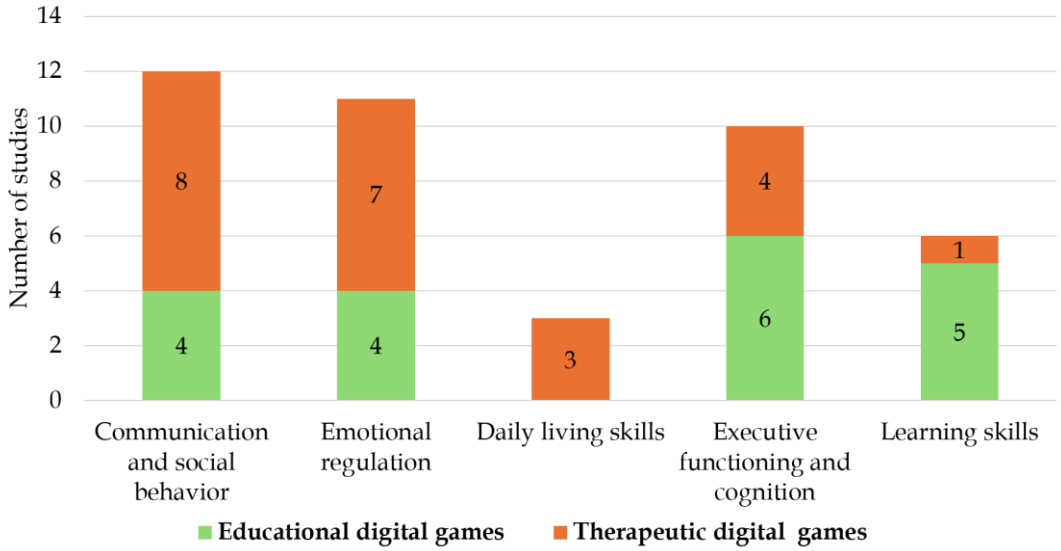

Figure 3: Overall distribution of reported developmental outcome domains across included studies

The findings show that communication and social behavior represent the most frequently reported outcome domain across both therapeutic and educational digital games, with 12 studies addressing this area, accounting for 28.6% of all 42 reported child outcomes. For example, one study used therapeutic digital games to increase social interaction and practice communication skills, such as Pico's Adventures (Malinverni et al., 2017), while educational digital games with interactive features, such as Balloon Pop, also supported social engagement among children (Rodriguez et al., 2022). Emotional regulation was the second most frequently reported outcome domain, appearing in 11 studies (26.2% of 42 reported child outcomes).

Several studies reported improvements in emotional outcomes through interventions using EmoGalaxy, Pico's Adventures, and other therapeutic digital games (Malinverni et al., 2017; Nawahdah & Ihmouda, 2019; Qidwai & Connor, 2018; Shams et al., 2020). Educational digital games were also reported to support emotional-development-related outcomes in simulated or interactive learning contexts (Adochiei et al., 2024; Christinaki et al., 2014; Vukicevic et al., 2019). Daily living skills were less frequently addressed compared to other domains (n = 3; 7.1% of 42 reported child outcomes). Studies targeting this domain typically used therapeutic digital games to promote independence and functional daily activities, such as EmoGalaxy (Shams et al., 2020), Pico's Adventures (Malinverni et al., 2017).

Executive functioning and cognitive skills appeared in both therapeutic and educational digital game interventions, with 10 studies addressing this domain (23.8% of 42 reported child outcomes). These studies primarily focused on improving attention, memory, behavioral control, and information-processing abilities. Several educational digital games were associated with reported improvements in memory and cognitive performance (Adochiei et al., 2024; Chien-Sing & YATIM, 2021; Junaidi et al., 2025; Sloan, 2024). Positive outcomes were also reported for therapeutic digital games that

