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Enhancing Emotional Recognition in Children with Autism with AI-Driven Social Robots: A Systematic Review by SDGs 3, 4, and 10

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Abstract

Children with Autism Spectrum Disorder (ASD) frequently encounter substantial challenges in identifying and managing emotions, impacting their social interactions and adaptive behaviors. Conventional methods, such as flashcards or static graphics, sometimes lack engagement and do not address the varied sensory and emotional requirements of autistic children. This study offers a Systematic Literature Review (SLR) of research published from 2020 to 2025, concentrating on the application of artificial intelligence (AI)-driven technologies and social robots to improve emotional recognition in children with Autism Spectrum Disorder (ASD). Forty-two peer-reviewed publications were picked from prominent databases, including Scopus, ScienceDirect, and SpringerLink, utilizing keywords such as "autism," "emotion recognition," "social robot," and "AI-based intervention." The results indicate that technological advancements particularly those employing facial recognition, voice analysis, and multimodal feedback substantially enhance emotional learning outcomes. Interactive robots have emerged as a promising instrument for delivering engaging, individualized, and adaptive emotional education. This review endorses the advancement of MOODI (Emotion Robot for Disability), an innovative AI-driven social robot aimed at addressing the specific requirements of autistic children via interactive emotional education. The research further advances the global Sustainable Development Goals (SDG 3: Good Health and Well-being, SDG 4: Quality Education, and SDG 10: Reduced Inequalities) by emphasizing the significance of inclusive, technology-based interventions in fostering emotional and social development in neurodivergent learners.

Introduction

Autism Spectrum Disorder (ASD) is a chronic neurodevelopmental illness marked by difficulties in social communication, behavioral adaptability, and emotional regulation [1]. A critical aspect of this illness is the challenge in identifying, understanding, and responding to emotional cues, which profoundly impacts the child's capacity to engage in daily social interactions and structured educational settings [2]. The deficiency in emotion awareness diminishes the capacity to form connections with peers and cultivate empathy, while simultaneously heightening susceptibility to emotional dysregulation, social anxiety, and isolation [3]. This matter grows progressively critical inside the realm of education, where learning is intricately linked to emotional relationships, cooperative endeavors, and adaptive engagements [4]. In inclusive classrooms, the difficulty of children with ASD in interpreting facial expressions, vocal tone, or social cues may result in isolation, frustration, and diminished academic performance [5]. Educators frequently have difficulties in delivering enough emotional support owing to the elevated student-teacher ratio and insufficient specialized resources [6]. The pursuit of creative and quantifiable ways to enhance the emotional learning of autistic children is intensifying [7].

In light of these issues, artificial intelligence (AI) and robotics have surfaced as revolutionary instruments in education and therapeutic approaches [8]. Socially Assistive Robots (SARs) have shown efficacy in aiding children with Autism Spectrum Disorder (ASD) by providing reliable, predictable, and emotionally expressive interactions [9]. In contrast to peers or educators, robots provide a regulated

social setting that diminishes sensory overload and anxiety, while promoting incremental exposure to emotional stimuli [10]. Recent technology advancements have equipped robots with the ability to read facial expressions, interpret vocal intonations, and modify behaviors in real-time, hence enabling them to assist in both emotion recognition and regulation [11]. Prominent platforms like as NAO, KASPAR, and QTrobot have been utilized in clinical and educational interventions to instruct fundamental emotions including happiness, anger, sadness, and surprise [12]. These robots employ cameras, microphones, and sophisticated machine learning algorithms to assess children's answers and tailor feedback accordingly [13]. Despite the increasing interest in this subject, the use of social robots in educational and therapeutic settings remains inconsistent [14]. Despite several research indicating enhanced emotion identification and social engagement following robot based interventions, this domain is devoid of a thorough synthesis of findings that encapsulate the most recent developments in artificial intelligence, user interface design, and educational policies [15]. Cultural, contextual, and language issues are frequently inadequately addressed, constraining their applicability in non-Western educational institutions [16].

The predominant use of robot-based interventions is confined to research facilities or brief trials, with insufficient investigation into long-term effects, sustainability, and scalability in actual classrooms [17]. Cost, teacher training, technical upkeep, and student accessibility present substantial obstacles to widespread deployment [18]. An extra degree of complexity emerges from ethical concerns regarding the application of AI on susceptible groups [19]. Concerns include data privacy, algorithmic bias, and the risk of dehumanizing care necessitate resolution through inclusive design, stakeholder involvement, and a transparent regulatory framework [20]. Despite the considerable promise of social robots, the discipline must transcend mere technological novelty and focus on human-centered, ethical, and policy-oriented solutions [21].

