Exploring Educational Software in Computing Education for Students with Autism Spectrum Disorder: A Systematic Mapping Study

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Abstract. *The growing inclusion of students with Autism Spectrum Disorder (ASD) in mainstream schooling requires adapted pedagogical approaches, especially in Computing. Educational software shows significant potential for developing computational thinking, but barriers in personalization and accessibility persist. This study presents a systematic mapping of 17 primary studies on educational software for teaching Computing to students with ASD. Our analysis reveals tools like visual programming and serious games focusing on fundamental skills, yet a lack of personalization and empirical validation remains. This mapping highlights critical research gaps and provides a structured overview to guide future development. We also classify the pedagogical strategies using Bloom's Taxonomy and the Computational Thinking competencies using Brennan and Resnick's framework to inform more inclusive solutions.*

1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that causes challenges in communication, social interaction, and restricted and repetitive behavior, directly affecting students' academic performance and socioemotional development [Lord et al. 2018].

Globally, there has been a growing emphasis on inclusive education, with international policies and conventions advocating for the right to education for all individuals with disabilities, including those with ASD. These foundational principles, established through documents like the United Nations Convention on the Rights of Persons with Disabilities (CRPD) [United Nations 2006] and the Salamanca Statement and Framework for Action on Special Needs Education [UNESCO 1994], are continuously reinforced by contemporary global agendas, such as the United Nations Sustainable Development Goal (SDG) 4, which explicitly aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" [United Nations 2015]. This persistent focus guides national legislations worldwide.

In Brazil, public inclusion policies, such as the Brazilian Inclusion Law [Brasil 2015] and constitutional and legal provisions for basic education [Brasil 1988,

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Brasil 1996], have sought to guarantee access for students with ASD to the regular school environments. According to data from the INEP 2024 School Census, the number of students with Autism Spectrum Disorder (ASD) in basic education increased by 44.4% between 2023 and 2024, rising from just over 636,000 to nearly 920,000 students [INEP 2025].

In Computer Science education, Digital Educational Resources (DERs) are tools that allow the promotion of an accessible, personalized, and adaptive learning environment [Mucundanyi and Woodley 2021, Edula et al. 2023]. Technologies such as virtual agents, virtual reality, educational software, games and gamified platforms have been used to support the development of cognitive and social skills of students with ASD [Valencia et al. 2019, UNESCO 2023]. However, the literature points out that most existing DERs lack adequate accessibility and personalization requirements, making their application with these students difficult [Chinchay et al. 2024, Epifânio and Da Silva 2020].

Despite advances in the use of technologies in Computer Science education, there is no comprehensive systematization of educational solutions adapted and developed specifically for students with ASD. The lack of clear guidelines, adapted resources, and effective integration of emerging technologies in computing education highlights gaps in the literature [Guarda and Duran 2024, Wankhede et al. 2024].

In view of this, it is necessary to carry out a Systematic Literature Mapping (SLM). This methodology, as described by [Petersen et al. 2015], allows gathering, organizing, and analyzing the available scientific production, providing a broad view of practices, challenges, and trends. The objective of this study is to provide a comprehensive overview of the literature on educational software and games in teaching Computing to students with ASD, highlighting the types of resources developed, assessment methods applied, design guidelines and protocols used, challenges faced, and opportunities for future research.

This article is organized as follows: Section 2 describes the methodology used in the SMS. Section 3 analyzes the research questions presented in the previous section and discusses the obtained results. Finally, the final considerations and suggestions for future work are described in Section 4.

2. Methodology

This section outlines the formal guidelines followed in this systematic mapping study. To meet the objectives of this study, we followed the systematic mapping protocol proposed by Petersen et al. (2015). The process is illustrated in Figure 1, for which we adapted the visual representation scheme from Geraldi et al. (2020), which involved defining the research questions, conducting a preliminary analysis of the area, developing and calibrating the search string, selecting scientific databases, and applying inclusion and exclusion criteria.