included well-structured and cognitively demanding tasks (Cordioli et al., 2024; Malinverni et al., 2017; Nawahdah & Ihmouda, 2019; Qidwai & Connor, 2018). Finally, the development of academic knowledge and learning skills was most frequently examined in studies using educational digital games, with six studies reporting improvements in this domain (14.3% of 42 reported child outcomes). Games such as Miss.Fly and ACA focused on letter recognition, phonological awareness, and vocabulary development, with studies reporting progress in learning skills (Al-Hammadi & Abdelazim, 2015; Gobbo et al., 2021). Additionally, hybrid educational-therapeutic games such as Caribbean Quest and Zirkus Empathico 2.0 integrated cognitive and social learning tasks (Hassan et al., 2025; Macoun et al., 2021). Overall, the synthesized findings suggest that digital games have been associated with a wide range of reported developmental outcomes for children with ASD.

5. Discussion

The findings of this review can be interpreted in relation to the three research questions. First, the reviewed studies show that digital games for children with ASD varied in design characteristics, including game purpose, technology format, implementation duration, participant age range, and study type. Second, the reported developmental outcomes were concentrated in five domains: communication and social behavior, emotional regulation, daily living skills, executive functioning and cognition, and learning skills. Third, the comparison between therapeutic and educational digital games suggests a descriptive pattern: therapeutic digital games were more frequently reported in relation to adaptive and intervention-oriented outcomes, whereas educational digital games were more frequently reported in relation to cognitive and learning-related outcomes.

However, this pattern should not be interpreted as a strict separation between the two game categories. The distinction between therapeutic and educational digital games is based on primary design purpose, and the reported developmental outcomes often overlapped across categories. Therefore, the following sections discuss therapeutic and educational digital games as two analytical categories, while recognizing that their developmental contributions may intersect in practice.

5.1. Reported developmental outcomes of therapeutic digital games

To clarify the reported developmental outcomes of therapeutic digital games, the findings were synthesized into key outcome domains, as presented in Table 2. This table suggests that therapeutic digital games were primarily associated with adaptive behavior (communication, emotional regulation, daily living skills) and executive functioning and cognition, with relatively less emphasis on formal learning outcomes.

Table 2: Reported developmental outcomes of therapeutic digital games for children with ASD

Outcome domain	Specific outcomes (with evidence sources)
Communication and social behavior	Reduced agitation and increased adaptive behavior (Guerra & Furtado, 2013); formation and reinforcement of greeting behavior (Uzuegbunam et al., 2015); initiation of social communication (Malinverni et al., 2017); increased joint attention, eye contact, and social language skills (Nawahdah & Ihmouda, 2019); increased proactive communication and cooperation in multiplayer mode (Hassan et al., 2025)
Emotional regulation	Improved overall emotional regulation (Shams et al., 2020); increased engagement and sustained participation (Najeeb et al., 2020; Qidwai & Connor, 2018); improved facial emotion recognition (Elhaddadi et al., 2021)
Daily living skills	Improved adaptive functioning (Derks et al., 2022); increased focus and intervention efficiency in ABA therapy (Cordioli et al., 2024); improved movement skills and object control relevant to daily functioning (Wu et al., 2025)
Executive functioning and cognition	Enhanced cognitive development (Guerra & Furtado, 2013); improved memory (Qidwai & Connor, 2018); improved attention and visual perception (Hassan et al., 2021); improved overall cognitive functioning (Derks et al., 2022)
Learning skills	Increased concentration in learning pre-academic skills (Najeeb et al., 2020)

As indicated in Table 2, therapeutic digital games were frequently associated with reported gains in communication and social behavior among children with ASD. For example, reduced agitation and increased adaptive behavior were reported in one study (Guerra & Furtado, 2013), while another demonstrated the formation and reinforcement of greeting behavior (Uzuegbunam et al., 2015). The initiation of social communication, including requests and turn-taking, was also observed in digital game-based interventions (Malinverni et al., 2017). In addition, improvements in joint attention, eye contact, and social language were documented (Nawahdah & Ihmouda, 2019), and multiplayer environments promoted proactive communication and cooperation (Hassan et al., 2025). These findings suggest that therapeutic digital games may provide structured opportunities for children with ASD to practice communication skills.