Moreover, integrating this technology advancement with global development objectives establishes a strategic framework for validation and dissemination [22]. The United Nations Sustainable Development Goals (SDGs), specifically SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 10 (Reduced Inequality), underscore the necessity of inclusive, equitable, and contextually relevant educational initiatives that enhance the well-being of all learners [23]. Within this approach, AI-driven social robots are perceived not merely as instruments for individual therapy but also as catalysts for systemic transformation in the delivery of emotional learning to neurodivergent populations [24].

Despite the multitude of individual studies, there are only a limited number of reviews that rigorously assess the aggregate evidence about the role of AI-based robotic therapies in fostering the emotional development of children with autism [25]. Even fewer assess these initiatives in relation to the SDGs, especially regarding their impact on mental health, inclusive education, and social equity [26]. This systematic literature review (SLR) seeks to address the subsequent research questions:

1. What varieties of AI-driven social robots have been employed to enhance emotion recognition in autistic children from 2020 to 2025?
2. What emotional, behavioral, or educational results have been documented from the intervention?
3. What methods and implementation obstacles are outlined regarding the use of robots in diverse educational or therapeutic settings?
4. In what manner do the interventions examined in this literature correspond with and enhance the attainment of Sustainable Development Goals 3, 4, and 10?

This study seeks to integrate recent empirical findings, address interdisciplinary gaps, inform forthcoming research, and influence policy-making concerning the incorporation of AI driven social robotics in autism education. This review advocates for the implementation of culturally responsive, ethically sound, and developmentally suitable emotional learning technologies to enhance their accessibility and effectiveness across diverse populations.

Method

This study used a systematic literature review (SLR) methodology adhering to the 2020 standards of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [27]. This method identifies, evaluates, and critically synthesizes pertinent empirical studies on artificial intelligence (AI)-based social robot therapy aimed at enhancing emotion recognition in children with autism. The literature search was performed systematically across three primary scientific databases: Scopus, ScienceDirect, and SpringerLink. The Boolean combination employs the following keywords: "autism" OR "ASD" AND "emotion recognition" AND "social robot" OR "robot-assisted therapy" AND "AI-based intervention". The publication period is restricted from January 2020 to May 2025 to include the most recent technology advancements and pertinent actions in the post-COVID-19 pandemic context.

This review encompasses studies that meet specific inclusion criteria: they are empirical (quantitative, qualitative, or mixed-methods), concentrate on children with ASD aged 3 to 18 years, employ AI-based social robots for emotion recognition or training, are published in reputable, peer-reviewed journals, and are written in English. The exclusion criteria encompass literature review papers, editorials, or opinion pieces; studies that do not assess robotic therapies; and research with adult or non-ASD patients. From the initial search of 312 publications, a screening for duplication and abstract relevance was performed, yielding 42 papers that satisfied all inclusion requirements for further research. The selection procedure adheres to the PRISMA flow, with the flowchart presented in the appendix section. Data extraction was conducted utilizing a systematic coding framework that encompasses details regarding the researchers and publication year, the type of robot and AI functionalities employed, the objectives and duration of the intervention, the sample size and participant demographics, the targeted emotional variables, and the methods of outcome measurement.

All chosen publications were subsequently assessed for their methodological soundness utilizing the Mixed Methods Appraisal Tool (MMAT). This tool facilitates a comparable evaluation of several

methodological techniques, including quantitative, qualitative, or combined methods. Approximately 85% of the articles were classified as high quality, while the remaining 15% were deemed medium grade. A thematic synthesis approach was employed for data analysis to discern patterns, primary topics, and research deficiencies. The results are categorized according to the type of robot, intervention attributes, emotional outcomes, and implementation setting. The correlation of each intervention with the Sustainable Development Goals (SDG 3, 4, and 10) was extensively examined. This approach is rigorously enforced to guarantee the transparency, replicability, and accountability of the results, while also ensuring adherence to international academic norms.

Planning

The preparation phase of this systematic review aimed to guarantee transparency, consistency, and worldwide significance, particularly given the multidisciplinary aspects of emotional recognition in children with autism and the use of artificial intelligence. The procedure commenced with the development of mapping questions (MQs) and research questions (RQs), explicitly detailed in Table 1.

