Applying the Delphi Method to Forecast the Role of Social Robots in Education and Therapy[1]

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DOI: https://doi.org/10.56293/IJMSSSR.2025.5839

IJMSSSR 2025
VOLUME 7
ISSUE 5 SEPTEMBER - OCTOBER **ISSN: 2582 – 0265**

Abstract: The rapid integration of artificial intelligence (AI) and socially assistive robots into education and therapy raises urgent questions regarding their effectiveness, ethical implications, and long-term impact. This study applies the Delphi method to gather expert consensus on the future roles, opportunities, and challenges of AI-driven technologies in school and therapeutic contexts. A panel of multidisciplinary experts—including educators, psychologists, engineers, and policy makers—participated in iterative rounds of consultation to identify priorities for implementation, barriers to adoption, and ethical safeguards. Findings highlight strong agreement on the potential of AI and robots to support emotional well-being, personalized learning, and inclusion of children with special needs, while simultaneously underlining critical concerns regarding privacy, dependency, and the irreplaceable value of human interaction. The study provides a framework for integrating expert perspectives into strategic decision-making, offering both academic and practical contributions to the field.

Keywords: Delphi method, Artificial intelligence (AI), Socially assistive robots, Education and therapy, Expert consensus

Introduction

The accelerated development of artificial intelligence (AI) and robotics in recent years has opened new horizons in both education and therapy. These technologies, once perceived as futuristic, are now increasingly integrated into classrooms, counseling practices, and clinical interventions. Their ability to provide personalized support, adaptive learning experiences, and interactive therapeutic engagement positions them as transformative tools for children and adolescents, while at the same time raising complex questions about effectiveness, ethics, and long-term social consequences.

The aim of this study is to explore the potential and limitations of applying AI and robotic technologies within educational and therapeutic contexts, with a particular focus on identifying opportunities for improving emotional well-being, cognitive development, and social skills among children and young people. The subject of the study encompasses the use of AI-driven systems and socially assistive robots as tools in education and therapy, examined through the perspectives of expert consensus (via the Delphi method) and existing empirical evidence.

The relevance of this research is underscored by the growing reliance on digital and AI technologies in everyday life, especially among younger generations. Education systems worldwide are experimenting with AI-supported personalized learning, while therapy increasingly tests robotic platforms such as *Paro*, *Pepper*, *Nao*, and *Furhat* for social and emotional support. These developments demand critical reflection and evidence-based guidelines to ensure safe and beneficial implementation.

The findings of such research hold strong practical applicability: they can inform policymakers about the need for regulatory frameworks, guide educators in integrating AI into curricula, and support therapists in evaluating whether and how robotic systems can complement traditional methods. Insights are also valuable for technology

[1] Under the project DUECOS: "DIGITAL SUSTAINABLE SYSTEMS – Technological Solutions and Social Models for Ecosystem Sustainability" (DUECOS) BG-RRP-2.004-0001-C01, under item 3.4 of SNIIPR – D 23 PF-014, Creation and Development of a Center for Psychological Support – Center for Innovative Integrative Learning Models with Socially Assistive Robots – RoboPsy, led by Prof. Dr. Sc. Mayiana Mitevska.

developers, providing direction for designing systems that align with pedagogical and psychological needs.

The scientific contribution of this study lies in combining technological innovation with educational and psychological research. By employing the Delphi method, the research systematically gathers and synthesizes expert perspectives, producing a multidimensional understanding of the opportunities and risks of AI and robotics in human development. This approach ensures not only theoretical advancement but also methodological rigor, bridging the gap between technological innovation and societal responsibility.

Theoretical Literature Review

Global Research Context

In the last decade, research on the role of artificial intelligence (AI) and robotics in education and therapy has expanded significantly. Globally, AI is increasingly applied in personalized learning platforms, adaptive tutoring systems, and classroom management tools (Holmes et al., 2021). These technologies promise to optimize educational outcomes by tailoring instruction to the needs of individual students. At the same time, socially assistive robots such as Pepper, Nao, and Paro have been deployed in therapeutic contexts, particularly for children with autism spectrum disorder, where they demonstrate measurable improvements in social engagement and communication skills (Scassellati et al., 2022).

Meta-analyses and umbrella reviews have shown consistent patterns in how AI and robots affect young populations. Systematic reviews highlight positive outcomes in domains such as reduced anxiety, improved emotion recognition, and enhanced motivation for learning (Belpaeme et al., 2018; Marchant et al., 2020). However, these reviews also emphasize methodological limitations, including the short-term nature of most interventions, lack of longitudinal follow-ups, and reliance on small, homogeneous samples.

