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A Systematic Review of Unplugged Pedagogy for Children with Autism Spectrum Disorder in K-12 Education

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ABSTRACT

Unplugged pedagogy has emerged as an alternative method for teaching fundamental concepts without the use of digital devices, making it highly relevant for the education of children with autism spectrum disorder (ASD). While unplugged pedagogy is considered beneficial in enhancing engagement and understanding, its effectiveness in the context of special needs education requires further in-depth investigation. This study aims to analyze the effectiveness of unplugged pedagogy for children with ASD education from kindergarten to senior high school (K-12) using the Systematic Literature Review (SLR) method based on the PRISMA framework. Literature was retrieved from the Scopus database using the keywords "unplugged" AND "Autism" OR "ASD" AND "Special Needs Education." Unplugged pedagogy is effective in improving engagement and conceptual understanding of computing among children with ASD in K-12 settings. The reviewed studies highlight the success of this approach in supporting skill generalization and increasing learning motivation, although challenges such as limited teacher training and contextual constraints remain significant barriers. These findings open opportunities for developing more adaptive pedagogical strategies for students with special needs, particularly those with ASD in K-12 education.

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1. INTRODUCTION

Education from kindergarten to senior high school (K-12) has undergone rapid development in recent decades, driven by the growing demand for digital literacy. One of the main challenges lies in teaching fundamental computing concepts, which are often abstract for students. As a solution, unplugged pedagogy has emerged as a method for teaching these foundational concepts without the direct use of digital devices (Huang & Looi, 2021). This approach incorporates physical activities, games, and simulations to help students grasp abstract computing ideas before transitioning to digital technologies (Li *et al*., 2022). It aligns with Kolb's experiential learning theory, which emphasizes a learning cycle involving concrete experiences, reflection, and abstraction.

Previous studies have shown that unplugged pedagogy can enhance students' understanding across various learning domains. Sigayret *et al*. (2022) found that this method contributes to improved student performance, while Aranda and Ferguson (2018) reported its effectiveness in introducing Computational Thinking (CT) without digital tools. Additionally, Han (2019) and Saxena *et al*. (2020) highlighted that unplugged pedagogy increases student engagement, particularly for those with limited access to technology.

However, despite the growing popularity of unplugged pedagogy, there remains a gap in the literature regarding its effectiveness across diverse educational contexts. Most research has focused on specific settings, such as early childhood education or classrooms with limited technological access. For example, Saxena *et al*. (2020) examined unplugged pedagogy in the context of early childhood education, but few studies have systematically explored its application in K-12 education, particularly for children with autism spectrum disorder (ASD).

Furthermore, although several studies have addressed unplugged pedagogy, to date, there has been no systematic review evaluating its effectiveness for children with ASD in K-12 education.

Therefore, this study aims to address this gap by conducting a systematic review of the effectiveness of unplugged pedagogy in K-12 education, with a specific focus on children with ASD. Using the PRISMA methodology, this study seeks to provide a structured and comprehensive mapping of the literature and offer recommendations for educators and curriculum developers in optimizing unplugged pedagogy in K-12 settings.

2. METHODS

2.2. Research Design

This study employs a systematic review method based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to evaluate the effectiveness of unplugged pedagogy in K-12 education, with a particular focus on children with ASD.

2.2. Literature Search Strategy

The literature search was conducted on May 4, 2025, using the Scopus database with the following combination of keywords: "unplugged" AND "Autism" OR "ASD".

2.3. Inclusion and Exclusion Criteria

The inclusion criteria applied in this study are as follows: (i) Articles published between 2020 and 2024; (ii) The type of document is limited to journal articles; (iii) The language of the document is English; and (iv) Studies that discuss unplugged pedagogy for children with ASD.

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The exclusion criteria applied in this study are as follows: (i) Articles written in languages other than English; (ii) Proceedings, books, and conference papers; and (iii) Studies that focus solely on children with ASD without the use of unplugged methods, and studies conducted outside the K-12 education context (e.g., university-level or professional training).