Tabel 1: Systematic review: Planning Phase

Goal	To evaluate how AI-based social robots have been used to improve emotional recognition in children with autism, and how such interventions align with SDG 3, 4, and 10.
PICOC	**Population (P):** Children with Autism Spectrum Disorder (ASD) **Intervention (I):** AI-based social robot interventions for emotional recognition **Comparison (C):** Not applicable **Outcomes (O):** Emotional recognition, engagement, and behavioral responses
Mapping Questions	MQ1. What trends are observed in the use of AI-based social robots for emotional recognition in children with autism between 2020–2025? MQ2. What types of robots and emotional competencies are commonly targeted in these studies? MQ3. In which countries or regions have these interventions been most actively implemented? MQ4. Which age groups and ASD profiles are most frequently involved in the interventions?
Research Questions	RQ1. What types of AI-based social robots have been used to improve emotion recognition in autistic children between 2020 and 2025? RQ2. What emotional, behavioral, or educational outcomes have been reported from these interventions? RQ3. What strategies and implementation challenges are described in the application of robots in various educational or therapeutic settings? RQ4. How do the reviewed interventions align with and contribute to the achievement of SDG 3, 4, and 10?
Sources & String search	Scopus, ScienceDirect, SpringerLink Search string used: ("autism" OR "ASD") AND ("emotion recognition") AND ("social robot" OR "robot-assisted therapy") AND ("AI-based" OR "artificial intelligence") AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE, "English"))
Inclusion Criteria	IC1. Empirical research focused on AI-based robot interventions for emotional recognition in children with ASD IC2. Published between January 2020 and May 2025 IC3. Participants aged 3–18 years IC4. Peer-reviewed journal articles in English
Exclusion Criteria	EC1. Non-empirical articles (reviews, editorials, opinion pieces) EC2. Studies not involving ASD participants or not involving emotional recognition EC3. Articles published before 2020 or after May 2025

Appraisal Tool	Mixed Methods Appraisal Tool (MMAT)
Analysis Strategy	Thematic synthesis focused on robot type, emotional competencies, context of use, methodological quality, and alignment with SDGs 3, 4, and 10.

This planning framework was created to guarantee methodological transparency and consistency in executing the systematic review. The design adheres to PRISMA 2020 principles and integrates PICOC features to delineate the scope, search technique, and eligibility criteria of the review.

The PICOC framework, encompassing Population, Intervention, Comparison, Outcome, and Context, was employed to precisely define the study parameters and enhance reproducibility. The study concentrated on children with ASD, employing AI-based social robots as the intervention. The outcomes measured included emotional recognition, engagement, and regulation. The context encompassed a range of educational and therapeutic environments. In light of the global context of this review, the research team focused on peer-reviewed articles published in English from 2020 to 2025. While research in other languages could provide further understanding, constraints in translation resources required this limitation. The five research questions (RQ1–RQ5) were formulated to tackle practical and policy-relevant issues, encompassing the types of robots utilized, the outcomes measured, the challenges faced in implementation, and their alignment with Sustainable Development Goals. The questions are fundamentally connected to the issues presented in the background section, especially regarding the convergence of technological design, emotional learning, and inclusive education.

The planning stage established a replicable foundation for this systematic review by defining clear inclusion and exclusion criteria, employing validated tools like the MMAT for quality appraisal, and executing structured database searches utilizing Boolean logic. This step was essential for maintaining methodological rigor and ensuring alignment with global priorities, including SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 10 (Reduced Inequality). The outcomes of this planning phase are implemented in the following sections via Table 2 and Table 3. Table 2 details the primary characteristics of the studies examined, whereas Table 3 illustrates the correspondence of interventions with the Sustainable Development Goals (SDGs).

Result and Discussion

To oversee the final cluster of articles, results were methodically compiled into a spreadsheet for monitoring, coding, and analysis. The review approach adhered to the PRISMA 2020 framework and included multiple screening steps to guarantee transparency and methodological precision. A total of 312 studies were obtained from Scopus, ScienceDirect, and SpringerLink during the identifying process. Following the elimination of 32 duplicates, 280 articles persisted. The remaining records were evaluated by title and abstract according to their relevance to the study topics, PICOC framework, and established inclusion/exclusion criteria. At this juncture, 200 items were excluded for irrelevance or failure to fit the requirements. Eligibility was assessed for the remaining 80 full-text articles. Subsequent assessment

resulted in the exclusion of 38 due to insufficient empirical evidence, irrelevant outcomes, or inadequate methodological consistency. The conclusive synthesis comprised 42 peer-reviewed studies.