The role of therapeutic digital games in emotional regulation is also clearly reflected in Table 2. Improved overall emotional regulation was reported in one intervention (Shams et al., 2020), while increased engagement and sustained participation were observed in others (Najeeb et al., 2020; Qidwai & Connor, 2018). In addition, improvements in facial emotion recognition were documented (Elhaddadi et al., 2021). These reported outcomes suggest that therapeutic digital games may help children with ASD process emotional cues more effectively while maintaining engagement in intervention activities.

In terms of daily living skills, the evidence in Table 2 shows that therapeutic digital games can extend beyond communication and emotion-related outcomes. Improvements in adaptive functioning were reported in a synthesis study (Derks et al., 2022), while increased focus and intervention efficiency were observed in an ABA-based gamified system (Cordioli et al., 2024). Furthermore, VR-based serious games improved movement skills and object control (Wu et al., 2025), which are directly relevant to daily functioning. These findings suggest that therapeutic digital games may enhance functional independence by supporting both behavioral regulation and motor-related capacities. However, the evidence also indicates that such improvements may be partial rather than comprehensive, reinforcing the role of digital games as supportive tools rather than stand-alone interventions.

The contribution of therapeutic digital games to executive functioning and cognition is another key pattern shown in Table 2. Enhanced cognitive development was reported in one study (Guerra & Furtado, 2013), while improvements in memory were observed in another (Qidwai & Connor, 2018). Increased concentration during pre-academic learning tasks was also documented (Najeeb et al., 2020), along with improvements in attention and visual perception (Hassan et al., 2021). In addition, broader evidence suggests that therapeutic digital games were reported to support overall cognitive functioning (Derks et al., 2022). These findings suggest that therapeutic digital games may engage children in structured and repetitive tasks that support attention, memory, and perceptual processing.

In summary, the analysis of Table 2 suggests that therapeutic digital games appear to be associated with several foundational developmental domains in children with ASD. Importantly, these reported contributions appear to depend on the design of the game and the intervention context, indicating that therapeutic digital games should be selected based on specific developmental goals rather than general technological appeal.

5.2. Reported developmental outcomes of educational digital games

The reported developmental outcomes of educational digital games are summarized in Table 3, which shows a different pattern compared to therapeutic digital games. Educational digital games were more frequently associated with executive functioning, cognition, and learning skills, while also supporting selected aspects of adaptive behavior.

Table 3: Reported developmental outcomes of educational digital games for children with ASD

Outcome domain	Specific outcomes (with evidence sources)
Communication and social behavior	Increased interest, attention, and cooperation during intervention sessions (Florou et al., 2009); improved emotion identification through natural user interfaces (Christinaki et al., 2014); communication and social skills (Macoun et al., 2021); positive emotions, and reduced inattention (Vukicevic et al., 2019); increased concentration, interaction, and more spontaneous communication (Rodriguez et al., 2022)
Emotional regulation	Improved overall emotional regulation (Macoun et al., 2021); positive emotions, and reduced inattention (Vukicevic et al., 2019);
Executive functioning and cognition	Improved skill generalization (Vukicevic et al., 2019); improved attention (Adochiei et al., 2024; Al-Hammadi & Abdelazim, 2015); improved memory (Adochiei et al., 2024; Al-Hammadi & Abdelazim, 2015); learning and generalization of graphic symbols (Hetzroni & Ne'eman, 2013); processing of randomness (Al-Hammadi & Abdelazim, 2015); executive functioning (Macoun et al., 2021); improved cognition, with age- and gender-related differences (Adochiei et al., 2024); increased cognitive accessibility (Sloan, 2024); development of practical skills (Chien-Sing & YATIM, 2021)
Learning skills	Vocabulary development (Gobbo et al., 2021; Pistoljevic & Hulusic, 2017); pre-math skills, and color–number recognition (Pistoljevic & Hulusic, 2017); increased subject-matter knowledge (Bossavit & Parsons, 2018); improved image recognition, vocabulary, and reading (Gobbo et al., 2021); concept formation, and imagination (Chien-Sing & YATIM, 2021); increased attention, interaction, and learning of abstract concepts (Rodriguez et al., 2022); improved focus during learning activities (Adochiei et al., 2024); increased moral awareness (Junaidi et al., 2025)