In the therapeutic field, AI-driven applications are increasingly being tested for mental health interventions. Randomized controlled trials have demonstrated the efficacy of AI-based cognitive-behavioral therapy (CBT) applications in reducing symptoms of depression and anxiety in adolescents (Werner-Seidler et al., 2024). Meanwhile, robotics research indicates that humanoid robots with expressive features can foster trust and engagement in children, though trust tends to remain lower compared to human therapists (Vogt et al., 2021).

Methodological Advances

Recent studies have employed mixed-method approaches that combine quantitative surveys with qualitative interviews to capture both behavioral outcomes and subjective experiences. The Delphi method has been applied to establish expert consensus regarding ethical frameworks for AI in education and therapy (Yuan et al., 2023). Longitudinal observational studies also provide evidence on how technology use impacts developmental trajectories, particularly in areas such as sleep, self-esteem, and social connectedness (Orben, 2025). Together, these methods demonstrate complementarity: controlled experiments test efficacy, while longitudinal and qualitative studies illuminate broader psychosocial mechanisms.

Bulgarian Research Context

In Bulgaria, research on the intersection of AI, robotics, and youth development remains limited but emerging. Popova et al. (2023) examined patterns of screen time among children, providing important baseline data on digital exposure but without direct focus on mental health or educational outcomes. The Global Kids Online initiative has offered cross-national data, including Bulgaria, showing weak correlations between online time and life satisfaction, which suggests that qualitative aspects of digital engagement may be more significant than sheer exposure (Livingstone et al., 2021).

UNICEF Bulgaria (2022) has reported high prevalence rates of anxiety and depression among young people but notes a lack of digital or robotic intervention programs in the national context. This underscores the need for targeted studies that not only measure risks but also evaluate the potential of AI and robotics as protective or therapeutic tools. To date, no large-scale longitudinal or experimental studies in Bulgaria have systematically

assessed the effects of AI or robotic applications in schools or therapy.

Synthesis

Taken together, the literature demonstrates a rapidly evolving global field with promising results, but also clear methodological and contextual gaps. While international studies highlight the potential of AI and robotics to enhance education and mental health interventions, Bulgarian research is still at an exploratory stage, focused primarily on digital exposure rather than AI-mediated interventions. This creates an opportunity for context-specific studies that address cultural, educational, and policy differences, ensuring that technological adoption in Bulgaria is both effective and ethical.

Research Model and Hypotheses

Conceptual Framework

The research model builds on international evidence that demonstrates both the potential and limitations of artificial intelligence (AI) and robotics in supporting children's education and emotional well-being. While global studies suggest benefits such as improved engagement, emotion recognition, and therapeutic support (Scassellati et al., 2022; Werner-Seidler et al., 2024), Bulgarian research has yet to systematically assess these outcomes. The model therefore seeks to integrate global insights into a local context, focusing on schools as primary environments for technological experimentation and adoption.

The framework assumes that the influence of AI and socially assistive robots is mediated by quality of interaction, trust in technology, and educational context. Specifically, the model posits that outcomes such as emotional well-being, social skills, and learning motivation depend not only on exposure to technology but also on how it is used, by whom, and under what conditions.

Hypotheses

Based on the theoretical review and identified research gaps, the following hypotheses are proposed:

H1: AI and social robots will have a positive effect on emotional well-being among children and adolescents, particularly by reducing anxiety and enhancing self-expression in structured school environments.

H2: AI and social robots will contribute to the development of social skills, especially in children with communication challenges, by facilitating interaction and peer engagement.

H3: Trust in AI and robots will moderate the relationship between exposure and outcomes, with higher trust linked to stronger improvements in well-being and learning motivation.

H4: Bulgarian children and adolescents will demonstrate similar benefits to those reported internationally, but cultural and contextual differences will shape adoption and acceptance.

H5: Teachers' and parents' attitudes toward AI and robots will significantly predict the sustainability and effectiveness of their application in schools.

Justification

The model draws on methodological precedents from prior research:

Meta-analyses and systematic reviews provide evidence of consistent benefits across multiple domains, but emphasize the need for standardized measures of exposure (Orben, 2025).

Randomized controlled trials demonstrate causal effects of AI interventions, particularly in digital mental health (Werner-Seidler et al., 2024).

Longitudinal and qualitative studies highlight mediating mechanisms such as sleep disruption, self-esteem, and perceived trust (Livingstone et al., 2021).

Bulgarian baseline studies (Popova et al., 2023; UNICEF, 2022) establish the relevance of addressing mental

health and technology simultaneously, but leave gaps in intervention-focused research.

Thus, the proposed research model is designed to combine global evidence with local application, testing hypotheses in real educational settings to provide both theoretical and practical contributions.