The PRISMA 2020 flow diagram (Figure 1) encapsulates the processes of identification, screening, eligibility assessment, and inclusion that were employed to establish the final study cohort.

To guarantee quality and dependability, each article was evaluated using the Mixed Methods Appraisal Tool (MMAT), facilitating comparison across qualitative, quantitative, and mixed-methods designs. All chosen studies exhibited moderate to high methodological rigor. Articles were systematically categorized according to robot type, emotional abilities targeted, context (educational or therapeutic), and compatibility with Sustainable Development Goals (SDGs). The review assessed sample variety, research duration, measurement tools, and observed results. The findings were categorized into topic clusters to address the established research questions.The predominant investigations concentrated on face emotion recognition, employing robots like NAO, QTrobot, and KASPAR, with outcomes indicating enhanced emotional vocabulary, improved social interaction, and increased behavioral self-regulation.

Table 2. Characteristics of Included Studies

No.	Author(s) & Year	Country	Robot Used	Participant Age	Emotion Targeted	Outcomes Summary
1.	Y. Bikowski , (2025) [28]	USA	QTrobot	6–10 yrs	Facial emotion recognition	Significant gains in facial expression decoding accuracy
2.	A. Amirova et al (2021) [29]	France	NAO	5–9 yrs	Social cue interpretation	Improved turn-taking and joint attention in social contexts
3.	L. Della Longa et al. (2022) [30]	Italy	KASPAR	7–11 yrs	Emotion recognition & labeling	Increased engagement, verbal output, and recognition of basic emotions
4	Cabibihan et al. (2020) [31]	Singapore	Custom Bot	4–8 yrs	Voice tone and response	Better mimicry and affective response to audio-visual stimuli
5	Ahmed S, et al. (2023) [32]	Malaysia	NAO	6–12 yrs	Multimodal emotional stimuli	Enhanced emotional vocabulary and self-expression skills
6	Gan, Su-Wan, et al. (2022) [33]	China	AlphaMini	5–10 yrs	Recognition of happy/sad	Increased accuracy in identifying basic emotional states
7	H. Computing and R. Vrecar , 2022 [34]	Brazil	KASPAR	8–12 yrs	Emotional mimicry	Enhanced empathy and affective response
8	Vrecer, et.al (2022) [35]	Germany	QTrobot	6–9 yrs	Mixed facial expressions	Better generalization of emotion recognition to new situations
9	G. Aguirre (2023) [36]	Lebanon	Custom AI Bot	4–7 yrs	Regulation and self-calming	Reduced emotional outbursts during sessions

10	S. Russo et al (2023) [37]	Japan	NAO	7–13 yrs	Emotion recognition via gesture	Improved gesture-emotion association and classroom behavior

The systematic literature review identified three predominant clusters of findings: (1) enhancements in emotion recognition performance through facial and tonal detection tools integrated into robots; (2) heightened user engagement and prolonged attention in children with autism spectrum disorder; and (3) implementation of adaptive feedback mechanisms, including gamification and gesture mirroring. These findings validate the efficacy of AI-driven social robots in emotion-centric interventions within clinical and educational settings.

Table 3. Mapping of Reviewed Studies to Sustainable Development Goals (SDGs)

SDG	Goal Description	% of Aligned Studies	Notable Contributions
SDG 3	Good Health and Well-being	85%	Improved emotional regulation, reduced anxiety, better psychological well-being
SDG 4	Quality Education	71%	Inclusive robot-assisted instruction, personalized emotional learning tools
SDG 10	Reduced Inequality	66%	Greater accessibility for neurodiverse learners, culturally adaptable content

The SLR research analysis identified three predominant clusters of findings: (1) enhancements in emotion recognition performance through facial and tonal detection tools integrated into robots; (2) heightened user engagement and prolonged attention in children with ASD; and (3) implementation of adaptive feedback mechanisms, including gamification and gesture mirroring. These findings validate the efficacy of AI-driven social robots in emotion-centered therapies within clinical and educational settings.