2.4. Study Selection and Screening Process

The selection process was carried out in several stages, namely identification, screening, eligibility, and inclusion. The following is a detailed explanation of each stage conducted during the data selection process:

(i) Identification: The initial search yielded several relevant articles from Scopus. Duplicate records were removed.
(ii) screening: The titles and abstracts of the articles were reviewed to determine their relevance. Articles that did not align with the research topic were eliminated.
(iii) Eligibility: Articles that passed the screening stage were assessed in full to evaluate their quality and relevance to the topic. Articles lacking empirical data or not focusing on unplugged pedagogy were excluded.
(iv) Inclusion: Articles that m*et al*l criteria were included in the final analysis.

2.5. PRISMA Diagram

Figure 1 presents the flowchart of the article selection process used in this study, following the stages described previously.

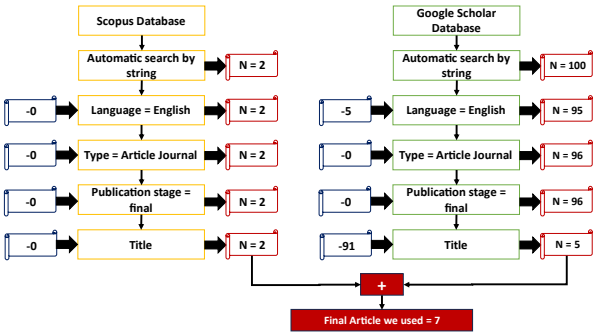

Figure 1. Article selection stages (PRISMA).

2.6. Data Analysis

The analysis was conducted by categorizing studies based on themes (e.g., effectiveness in conceptual understanding vs. learning motivation), identifying key trends in the literature (e.g., success factors of unplugged pedagogy), and recognizing research gaps for future study recommendations.

2.7. Synthesis and Reporting of Results

The results of the data analysis will be presented in narrative form, tables, and figures to address several research questions formulated as follows:

(i) RQ1: What are the publication trends of research related to unplugged pedagogy in the context of education for children with ASD at the K-12 level?
(ii) RQ2: What are the primary goals and methodological approaches used in research on unplugged pedagogy for children with ASD?
(iii) RQ3: How effective is unplugged pedagogy in improving engagement and conceptual understanding in children with ASD in K-12 environments?

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(iv) RQ4: What factors support or hinder the successful implementation of unplugged pedagogy for students with ASD?
(v) RQ5: What research gaps remain unexplored regarding unplugged pedagogy in the context of special needs education in K-12?

The final report will be structured according to the PRISMA guidelines to ensure transparency and replicability in future research.

3. RESULTS AND DISCUSSION

Table 1 presents the metadata and main focus of the seven articles selected to support this study. Among these seven articles, only three were considered highly relevant to the research topic, while the remaining four were classified as less relevant or entirely irrelevant. After further analysis, including a comprehensive review of the article contents—such as objectives, methods, and reported results—the three articles deemed relevant directly demonstrate a strong connection to the use of unplugged pedagogy with children with ASD.

Table 1. Summary of Metadata and Relevance of Articles to Unplugged Pedagogy Research for Children with ASD.

Title	Focus	Results	Reference
Effectiveness of Video Self-Modeling in Teaching Unplugged Coding Skills to Children with Autism Spectrum Disorders †	Examining the effectiveness of video self-modeling in teaching unplugged coding to children with ASD aged 10–12	Significant improvement in skills was observed; these skills were generalized to other contexts and maintained after 12 weeks.	Kurnaz (2025)
The effect of unplugged coding education for special education students on problem-solving skills	Investigating the effects of unplugged coding education on special needs students with mild intellectual disabilities	Significant improvement in problem-solving skills was found.	Demir (2021)
Square Pegs and Round Holes: Pedagogy for Autistic Students in Computing Education	Developing a computational pedagogy framework for students with autism	Unplugged computing is an approach favored by students; the main challenge lies in the teachers' understanding of this approach.	Shah *et al.* (2024)

3.1. RQ1: How are the Publication Trends of Research Related to Unplugged Pedagogy in the Context of Education for Children with ASD at the K-12 Level?