2.1. Research questions

We organized the research questions to guide the systematic mapping of the literature, structured into three main categories: study characteristics, study evaluation, and gap synthesis. The questions are listed below:

- **Study Characteristics**
  - **RQ1:** What digital resources for teaching Computing to students with Autism Spectrum Disorder (ASD) are described in the literature?
  - **RQ2:** What guidelines, methodologies or protocols are used in the use of these digital resources?
- **Study Evaluation**
  - **RQ3:** How are these resources evaluated in terms of their effectiveness and educational impact?
- **Gap Synthesis**
  - **RQ4:** What challenges and solutions are reported in the development and implementation of these resources?
  - **RQ5:** What research gaps and future opportunities are identified in the literature?

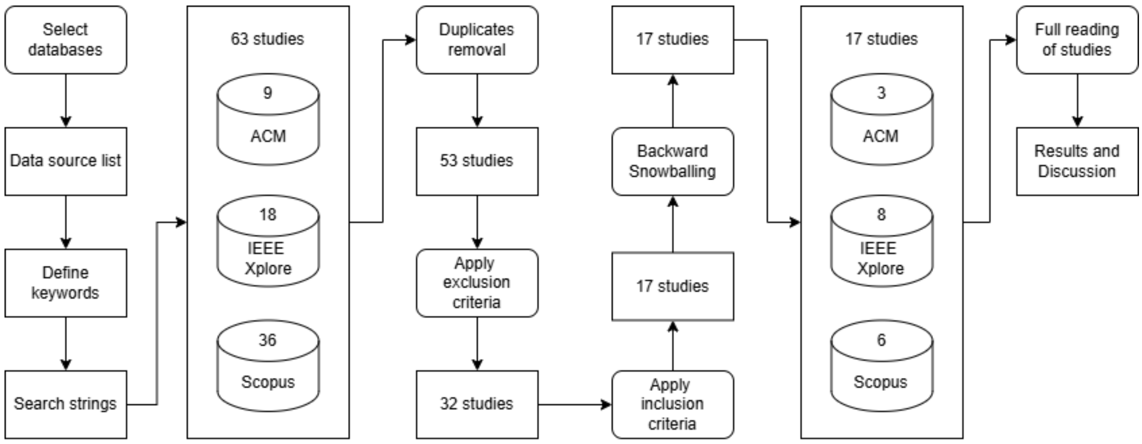

Figure 1. Research method representation inspired by Geraldi et al. [Geraldi et al. 2020]

2.2. Sources and search strategy

The search string was meticulously developed to ensure both comprehensiveness and precision, primarily guided by the the PICO (Population, Intervention, Comparison, and Outcomes) framework, as suggested by Kitchenham and Charters [Kitchenham and Charters 2007]. This approach facilitated the systematic formulation of search terms. For the Population (P), terms related to Autism Spectrum Disorder were included. The Intervention (I) component focused on two key aspects: terms related to computing education and those identifying the specific digital tools and educational software. Regarding Comparison (C), the search was broad to include empirical studies regardless of a comparative group, and for Outcomes (O), no specific restrictions were placed on the effects obtained, with these aspects being addressed primarily through the study selection criteria.

Keywords within each conceptual group were connected by the logical operator ‘OR’, while the three main groups were combined using ‘AND’. This structure ensured the retrieval of articles encompassing all three conceptual areas, requiring at least one term from each group to be present in any combination. The search string employed is presented below, with adaptations made according to the formatting required by each database, when necessary:

(Autism OR Autistic OR "Autism Spectrum Disorder" OR ASD) AND ("computational thinking" OR "programming education" OR "computing education" OR "visual programming") AND ("assistive technology" OR "inclusive education" OR "digital tools" OR "virtual learning" OR platform OR software OR game*).

We carried out the search in the reference databases in the areas of education, computing, and assistive technology: IEEE Xplore[1], Scopus[2], and ACM Digital Library[3]. It is important to note that the search string was adapted according to the specificities and restrictions of each database consulted.

2.3. Inclusion and exclusion criteria

The study selection process followed a systematic approach, beginning with the removal of duplicate articles identified across the selected databases.

Subsequently, a preliminary screening was conducted by analyzing the titles and abstracts of the remaining articles. During this phase, we applied the exclusion criteria sequentially. If an article met more than one exclusion criterion, its removal was justified by the first applicable criterion. The following criteria led to the exclusion of studies:

1. Studies not available in electronic full-text format.
2. Studies not written in English or Portuguese.
3. Grey literature or non-peer-reviewed publications, such as prefaces, books, editorials, abstracts, posters, panels, lectures, round tables, workshops, or demonstrations.
4. Works in progress or incomplete studies.
5. Studies that do not directly address the intersection of computing education, Autism Spectrum Disorder (ASD), and educational software or digital games.