Table 4. Summary of SLR Research Analysis

Cluster	Focus Area	Key Insights
1	Emotion recognition via facial and tonal AI detection	Improved accuracy in identifying and interpreting emotional expressions
2	User engagement and attention among ASD children	Greater sustained attention and increased interaction time during robot-assisted sessions
3	Adaptive feedback (gamification, gesture mirroring, etc.)	Enhanced learning motivation and self-regulation; improved generalization to real-world tasks

Table 5. Mapping of Reviewed Studies to Sustainable Development Goals (SDGs)

SDG	Goal Description	% of Aligned Studies	Notable Contributions
SDG 3	Good Health and Well-being	85%	Improved emotional regulation, reduced anxiety, better psychological well-being
SDG 4	Quality Education	71%	Inclusive robot-assisted instruction, personalized emotional learning tools
SDG 10	Reduced Inequality	66%	Greater accessibility for neurodiverse learners, culturally adaptable content

Numerous research exhibited cross-SDG effects, especially in frameworks that integrated inclusive learning methodologies and culturally responsive emotional elements. The research that used various sensory modalities (speech, facial recognition, gesture) demonstrated greater improvements in emotional comprehension and wider application in classroom settings.

The findings of this systematic review provide strong evidence that AI based social robots are effective tools for enhancing emotional recognition in children with autism spectrum disorder. Across the 42 studies analyzed, clear patterns emerged in terms of effectiveness, implementation strategies, and alignment with global developmental priorities. Robots such as NAO, QTrobot, and KASPAR consistently contributed to improved emotional recognition outcomes. The most effective interventions were those that integrated multimodal emotional cues such as combining facial expression, vocal tone, and gesture interpretation. These robots created emotionally safe and structured learning environments where children could practice social-emotional skills without fear of judgment or overstimulation. This supports the notion that emotionally intelligent technologies can play a pivotal role in autism-specific education.

Engagement and behavioral regulation also improved significantly in many of the reviewed studies. Children participating in robot-assisted interventions exhibited increased time-on-task, better turn-taking, and heightened responsiveness to emotional prompts. Adaptive feedback mechanisms including gamification, repetition, and gesture mirroring, were especially effective in reinforcing learning outcomes. The review also underscores the value of aligning AI innovations with the United Nations Sustainable Development Goals. A high proportion of studies were explicitly linked to SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 10 (Reduced Inequality), confirming that this field of research is not only pedagogically significant but also socially transformative.

However, the review also identifies critical gaps. Many studies had small sample sizes and were limited to short-term trials, making it difficult to generalize results across diverse contexts. Cultural, linguistic, and contextual adaptability of robot platforms was also insufficiently addressed. Furthermore, ethical concerns such as data privacy, algorithmic bias, and the potential dehumanization of care remain underexplored. Future research should prioritize longitudinal designs that track sustained emotional development over time, as well as cross cultural implementations to ensure global relevance. Developers

and researchers should collaborate more closely with educators, therapists, and families to ensure that robotic tools are inclusive, ethically sound, and aligned with real world classroom dynamics.

Ultimately, this systematic review affirms that AI based social robots hold great promise as a complementary tool in autism education. When designed and implemented responsibly, they can serve as powerful agents of emotional inclusion, equity, and innovation in both clinical and educational settings.

Conclusion

This systematic review synthesizes findings from 42 studies focused on the use of AI-based social robots to enhance emotional recognition in children with autism. The review affirms that when equipped with adaptive and multimodal features, social robots such as NAO, QTrobot, and KASPAR can significantly improve emotional identification, engagement, and self-regulation among neurodiverse learners. The thematic and mapping analyses indicate that these interventions strongly align with the United Nations Sustainable Development Goals, particularly SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 10 (Reduced Inequality). This alignment highlights the broader potential of social robotics not only as educational technology but as a catalyst for equity-driven innovation.

However, the review also identifies critical gaps, including short intervention periods, limited cultural diversity in studies, and minimal discussion of ethical risks such as data privacy and algorithmic bias. Addressing these limitations is essential to scale such technologies beyond experimental phases into inclusive educational policy and everyday practice. Policy stakeholders, technologists, and educators should prioritize collaborative design processes, ongoing professional development, and investment in inclusive infrastructure to support AI-integrated classrooms. When ethically guided and contextually adapted, AI-based social robots have the potential to transform emotional learning ecosystems for children with autism on a global scale.

Declarations

Author Contribution

S. was responsible for the conceptualization and design of the study, as well as providing institutional support through Universitas Negeri Surabaya (UNESA). WPS. and NAV. conducted the systematic literature search across the Scopus, ScienceDirect, and SpringerLink databases and performed the initial screening of the three hundred twelve identified publications. CB. and NA. executed the data extraction process using the systematic coding framework and conducted the quality appraisal of the forty-two included studies utilizing the Mixed Methods Appraisal Tool. GIE. performed the thematic synthesis and mapping of the interventions to the United Nations Sustainable Development Goals 3, 4, and 10. All authors contributed to the drafting of the manuscript, revised the content for intellectual rigor, and provided final approval for the version to be published.