Figure 2 shows the trend of total publications or findings from 2020 to 2025. Overall, Figure 2 indicates significant fluctuations from year to year.

In 2020, the total number was 12, then slightly decreased to 11 in 2021. However, there was a sharp increase in 2022, reaching a total of 23. This surge is likely due to increased attention or research activities in the field during that year. A decrease occurred again in 2023, bringing the number back to 13, before experiencing the highest peak in the observed period in 2024, with a total of 30. Unfortunately, this trend did not continue, as the number sharply dropped to only 2 in 2025.

These fluctuations suggest a dynamic in the field, driven by factors such as researcher attention, funding, or developments in the issue. The spikes in 2022 and 2024 may be linked to external factors like new policies, increased research funding, or shifts in academic trends. Conversely, the sharp decline in 2025 could be due to reduced interest or funding, a shift in focus to other issues, or limited access to data.

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In the literature review, such phenomena are explained by the research trend lifecycle theory (Li *et al*., 2018; Peltoniemi, 2011), where research fields go through stages of early growth (slow growth), peak (high publication numbers), and decline (saturation or shifting interests). Additionally, Rogers' diffusion of innovation theory is relevant, as it states that the adoption of an approach or issue spreads from innovators to early majorities and eventually declines as innovations replace the old ones (Sahin, 2006; García-Avilés, 2020).

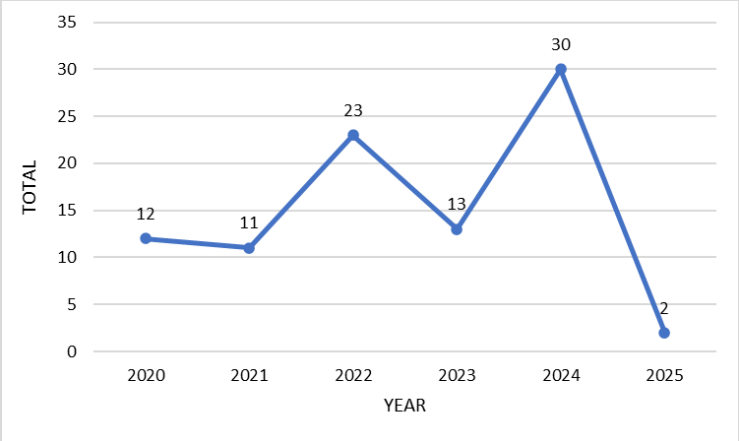

Figure 2. Publication trends on research topics before the inclusion and exclusion selection.

3.2. RQ2: What Are the Main Goals and Methodological Approaches Used in Studies on Unplugged Pedagogy for Children with ASD?

Research on unplugged pedagogy in the context of children with ASD reveals diverse objectives, but generally focuses on improving the accessibility of computer science learning through more inclusive and hands-on approaches. The main objectives of the studies reviewed include: Evaluating the effectiveness of unplugged teaching strategies on specific cognitive skills, exploring the specific needs of students with ASD in computer learning environments, and designing an adaptive pedagogical framework suited to the unique characteristics of children with ASD.

Kurnaz (2025) explicitly aims to test the effectiveness of a video self-modeling-based teaching model in teaching unplugged programming skills to children with ASD aged 10 to 12. This study uses a multiple-probe across-subjects experimental design, which is commonly used in special education research due to its ability to capture gradual and controlled changes in individual behavior. The findings show that this approach successfully helped participants master unplugged skills and retain them for up to 12 weeks after the intervention. Additionally, social validity data collected from participants and parents indicated that the approach was positively viewed and considered practical for teaching practices.

In addition to focusing on intervention effectiveness, another prominent objective is seen in research by Shah *et al*. (2024), which developed an inclusive pedagogical framework for computer science education that is friendly to students with ASD. The framework was designed based on principles of personalization and explicit learning, considering the typical needs of autistic children for structure, predictability, and hands-on learning. This study used a mixed-methods approach, including a literature review, surveys of teachers, and interviews with special educators to gather comprehensive data. The results indicated that unplugged pedagogy was viewed as one of the most effective and appropriate approaches for students with ASD because it allows them to learn in a low-pressure environment while still developing logical and computational thinking skills.