After the initial exclusion phase, a full-text reading of the remaining articles was performed to apply the inclusion criteria and determine their suitability for the systematic mapping. We included studies that met all of the following criteria:

1. Studies must present original research findings (e.g., empirical studies, design science research, case studies, conceptual proposals with concrete solutions).
2. Studies must specifically describe the use, development, or evaluation of educational software.
3. Studies must be situated within the context of computing education (e.g., teaching programming, computational thinking, computational literacy).
4. Studies must involve or directly relate to students with Autism Spectrum Disorder (ASD) as the target population.

Additionally, backward snowballing was employed by systematically examining the reference lists of all initially included primary studies. Although this complementary technique was applied, no additional articles meeting the inclusion criteria were identified.

[1] https://ieeexplore.ieee.org/
[2] https://www.scopus.com/
[3] https://dl.acm.org/

The entire selection process, including the number of articles at each stage, is summarized in Figure 1, resulting in a final set of 17 primary articles included in this systematic mapping.

2.4. Data extraction

Key point	Details
Identifier (ID)	Unique identifier for the study.
Title	Full title of the article (RQ1).
Authors	Names of all authors.
Publication Year	Year of publication (RQ5).
Publication Venue	Conference proceedings or journal where published (RQ5).
Country	Country where the study was conducted or authors are affiliated (RQ1).
Study Objectives	Main goals or aims of the primary study (RQ1, RQ3).
Digital Resource	Description of the educational software or digital game (RQ1).
Evaluation Methods	Methods used to evaluate the digital resource (RQ3).
Guidelines Mentioned	Specific guidelines, protocols, or best practices referenced (RQ2).
Pedagogical Categories	Learning levels based on Bloom's Taxonomy [Ferraz and Belhot 2010] (RQ1, RQ2).
Computational Concepts	Computational thinking concepts or practices addressed [Brennan and Resnick 2012] (RQ1, RQ2).
Main Findings	Key results or conclusions of the study (all RQs, esp. RQ2, RQ5).
Challenges and Solutions	Identified barriers and proposed strategies for overcoming them (RQ4).
Identified Gaps	Areas for future research or limitations highlighted by the study (RQ5).
Type or Level of ASD	Specific autism spectrum disorder type or severity level of participants (RQ1).
Level of Education	Educational level of the target audience (RQ1).

Table 1. Data Extraction Form Items

We conducted the data analysis using both qualitative and quantitative methods to provide a comprehensive understanding of the patterns, challenges, and gaps in the reviewed studies. The quantitative analysis included frequency counts (such as the number of studies addressing each type of digital resource) and the temporal and geographic distribution of the studies, which we visualized using charts and tables that highlight the frequencies and trends. The qualitative analysis aimed to identify important themes and patterns, as well as challenges and proposed solutions, by coding the information to facilitate categorization. Additionally, we used pedagogical classifications such as Bloom's Taxonomy [Ferraz and Belhot 2010] and Brennan and Resnick's Computational Thinking Taxonomy [Brennan and Resnick 2012] to categorize the strategies and tools identified... This process enabled an analysis of the internal validity of the studies.

This process will enable an analysis of the internal validity of the studies, considering the clarity of evaluation methods and the relevance of results to the study objectives. The data extraction table was designed to directly address the proposed research questions, as outlined in Table 1.

Protocol validation involved consulting experts in computer and inclusive education for students with ASD, alongside a peer review by the last author, a Computer Science Professor. A pilot test, conducted with a sample of studies, refined the search, selection, and data extraction procedures for accuracy and reliability.

3. Results

This section provides an overview of the studies selected through the data extraction and filtering processes described in Section 2.2. Subsequently, the results related to the research questions presented in Section 2.1 will be discussed in detail. Data extraction was conducted based on the articles included in the systematic mapping, organized in a collaborative spreadsheet[4], enabling the systematization of information and a detailed analysis of the studies.