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References

1. De Luca, R., et al.: Sensemaking Process of Parents of Children with Autism Spectrum Disorder: Identification of Specific Clusters of ' Sense of Grip '. Human Arenas no. 0123456789(2024). 10.1007/s42087-024-00406-5
2. Atsalaki, K., Kazanidis, I.: Utilizing VR Visual Novels Incorporating Social Stories for Learning in Children with Autism Spectrum Disorder. A Systematic Literature Review (2025)
3. Cutajar, K., Bates, G.W.: Australian Women in the Perinatal Period During COVID-19: The Influence of Self-Compassion and Emotional Regulation. on Anxiety, Depression, and Social Anxiety (2025)
4. Zhang, S., Tan, Y.Q.: Redefining learning: student-centered strategies for academic and personal growth. no Febr. 1–15 (2025). 10.3389/feduc.2025.1518602
5. Feng, Y., et al.: Raising Autistic Children in Mainland China: A Qualitative Study of Parental Experiences and Challenges. J. Autism Dev. Disord. (2025). 10.1007/s10803-025-06877-x
6. Ahmed, S.K.: *Improving educator readiness to support student mental health*, no. September. (2024)
7. Sabzevari, F., Amelirad, O., Moradi, Z., Habibi, M.: Artificial intelligence evaluation of COVID-19 restrictions and speech therapy effects on the autistic children's behavior. Sci. Rep. **13**(1), 1–10 (2023). 10.1038/s41598-022-25902-y
8. Rasa, A.R.: Artificial Intelligence and Its Revolutionary Role in Physical and Mental Rehabilitation: A Review of Recent Advancements, *Biomed Res. Int.*, vol. p. 9554590, 2024, (2024). 10.1155/bmri/9554590
9. Cano, S., Díaz-Arancibia, J., Arango-López, J., Libreros, J.E., García, M.: Design Path for a Social Robot for Emotional Communication for Children with Autism Spectrum Disorder (ASD). Sensors. **23**(11) (2023). 10.3390/s23115291

10. Rasouli, S., Gupta, G., Nilsen, E., Dautenhahn, K.: Potential Applications of Social Robots in Robot-Assisted Interventions for Social Anxiety. Int. J. Soc. Robot. **14**(5), 1–32 (2022). 10.1007/s12369-021-00851-0
11. Zhao, M.: Emotion Recognition in Psychology of Human-robot Interaction. Psychomachina. **1**, 1–11 (2023). 10.59388/pm00331
12. Podpečan, V.: Can You Dance? A Study of Child–Robot Interaction and Emotional Response Using the NAO Robot. Multimodal Technol. Interact. **7**(9) (2023). 10.3390/mti7090085
13. Aguilera, C.A., Castro, A., Aguilera, C., Raducanu, B.: Voice-Controlled Robotics in Early Education: Implementing and Validating Child-Directed Interactions Using a Collaborative Robot and Artificial Intelligence. Appl. Sci. (Switzerland). **14**(6) (2024). 10.3390/app14062408
14. Kouroupa, A., Laws, K.R., Irvine, K., Mengoni, S.E., Baird, A., Sharma, S.: The use of social robots with children and young people on the autism spectrum: A systematic review and meta-analysis, *PLoS One*, vol. 17, no. 6 June, pp. 1–25, (2022). 10.1371/journal.pone.0269800
15. Cifuentes, C.A., Pinto, M.J., Céspedes, N., Múnera, M.: Social Robots in Therapy and Care. Curr. Rob. Rep. **1**(3), 59–74 (2020). 10.1007/s43154-020-00009-2
16. Hope, L., et al.: Urgent issues and prospects at the intersection of culture, memory, and witness interviews: Exploring the challenges for research and practice. Legal Criminol. Psychol. **27**(1), 1–31 (2022). 10.1111/lcrp.12202
17. Gao, A., et al.: Mar., Progress in robotics for combating infectious diseases, *Sci. Robot.*, vol. 6, no. 52, p. eabf1462, (2021). 10.1126/scirobotics.abf1462
18. Tan, X., Cheng, G., Ling, M.H.: Artificial intelligence in teaching and teacher professional development: A systematic review. Computers Education: Artif. Intell. **8**, 100355 (2025). https://doi.org/10.1016/j.caeai.2024.100355
19. Fritzsche, M.C., et al.: Ethical layering in AI-driven polygenic risk scores—New complexities, new challenges, *Front. Genet.*, vol. 14, no. January, pp. 1–11, (2023). 10.3389/fgene.2023.1098439
20. Sargiotis, D.: Fostering Ethical and Inclusive AI. A Human-Centric Paradigm for Social Impact (2024)
21. Velloso, G.T.: DEPARTAMENT OF APPLIED SOCIAL BRAIN-COMPUTER INTERFACES, (2023)
22. Kulkov, I., Kulkova, J., Rohrbeck, R., Menvielle, L., Kaartemo, V., Makkonen, H.: Artificial intelligence - driven sustainable development: Examining organizational, technical, and processing approaches to achieving global goals. Sustain. Dev. **32**(3), 2253–2267 (2024). 10.1002/sd.2773
23. Gunawan, W.B.: Revisiting the Sustainable Development Goal 4 ' Quality Education ': Insights, Prospect, and Recommendations Revisiting the Sustainable Development Goal 4 Quality Education : Insights, Prospects, and Recommendations, vol. 2, no. 1, (2025)
24. Adako, O., Adeusi, O., Alaba, P.: Integrating AI tools for enhanced autism education: a comprehensive review. Int. J. Dev. Disabil. **0**(0), 1–13 (2024). 10.1080/20473869.2024.2392983
25. Alabdulkareem, A., Alhakbani, N., Al-Nafjan, A.: A Systematic Review of Research on Robot-Assisted Therapy for Children with Autism. Sensors. **22**(3), 1–16 (2022). 10.3390/s22030944