As shown in Table 3, educational digital games appear to support communication and social behavior mainly by promoting participation in learning contexts. Increased interest, attention, and cooperation during intervention sessions were reported in one study (Florou et al., 2009). Emotion identification was improved through natural user interfaces (Christinaki et al., 2014), while Kinect-based games led to improved skill generalization, more positive emotions, and reduced inattention (Vukicevic et al., 2019). Improvements in communication and social skills were also observed in another study (Macoun et al., 2021).

Additionally, increased concentration, interaction, and spontaneous communication were reported in game-based learning activities (Rodriguez et al., 2022). These findings suggest that educational digital games may enhance adaptive behavior indirectly by creating engaging and structured learning environments that encourage participation. The contribution of educational digital games to emotional regulation is also evident, although less prominent than in therapeutic digital games. Improved overall emotional regulation and more positive emotional states were reported in specific interventions

(Macoun et al., 2021; Vukicevic et al., 2019). These outcomes likely reflect the motivational and interactive nature of educational digital games, which can reduce anxiety and increase enjoyment during learning activities.

The most frequently reported pattern in Table 3 relates to executive functioning and cognition. Educational digital games were associated with improved attention (Adochiei et al., 2024; Al-Hammadi & Abdelazim, 2015), memory (Adochiei et al., 2024; Al-Hammadi & Abdelazim, 2015), and processing abilities (Al-Hammadi & Abdelazim, 2015), while also supporting the learning and generalization of graphic symbols (Hetzroni & Ne'eman, 2013), and gross motor skills, and skill generalization (Vukicevic et al., 2019). Improvements in executive functioning were reported in game-based environments (Macoun et al., 2021), and broader gains in memory and cognition were observed in another study (Adochiei et al., 2024). In addition, the development of cognitive accessibility frameworks highlights the importance of designing games that accommodate diverse cognitive needs (Sloan, 2024). These findings suggest that some educational digital games may function as cognitively demanding environments that require children to attend, process information, and respond to structured tasks, thereby strengthening core cognitive processes.

Educational digital games were also frequently associated with learning skills, as shown in Table 3. Vocabulary development, pre-math skills, and color–number recognition were reported in interactive e-book interventions (Pistoljevic & Hulusic, 2017). Increased subject-matter knowledge was also documented (Bossavit & Parsons, 2018), while improvements in image recognition, vocabulary, and reading were observed in another study (Gobbo et al., 2021). Additional findings include the development of practical skills, concept formation, and imagination (Chien-Sing & YATIM, 2021), as well as increased moral awareness (Junaidi et al., 2025). Furthermore, game-based learning supported the acquisition of abstract concepts (Rodriguez et al., 2022) and improved attention during learning tasks (Adochiei et al., 2024). These results suggest that educational digital games may support foundational academic and pre-academic learning, although the strength of this conclusion depends on the methodological quality and reporting detail of the included studies.

In summary, the analysis of Table 3 suggests that educational digital games were reported to support developmental outcomes through two main pathways. First, they may enhance adaptive participation in learning environments by increasing engagement, interaction, and cooperation. Second, they may support intellectual functioning and learning skills, particularly in attention, memory, and academic development. Compared with therapeutic digital games, educational digital games are more strongly oriented toward cognitive and learning outcomes. However, the overlap between the two categories of digital games indicates that both therapeutic and educational elements can coexist depending on design and implementation.

6. Conclusion

This structured narrative review used qualitative content analysis to synthesize published studies on digital games for children with ASD, focusing on design characteristics and reported developmental outcome domains. The findings indicate that the reviewed studies reported diverse uses of digital games and a range of developmental outcome domains, including communication and social behavior, emotional regulation, daily living skills, executive functioning and cognition, and learning skills.