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Methodologically, these studies tend to employ qualitative or quasi-experimental study designs, depending on the specific goals of the study. Kurnaz (2025) uses a single-subject experimental approach to directly measure effectiveness, while Shah *et al*. (2024) rely on data triangulation to understand the broader and more comprehensive context of teaching. This diversity in approaches reflects the researchers' efforts to address the complexities of children with ASD, who require flexible and evidence-based teaching methods.

Table 2 summarizes the research objectives and methods used in the selected articles that have gone through the selection process based on the previously established inclusion and exclusion criteria.

Table 2. Main aims and methodological approaches of each relevant article related to unplugged pedagogy for children with ASD.

Objective	Methodological	Reference
Menguji efektivitas video self-modeling dalam mengajarkan keterampilan unplugged coding kepada anak dengan ASD	Desain eksperimen multiple-probe across subjects; pengumpulan data melalui observasi dan validitas sosial	Kurnaz (2025)
Mengembangkan kerangka pedagogis fleksibel dan inklusif untuk siswa autistik dalam pembelajaran ilmu komputer, termasuk unplugged computing	Metode campuran: tinjauan literatur, survei guru, wawancara, dan pengalaman etnografis	Shah *et al.* (2024)
Menganalisis pengaruh coding unplugged terhadap kemampuan pemecahan masalah siswa berkebutuhan khusus (termasuk ASD)	Studi kuasi-eksperimental dengan desain pretest-posttest terhadap 34 siswa	Demir (2021)

3.3. RQ3: How Effective is Unplugged Pedagogy in Increasing Engagement and Conceptual Understanding in Children with ASD in K-12 Environments?

Several studies reviewed in this study demonstrate that unplugged pedagogy is significantly effective in increasing engagement and conceptual understanding in children with ASD, particularly in K-12 environments.

The study by Kurnaz (2025) explicitly shows that video self-modeling in unplugged coding learning is effective in improving skill mastery in ASD students aged 10–12. The four participants in this study successfully mastered coding skills without the use of computers through a physical and visual activity-based approach. Moreover, they were able to generalize these skills to new situations. This finding is reinforced by social validity data from parents and students, which indicated positive responses to the approach. These results suggest that unplugged learning designed with clear visualization and consistent repetition can help ASD students absorb abstract concepts more easily.

Meanwhile, Demir (2021) examined the impact of unplugged coding learning on problem-solving skills in students with special needs, including those with ASD. The results showed significant improvement in problem-solving skills across all aspects after the intervention. Before the learning intervention, students' average scores in completing logic-based tasks were 10.68, whereas after the intervention, the scores increased to 13.36. This suggests that unplugged activities not only facilitate concept comprehension but also enhance active participation and cognitive engagement in problem-solving tasks.

From the perspective of an inclusive learning environment, Shah *et al*. (2024) stated that autistic children showed more positive responses to hands-on approaches such as unplugged computing and physical computing. This approach was seen as aligning with their learning preferences, which favor structure, predictability, and logic-based activities. Additionally, the teachers involved in the study rated unplugged pedagogy as supportive of student

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engagement in learning and helpful in reducing anxiety that often arises when facing complex digital technologies.

Overall, the findings from various studies indicate that unplugged pedagogy is effective in enhancing both emotional and cognitive engagement in children with ASD, particularly because of its concrete, multisensory, and adaptable nature. Active involvement in activities such as games, simulations, and physical activities not only makes learning more enjoyable but also improves the absorption of abstract concepts like algorithms and logical sequences.

3.4. RQ4: What Factors Support or Inhibit the Successful Implementation of Unplugged Pedagogy for Students with ASD?

Based on the analysis of the reviewed articles, several factors influence the success of implementing unplugged pedagogy for students with ASD in K-12 environments. These factors are divided into two broad categories: supporting factors and inhibiting factors. **Table 4** presents a summary of the supporting and inhibiting factors for the successful implementation of unplugged pedagogy for children with ASD.