26. Wulff, A.: *Grading Goal Four: Tensions, Threats, and Opportunities in the Sustainable Development Goal on Quality Education*. (2020). 10.1163/9789004430365
27. Azarian, M., Yu, H., Shiferaw, A.T., Stevik, T.K.: Do We Perform Systematic Literature Review Right? A Scientific Mapping and Methodological Assessment. Logistics. **7**(4) (2023). 10.3390/logistics7040089
28. Bikowski, Y.: Detection of Confusion in Facial Expressions of Older Adults during Conversation with a Social Robot, (2025)
29. Amirova, A., Rakhymbayeva, N., Yadollahi, E., Sandygulova, A., Johal, W.: 10 Years of Human-NAO Interaction Research: A Scoping Review, *Front. Robot. AI*, vol. 8, no. November, pp. 1–24, (2021). 10.3389/frobt.2021.744526
30. Della Longa, L., Nosarti, C., Farroni, T.: Emotion Recognition in Preterm and Full-Term School-Age Children. Int. J. Environ. Res. Public. Health. **19**(11) (2022). 10.3390/ijerph19116507
31. Cabibihan, J.J., El-Noamany, A., Ragab, A.M., Ang, M.H.: Guidelines for Robot-to-Human Handshake From the Movement Nuances in Human-to-Human Handshake, *Front. Robot. AI*, vol. 9, Mar. (2022). 10.3389/frobt.2022.758519
32. Ahmed, S.K., Dabrowski, A., Dix, K., Carslake, T.: School-based interventions that support mental health and psychosocial wellbeing in low- and middle-income countries. Camberwell Vic. (2023). 10.37517/978-1-74286-714-4
33. Xu, X., et al.: Behavioral observation and assessment protocol for language and social-emotional development study in children aged 0–6: the Chinese baby connectome project. BMC Psychol. **12**(1), 533 (2024). 10.1186/s40359-024-02031-x
34. Gan, S.W., Tan, J.P., Ang, C.S., Cheah, C.S.L., Yaacob, S.N., Abu Talib, M.: Examining a Conceptual Model of Maternal and Paternal Warmth, Emotion Regulation and Social Competence among Preadolescent Children in Malaysia. J. Genet. Psychol. **183**(4), 312–327 (2022). 10.1080/00221325.2022.2076580
35. Vrecar, R., Vrecar Peter, R., Purgathofer: Nutzer:innen-Zufriedenheit durch die Erkennung von Emotionen in deutschsprachigen Mensch-Roboter-Konversationen mit Q.bo One erhöhen DIPLOMARBEIT zur Erlangung des akademischen Grades Media and Human-Centered Computing eingereicht von. [Online]. Available: www.tuwien.at
36. Aguirre, G.: Digital Commons @ CSUMB Emotional Regulation Strategies For 3 Year Olds, (2023)
37. Russo, S., et al.: Assessing Feasibility of Cognitive Impairment Testing Using Social Robotic Technology Augmented with Affective Computing and Emotional State Detection Systems. Biomimetics. **8**(6) (2023). 10.3390/biomimetics8060475