The 17 articles included in this mapping (see Table 2) span the period from 2016 to 2025. Research related to computing education for individuals with Autism Spectrum Disorder (ASD) began appearing in the selected sources in 2016. In terms of geographical distribution, Brazil and the United States are the leading contributors to scientific output, each with four articles. In Brazil's case, this reflects a strong interest in inclusive educational technologies and local adaptations, including collaborations with countries like Chile. The United States exhibits a more diversified approach, often exploring generalizable tools.

Chile, though with fewer articles, makes significant contributions through partnerships with Brazil, highlighting the importance of regional collaboration in advancing innovative practices. Other countries such as Egypt and the United Kingdom also provide relevant contributions, with studies focused on adaptive pedagogical approaches.

ID	Title
1	*"Can You Help Me" An Experience Report of Teamwork in a Game Coding Camp for Autistic High School Students* [Moster et al. 2022]
2	*Applied the Augmented Reality Technology Combined with Social Stories Strategies and Computational Thinking Games to Improve the Social Skills of Children with ASD* [Lee and Hsu 2024]
3	*Applying the Game Mode and Teaching Strategies of Computational Thinking to the Improvement of Social Skills Training for Children with Autism Spectrum Disorders* [Lee 2020]
4	*Building Serious Games to Exercise Computational Thinking: Initial Evaluation with Teachers of Children on the Autism Spectrum* [Malpartida and da Hora Rodrigues 2025]
5	*CodaRoutine: A Serious Game for Introducing Sequential Programming Concepts to Children with Autism* [Elshahawy et al. 2020a]

[4] `https://docs.google.com/spreadsheets/d/1JklhspDZk6BA1lTXbc687lrUuIY0HI3W/`

6	*Computational Thinking and Social Skills in Virtuoso: An Immersive, Digital Game-Based Learning Environment for Youth with Autism Spectrum Disorder* [Schmidt and Beck 2016]
7	*CT4All: Enhancing Computational Thinking Skills in Adolescents with Autism Spectrum Disorders* [Munoz et al. 2018a]
8	*Designing Accessible Visual Programming Tools for Children with Autism Spectrum Condition* [Zubair et al. 2023]
9	*Developing Computational Thinking for Children with Autism using a Serious Game* [Elshahawy et al. 2020b]
10	*Developing Computational Thinking Skills in Adolescents With Autism Spectrum Disorder Through Digital Game Programming* [Munoz et al. 2018b]
11	*From Start to Finish: Teenagers on the Autism Spectrum Developing Their Own Collaborative Game* [Bossavit and Parsons 2017]
12	*Game Design Workshop to Develop Computational Thinking Skills in Teenagers with Autism Spectrum Disorders* [Munoz et al. 2016]
13	*Integrating Social Skills Practice with Computer Programming for Students on the Autism Spectrum* [Eiselt and Carter 2018]
14	*Perception of Parents towards Fun Puzzle Games in Helping Mild Autistic Children Improve Their Computational Thinking Skills* [Chien-Sing and YATIM 2021]
15	*Programming Robotic Behavior by High-Functioning Autistic Children* [Lahav et al. 2019]
16	*Tracking Representational Flexibility Development through Speech Data Mining* [Ke et al. 2020]
17	*Towards Developing Computational Thinking Skills Through Gamified Learning Platforms for Students with Autism* [Elshahawy et al. 2022]

Table 2. Distribution of Digital Resources by Category

3.1. RQ1: What digital resources for teaching Computing to students with Autism Spectrum Disorder (ASD) are described in the literature?

The digital resources described in the literature for teaching computing to students with Autism Spectrum Disorder (ASD) can be categorized into five main groups (see Table 3), reflecting diverse educational and technological approaches.

Firstly, Visual Programming Environments and Coding Tools are widely used, with a strong emphasis on Block-Based Programming Languages (BBPLs) like Scratch for digital game design workshops [Munoz et al. 2016]. Other tools mentioned include App Inventor within game programming methodologies [Munoz et al. 2018b], and general computer programming classes utilizing tools such as Scratch 2.0, Greenfoot, and Processing. The development of collaborative games by teenagers using visual programming software like Kodu Game Lab is also noted. Furthermore, research explores visual programming tools such as Scratch and Pocket Code, which are adapted with accessibility enhancements, including improved icons, mobile device support, and element personalization. The Game Coding Camp, a hybrid environment utilizing Unity and C for game coding, also falls into this category [Moster et al. 2022].