Table 4. Summary of supporting and inhibiting factors of unplugged pedagogy for children with ASD.

Category	Factor	Explanation	Reference
Supporting	Visual and Structured Learning Design	Video self-modeling helps ASD students follow the learning steps systematically.	Kurnaz (2025)
	Hands-on and Contextual Activities	Concrete activities like unplugged coding help link abstract concepts to the real world.	Shah *et al.* (2024)
	Inclusive and Supportive Learning Environment	Small group learning with a flexible approach enhances engagement and learning outcomes.	Demir (2021)
	Parental Involvement	Parental support reinforces learning outcomes and ensures the sustainability of practice outside of school.	Kurnaz (2025)
Inhibiting	Lack of Teacher Understanding of Inclusive Pedagogy	Teachers are not yet accustomed to approaches like unplugged computing or PRIMM.	Shah *et al.* (2024)
	Limited Resources and Adaptive Materials	Not all schools have access to materials and tools suitable for the needs of ASD students.	Demir (2021)
	Lack of Research and Practical Guidelines	There are no standardized or practical guidelines to support the widespread implementation of unplugged pedagogy.	Kurnaz (2025); Shah *et al.* (2024)

(i) Supporting Factors include:

- Visual and Structured Learning Design: Kurnaz (2025) emphasizes the importance of using video self-modeling to help children with ASD understand and internalize unplugged coding skills. Clear visualizations, structured steps, and repetition in the videos enable students to follow the lessons more easily without feeling overwhelmed. This aligns with the learning characteristics of ASD students, who require structure and predictability.
- Hands-on and Contextual Activities: Shah *et al.* (2024) show that children with ASD respond better to learning approaches based on concrete activities, such as physical computing and unplugged computing. These activities provide direct experiences that help them link abstract concepts to the real world. Such approaches also reduce anxiety, as they do not rely on complex digital interfaces.

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- Supportive and Inclusive Learning Environment: Demir (2021) highlights the importance of a learning environment that allows students with special needs to learn at their own pace and style. Small group interventions in a supportive atmosphere have proven to significantly enhance problem-solving abilities. Teacher support and the use of flexible methods are also key factors for success.
- Parental Involvement: In Kurnaz (2025), social validity data collected from parents showed that they supported the unplugged pedagogy approach and felt positive about its impact. This support is crucial for the continuity of learning at home and reinforcing the skills learned at school.

(ii) Inhibiting Factors include:

- Lack of Teacher Knowledge about Inclusive Pedagogy: One major barrier highlighted by Shah *et al*. (2024) is the limited understanding of teachers regarding various pedagogical approaches that are effective for ASD students. While approaches such as unplugged computing are considered effective, many teachers do not have adequate training or experience to implement them optimally.
- Limited Resources and Adaptive Materials: Some studies, including Demir (2021), suggest that the implementation of unplugged pedagogy requires specific teaching materials that often need to be tailored to the needs of students with special needs. The lack of adaptive materials and the absence of practical guidelines can be significant barriers to its implementation in classrooms.
- Lack of Research and Practical Guidelines: Both Kurnaz (2025) and Shah *et al*. (2024) note that there is still a lack of literature providing implementable guidelines that teachers can follow. The absence of large-scale empirical research means that unplugged pedagogy for ASD is still heavily reliant on individual experiments and has not been standardized.

3.5. RQ5: What Are the Research Gaps That Have Not Been Explored in Depth Related to Unplugged Pedagogy in the Context of Special Needs Education in K-12?

The review results show that while there has been significant progress in the use of unplugged pedagogy for students with special needs, particularly children with ASD, there are still several important areas that have not been deeply explored in the literature. **Table 5** below summarizes some of the identified research gaps that require further attention in future studies.