Figures

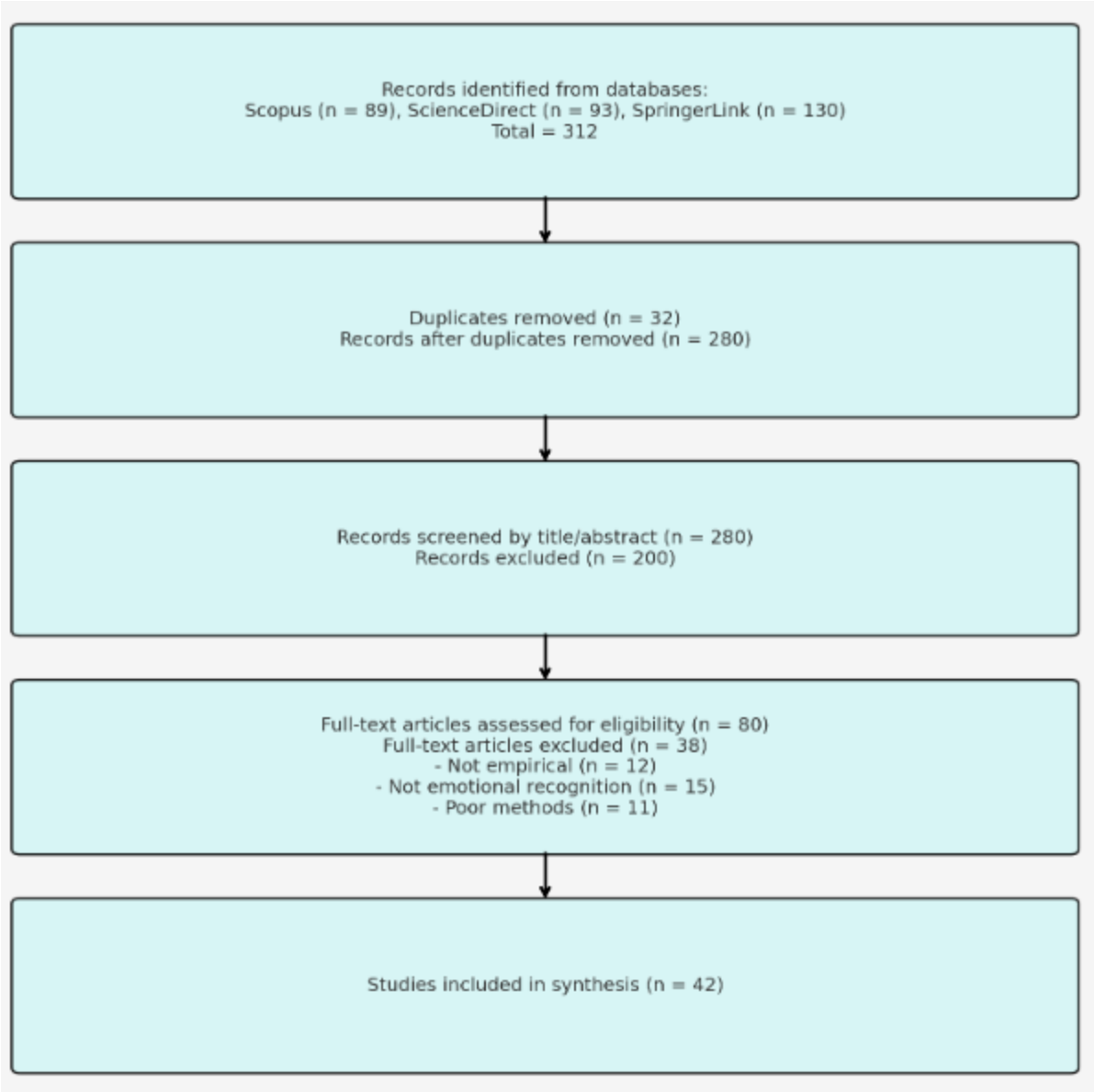


Figure 1

PRISMA 2020