Category of Digital Resource	Number of Articles
Visual Programming Environments and Coding Tools	6
Serious Games and Educational Games	5
Immersive Technologies (Augmented and Virtual Reality)	2
Robotic Learning Environments	1
Gamified Learning Platforms and Methodologies	3

Table 3. Distribution of Digital Resources by Category

Secondly, Serious Games and Educational Games are prominent for teaching computational thinking and programming concepts interactively. Examples include “Codaroutine” (developed with Unity 3D) [Elshahawy et al. 2020a] and various online “fun puzzle game” or ”minigames” such as categorization, matching-order, and image puzzles [Chien-Sing and YATIM 2021]. The “Virtuoso” system, an immersive game-based learning environment, also employs programmable virtual robots for teaching programming and computational thinking.

Thirdly, Immersive Technologies, specifically Augmented Reality (AR) and Virtual Reality (VR), are used. An AR-based social story game integrates computational thinking techniques with therapeutic elements [Lee and Hsu 2024]. VR learning environments are also described for modeling and creating simulations.

Fourthly, Robotic Learning Environments offer hands-on experiences, exemplified by the use of KinderBot, an iconic programming software on iPads, to program EV3 robots in a visual and intuitive manner [Lahav et al. 2019].

Finally, Gamified Learning Platforms and Methodologies integrate interactive resources to facilitate learning. This includes instructional design guidelines like CT4All, which guide digital programming workshops, particularly using Scratch [Munoz et al. 2018a]. Additionally, broader strategies combining “game mode and teaching strategies of Computational Thinking” with interactive technology are highlighted as intervention methodologies. The literature also discusses the use of gamified learning platforms that integrate interactive resources to engage students [Elshahawy et al. 2022].

These resources collectively offer a broad spectrum of technological tools and pedagogical strategies to support computing education for students with ASD.

3.2. RQ2: What guidelines, methodologies or protocols are used in the use of these digital resources?

The studies reviewed employ several key guidelines and methodologies tailored to support students with ASD, falling into distinct categories that reflect diverse approaches to teaching and development:

- **Pedagogical Methodologies and Principles for ASD:** These approaches frequently utilize established frameworks like TEACCH (Treatment and Education of Autistic and Related Communication Handicapped Children), which emphasizes structuring the physical environment, using visual supports, and understanding the culture of autism in workshop design [Munoz et al. 2016]. Methodologies also draw from Paulo Freire’s Pedagogy of Autonomy and the GAIA guide focused on autism [Munoz et al. 2016]. Additionally, the integration of Social Stories Strategies combined with Augmented Reality (AR) and Computational Thinking (CT) games is noted for improving social skills [Lee and Hsu 2024].

- **Computational Thinking (CT) Frameworks and Guidelines:** These are central to curriculum and activity design. Many approaches are based on established CT frameworks (e.g., Wing, Snyder, Brennan, and Resnick) [Munoz et al. 2018b]. Specific guidelines like CT4All are defined to support the construction of didactic activities promoting CT in adolescents with ASD through digital game development [Munoz et al. 2018a].
- **Software and Game Design and Development Methodologies:** These guide the creation of resources. The ADDIE model for instructional design is referenced for systematic approaches to creating educational resources [Elshahawy et al. 2020b]. Design processes also incorporate participatory design to align with curricular requirements, and some studies provide specific design recommendations for accessible visual programming tools for children with ASD.
- **General Pedagogical Approaches and Contextual Considerations:** This category highlights broader aspects. Studies explore the importance of visual tools for children with autism [Chien-Sing and YATIM 2021], discuss challenges in hybrid education environments for individuals with autism, and emphasize collaborative problem-solving skills [Moster et al. 2022]. The aim often involves balancing education with enjoyment and promoting asset reuse through algorithmic changes, along with integrating social skills practice within programming lessons.

These diverse guidelines and methodologies underscore a comprehensive effort to make computing education engaging and accessible for students with ASD, addressing both their cognitive and social developmental needs.