(i) Lack of Longitudinal Studies: One of the main gaps is the absence of longitudinal studies. Research such as Kurnaz (2025) shows that skills acquired through unplugged approaches can be maintained for up to 12 weeks post-intervention. However, this duration is still short and does not provide an understanding of the long-term impact on academic or socio-emotional development for children with ASD. Therefore, more extensive longitudinal studies are needed to evaluate the sustainability of learning outcomes in a broader and long-term context.

(ii) Limited Learning Contexts: Another area of concern is the limited learning contexts in which studies have been conducted. Most of the research has been carried out in highly controlled environments, such as special schools or experimental settings with a small number of participants. For example, studies by Kurnaz (2025) and Demir (2021) implemented interventions on a small scale and in a limited scope. This raises questions about how effectively unplugged pedagogy can be applied in general schools with greater student diversity, limited learning time, and varying teacher competencies.

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(iii) Methodological Limitations: In terms of methodology, most studies still use simple experimental designs or mixed methods that tend to be descriptive. For instance, Shah *et al*. (2024) developed a pedagogical framework based on ethnographic experience and teacher surveys, but participatory and design-based research approaches are still rarely used. These approaches hold great potential for exploring the real needs of students and teachers contextually and collaboratively.

(iv) Focus on Differentiating Individual Student Needs: The focus on differentiating the individual needs of students with ASD in the implementation of unplugged pedagogy is still very limited. Although Shah *et al*. (2024) emphasized the importance of personalized learning, not many studies have explicitly explored how unplugged strategies can be tailored to the individual characteristics of children with ASD, such as verbal abilities, sensory preferences, and visual or auditory learning styles.

(v) Teacher Training and Professional Development: Teacher training and professional development have not been a primary focus in the existing literature. The success of implementing unplugged pedagogy is highly dependent on teachers' readiness to design and adapt learning activities. However, as demonstrated by Shah *et al*. (2024), many teachers are still unfamiliar with this approach and need more support in the form of ongoing training and appropriate pedagogical resources.

(vi) Integration of Digital Technology: Finally, the integration of digital technology as a complement to unplugged pedagogy has rarely been discussed. A hybrid approach that combines unplugged and plugged learning has significant potential to bridge the various needs of students with ASD, but there is no empirical research that specifically explores this transition strategy or its effectiveness in the context of inclusive learning.

Table 5. Summary of identified research gaps.

Gap Area	Explanation	Reference
Limited Longitudinal Studies	The long-term effectiveness of unplugged pedagogy has not been thoroughly explored.	Kurnaz (2025)
Learning Environment Not Representative	Most studies are conducted in specialized settings, not reflecting general school contexts.	Demir (2021); Kurnaz (2025)
Homogeneous Methodology	There is a lack of studies using participatory or design-based research approaches.	Shah *et al*. (2024)
Personalization of Learning Not Maximized	Limited exploration on adapting unplugged pedagogy based on the individual needs of students with ASD.	Shah *et al*. (2024)
Teacher Training Not a Focus	Teacher readiness to implement unplugged pedagogy has not been sufficiently researched.	Shah *et al*. (2024)

4. CONCLUSION

Based on a systematic review of three main articles, it can be concluded that unplugged pedagogy holds significant potential in supporting computer science education for children with ASD at the K-12 level. In general, this approach has proven effective in enhancing the understanding of basic computational concepts and student engagement in learning. Additionally, the research shows that students with ASD can generalize the skills taught through unplugged approaches to new contexts and maintain these skills over a certain period. Methods such as video self-modeling, physical games, and collaborative activities have been shown to facilitate a more inclusive and meaningful learning process.

However, this review also reveals several challenges that may hinder the optimal implementation of unplugged pedagogy, such as the lack of teacher training, limited resources, and insufficient understanding of the characteristics of students with ASD.

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Furthermore, there are research gaps, including the lack of longitudinal studies, limited research in regular school settings, and the absence of in-depth exploration of differentiated learning tailored to neurodivergent profiles. Therefore, further research that is more extensive and contextual is needed to strengthen the empirical foundation and develop more adaptive pedagogical strategies for students with special needs.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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