Notably, games designed with therapeutic orientation tend to focus primarily on communication and social behavior, and emotional regulation, while educational digital games were more frequently reported in relation to cognitive function and basic learning skills. However, the existing evidence remains fragmented, and the substantial variation across studies in terms of intervention design, implementation duration, target populations, and outcome measures limits the ability to make direct comparisons and draw generalizable conclusions regarding the potential of digital games.

Therefore, the findings should be interpreted as a content-based synthesis of reported trends and outcome domains rather than definitive evidence of universal intervention effectiveness. The main contribution of this review is that it organizes fragmented evidence into an integrated synthesis linking digital game design characteristics, therapeutic and educational digital game purposes, and five domains of developmental outcomes reported in children with ASD.

Limitations: This study has several limitations. First, it was designed as a structured narrative review, with qualitative content analysis used for synthesis, rather than as a full systematic review or meta-analysis. Therefore, it did not estimate pooled effect sizes or formally determine the causal effectiveness of digital games. Second, no protocol was prospectively registered, although the search strategy, inclusion criteria, extraction framework, and coding procedures were discussed and agreed upon by the research team before and during the review process. Third, the search did not include Scopus because the authors did not have institutional access to this database during the search period.

In addition, other databases such as ERIC, PsycINFO, and ACM Digital Library were not searched systematically. This may have limited the coverage of relevant studies. Fourth, because some included studies reported broad age ranges, age-related patterns should be interpreted as descriptive trends across the reviewed studies rather than as age-specific conclusions for distinct developmental stages. Fifth, the synthesis relied only on information reported in the included studies. Therefore, when some studies did not provide sufficient details about participant characteristics, implementation duration, game types, technology format, or age range, it may have been more difficult to compare patterns across studies accurately.

Finally, based on a reviewer's comment, we acknowledge that the search string did not include some broader terms, such as "serious game", "video game", "computer game", "game-based learning", "gamification", "virtual reality", and "augmented reality". Although these terms could have increased search sensitivity, they might also have retrieved many records outside the scope of this review, including non-digital games, general gamified activities, or VR/AR applications without a game-based design. Therefore, their absence may have limited retrieval of some relevant studies. Future reviews should adopt broader search strategies to provide a more comprehensive synthesis of digital game–based interventions for children with ASD.

Research implications: From a research perspective, future research should adopt more rigorous and standardized designs to improve comparability across studies. Researchers should provide clearer descriptions of intervention characteristics, including game mechanics, implementation dosage, instructional context, and target outcomes. Another important implication for research is the need to distinguish more clearly between therapeutic and educational digital games while also recognizing the overlap between them. The findings of this review indicate that therapeutic digital games tend to focus more on adaptive behavior, whereas educational digital games more often target executive functioning, cognition, and learning skills. Future studies should examine these differences more systematically and explore how particular design features contribute to specific developmental outcomes.

Practical implications: From a practical perspective, the review suggests that digital games should not be selected merely because they are engaging or technology based. Instead, they should be chosen according to the developmental needs of children with ASD and the intended educational or intervention goals. For teachers, therapists, and educational administrators, this means aligning game selection with specific target domains, such as social communication, emotional development, or foundational learning skills. It also implies the need for careful implementation, including appropriate scaffolding, monitoring, and adaptation to individual differences. Overall, digital games appear to hold meaningful promises as supportive tools, but their value in practice depends on purposeful design and informed use.

Conflict of Interest

The authors have declared that no competing interests exist.

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developmental outcomes. More than 80% of the present journal manuscript consists of new or substantially revised content compared with the conference version. The authors confirm that the conference version has been fully disclosed and that the present submission does not involve duplicate publication.

During manuscript preparation, the authors used ChatGPT (GPT-5.5 Thinking, OpenAI) only to improve grammar, clarity, and readability. AI tools were not used to generate data, conduct literature search, screen studies, extract data, analyze results autonomously, or create references. All AI-assisted text was carefully reviewed, verified, and edited by the authors, who take full responsibility for the accuracy, integrity, and final content of this manuscript.

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