3.3. RQ3: How are these resources evaluated in terms of their effectiveness and educational impact?

The resources are evaluated using a variety of methods, focusing on both the acquisition of computational thinking (CT) skills and user engagement. Some studies assess the effectiveness of the resources by analyzing artifacts (games) produced by participants in pilot workshops, often using rubrics to measure CT skill development [Munoz et al. 2016, Munoz et al. 2018b, Munoz et al. 2018a]. Evaluation methods typically include pre- and post-assessments to measure the acquisition of programming concepts and problem-solving skills [Elshahawy et al. 2020a, Lee and Hsu 2024]. Other methods include surveys for parents or caregivers to assess satisfaction and perceived usefulness, alongside direct observations of children's interactions with the resources [Elshahawy et al. 2020b, Elshahawy et al. 2020a, Chien-Sing and YATIM 2021, Lee and Hsu 2024].

Some studies use qualitative methods, such as video recordings of participant behaviors and verbal interactions, to evaluate teamwork and the overall experience during coding activities [Moster et al. 2022, Bossavit and Parsons 2017, Ke et al. 2020]. In some cases, a posttest is administered several months later to assess the retention of learned skills [Munoz et al. 2018a]. Certain studies also employ educational design research methodologies to refine the resources based on feedback from educators and experts [Schmidt and Beck 2016, Malpartida and da Hora Rodrigues 2025, Ke et al. 2020, Zubair et al. 2023]. Additionally, a few studies use semi-structured interviews with specialists or employ data mining techniques to analyze participant performance in real-time [Ke et al. 2020, Zubair et al. 2023].

In summary, evaluations focus on both quantitative measures, such as pre/post tests and questionnaires, and qualitative methods, such as observations and expert feedback, to assess the educational impact and effectiveness of the resources.

3.4. RQ4: What challenges and solutions are reported in the development and implementation of these resources?

Regarding RQ4, the challenges encountered in the development and implementation of educational resources for students with ASD include the need to simplify interfaces to make them more accessible and intuitive, especially for students with varying skill levels [Elshahawy et al. 2020b, Zubair et al. 2023]. To overcome this challenge, solutions such as adaptable interfaces and iterative user testing were developed [Elshahawy et al. 2020b, Zubair et al. 2023]. Another challenge is addressing the diversity of student abilities, which requires the creation of personalized and flexible resources [Elshahawy et al. 2020a, Elshahawy et al. 2022]. One applied solution was the design based on the specific needs of each student, using user-centered approaches [Elshahawy et al. 2020a].

Technical difficulties, such as device malfunctions or adaptation issues with platforms, were also identified. To resolve these problems, strategies such as continuous technical support and the use of robust and well-documented technologies were implemented. Additionally, recruiting participants for testing and validation presented limitations due to availability and location [Munoz et al. 2016, Munoz et al. 2018b, Malpartida and da Hora Rodrigues 2025]. As a solution, partnerships with schools and specialized institutions were established, expanding the reach of the studies.

Finally, expanding the studies to larger groups and generalizing the results presented additional challenges [Munoz et al. 2016, Munoz et al. 2018b, Elshahawy et al. 2020a]. The solution adopted included conducting more extensive and varied tests in different educational contexts, allowing for the collection of broader and more representative data.

3.5. RQ5: What research gaps and future opportunities are identified in the literature?

The articles selected in this systematic mapping of the literature (MSL) highlight several gaps and future opportunities in teaching computer science to students with ASD, in response to RQ5. One of the gaps mentioned is the lack of specific guidelines for the development of digital educational resources that broadly address the needs of students with ASD [Zubair et al. 2023]. This opens up opportunities for the creation of guidelines and protocols that can guide the design and implementation of these resources.

Another gap highlighted is the limited diversity of empirical studies on the effectiveness of digital tools in different educational contexts and age groups [Munoz et al. 2016, Munoz et al. 2018b, Elshahawy et al. 2020b, Elshahawy et al. 2020a, Munoz et al. 2018a, Elshahawy et al. 2022, Bossavit and Parsons 2017]. This suggests the need to expand experiments and longitudinal evaluations that consider various cultural and pedagogical aspects.

Furthermore, there is a shortage of resources that address advanced computing skills for students with ASD, such as programming logic and algorithmic thinking. As an opportunity, studies point to the development of tools that integrate more complex challenges, tailored to the individual progress of each student.

Finally, the lack of systematic integration of emerging technologies, such as artificial intelligence and virtual reality, to personalize learning and improve inclusion is emphasized. This suggests opportunities to explore these technologies as key elements in teaching computer science to students with ASD, enhancing their effectiveness and accessibility.

3.6. Pedagogical Analysis: Bloom's Taxonomy and Brennan and Resnick's Framework

This section presents the pedagogical analysis of the selected studies, classifying approaches according to Bloom's Taxonomy and Computational Thinking (CT) concepts, practices, and perspectives using Brennan and Resnick's framework. This categorization reveals the predominant pedagogical focus and critical gaps for the development of inclusive solutions for students with Autism Spectrum Disorder (ASD).

The application of Bloom's Taxonomy to the studies revealed a predominance in the Understanding and Applying categories. This emphasis indicates that existing educational software for ASD primarily aims at structured comprehension and tangible application of fundamental computational concepts.

In contrast, a lower prevalence was observed in the Remembering and Evaluating categories. The low incidence in "Remembering" may be associated with common challenges in information retention and quick recall for individuals with ASD. Similarly, the scarcity in "Evaluating" may reflect difficulties in making judgments based on abstract criteria or in assessing the quality of complex problem-solving solutions, possibly linked to executive function challenges. The Analyzing and Creating categories were also identified. The observed disparity suggests the need for greater support and pedagogical scaffolding in these less explored categories, aiming for a more comprehensive computational development.

The analysis of the studies according to Brennan and Resnick's framework identified the following Computational Thinking patterns:

- Computational Concepts: Sequence (16 mentions) and Condition (15 mentions) were the most prevalent. Their prominence aligns with ASD students' preference for structured tasks and explicit logic. Repetition and Events were also frequently mentioned (13 mentions each), indicating relevance for iterative processes and interactive elements.
- Computational Practices: Iterating and Incrementing (17 mentions) and Testing and Debugging (17 mentions) were the most frequently reported. These practices are crucial for the iterative approach to problem-solving and refining solutions. Reusing and Remixing (12 mentions) and Abstracting and Modularizing (13 mentions) were cited less frequently. The lesser emphasis on "Reusing and Remixing"

points to an opportunity for code optimization and building more efficient solutions.

- Computational Perspectives: Being Expressive, Being Connected, and Being Critical were mentioned in all 17 studies. Despite their high frequency, which acknowledges the importance of creativity, collaboration, and critical thinking, there is room for studies to detail how digital tools and pedagogical strategies actively foster these perspectives in students with ASD.

In summary, the studies prioritize fundamental computational concepts and practices. However, clear opportunities emerge to explore concepts such as “Repetition” and “Reusing and Remixing,” and to deepen the promotion of “perspectives,” aiming for the development of more advanced CT skills and a holistic learning experience for students with ASD.

4. Conclusion and Future Works

This systematic mapping study investigated the use of educational software in computing education for students with Autism Spectrum Disorder (ASD), analyzing 17 primary studies. A variety of digital resources were identified, such as visual programming environments and serious games, along with the pedagogical methodologies and computational thinking frameworks that support them.

The pedagogical analysis, utilizing Bloom’s Taxonomy and Brennan and Resnick’s framework, revealed a predominant focus on the ”Understanding” and ”Applying” levels. Prominence was observed for the concepts of ”Sequence” and ”Condition,” and the practices of ”Iterate and Increment” and ”Test and Debug.” Although these provide a solid foundation, opportunities were identified for further exploration of concepts such as ”Repetition” and ”Reuse and Refine,” and greater support for the ”Remembering” and ”Evaluating” levels.

The mapping highlights the need for specific guidelines for the development of inclusive digital resources and the scarcity of diverse and longitudinal empirical studies. Furthermore, a gap was noted in addressing advanced computational skills and in the systematic integration of emerging technologies like artificial intelligence and virtual reality for personalization and inclusion.

In summary, this study offers a structured overview that can guide future research and the development of more inclusive and effective computing solutions for students with ASD. Future perspectives involve promising opportunities. As immediate future work, the objective is to develop a set of guidelines for the creation of educational software focused on computing education for students with ASD, as well as the development of digital resources based on these guidelines. Further research could also explore teaching methodologies that effectively integrate such resources, investigate the long-term impacts of using these tools on students’ cognitive and academic development, and deepen the application of emerging technologies to address the heterogeneity of ASD.

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