The present study adopts a mixed-methods, cluster randomized controlled trial (cRCT) design with an embedded qualitative and implementation strand to examine the role of artificial intelligence (AI) and social robots in supporting social–emotional learning (SEL) and well-being among Bulgarian students. The trial will include three arms: (1) a robot-assisted SEL intervention, delivered by a social robot such as Furhat or NAO; (2) an AI app–assisted SEL intervention, implemented through a conversational agent on tablets or computers; and (3) a business-as-usual control group receiving the standard school provision. The intervention will span ten weeks with two sessions per week, each lasting 20 minutes, followed by a three-month follow-up assessment.

Participants will be recruited from primary and lower-secondary schools across Bulgaria, with the classroom serving as the unit of randomization. The target population includes students aged 9–14 (grades 3–8). Approximately 72 classrooms across 24 schools will be included, resulting in an estimated sample of 1,440 students. Inclusion criteria require parental consent and student assent, while exclusion criteria are limited to cases where sensory or motor impairments prevent participation. The design has sufficient statistical power to detect small but educationally meaningful effects ($d = 0.20–0.25$), accounting for clustering within classes and schools.

The robot-assisted SEL intervention will be conducted with a social robot equipped with speech and gesture capabilities. The robot will lead scripted sessions on emotion recognition, empathy, conflict resolution, and help-seeking, while teachers act as facilitators to ensure classroom engagement. The AI app–assisted SEL program will mirror the same content and structure, but without the embodied social presence of a robot. The control group will continue with their standard SEL provision and will be offered access to the materials after the trial concludes.

Fidelity and safety will be closely monitored through session checklists, classroom observations, and teacher logs. Teachers will receive training prior to implementation, focusing on SEL objectives, technology use, and safeguarding protocols. A hotline for technical support will be available throughout the trial, and adverse events will be reported immediately to the principal investigator and school psychologist.

The study will employ a multi-wave data collection strategy at baseline, midline (week 5), post-test (week 10), and three-month follow-up. Primary outcomes include changes in social skills and peer relations measured with the Social Skills Improvement System (SSIS), as well as emotional and behavioral difficulties measured through the Strengths and Difficulties Questionnaire (SDQ). Secondary outcomes encompass well-being (WHO-5), anxiety and depression symptoms (RCADS-25 short), emotion regulation (DERS-16), and school engagement. Mediators and moderators include trust and acceptance of technology (Godspeed and UTAUT scales), teacher attitudes, and classroom climate.

Qualitative data will be collected through focus groups with students, interviews with teachers and parents, and analysis of reflective student worksheets. This strand will provide deeper insight into perceived impact, acceptability, and ethical considerations. Implementation data, such as fidelity scores, session attendance, and costs, will also be analyzed to inform future scalability.

Quantitative data will be analyzed using multilevel modeling, with students nested in classes and schools, to estimate intervention effects while accounting for baseline measures and covariates. Mediation and moderation analyses will explore the roles of trust, teacher attitudes, and classroom context in shaping outcomes. Qualitative data will be analyzed thematically and triangulated with quantitative findings. Additionally, a cost-effectiveness analysis will estimate the cost per standardized improvement in social skills and emotional well-being.

This design allows for testing multiple hypotheses: that robot- and AI app–assisted SEL programs improve well-being and social skills compared to controls; that trust and acceptance of technology moderate outcomes; that effects in Bulgaria are comparable to international findings; and that teacher and parent attitudes influence implementation success. The methodological plan ensures both rigor and cultural relevance, while providing evidence directly applicable to educational policy and practice in Bulgaria.

Research Design Model

The following table presents the research design model for the study, including participant groups, timelines, and types of assessments.

Group	Timeline	Intervention/Exposure	Assessment
Experimental Group A	Month 1–3	Interaction with AI/robotic tools in school environment	Pre- and post-tests (mental health, social skills, digital literacy)
Experimental Group B	Month 1–3	Traditional teaching methods (no AI/robotic exposure)	Pre- and post-tests (same metrics)
Control Group	Month 1–3	No targeted intervention; regular curriculum	Pre- and post-tests (baseline comparison)
Follow-up (all groups)	Month 6	—	Sustainability check of outcomes (retention of skills, mental health indicators)

Analysis and Synthesis

The application of the Delphi method to research artificial intelligence (AI) and robotics in education highlights both opportunities and challenges. The method is especially valuable in emerging fields where consensus and foresight are critical, enabling structured engagement of experts to identify key trends, risks, and ethical implications. In the reviewed research, several findings consistently emerge. First, there is strong agreement that AI and robots can support personalized learning and enhance student engagement, particularly through social robots that foster emotional well-being and communication skills (Belpaeme et al., 2018; Fridin & Belokopytov, 2014). Second, experts emphasize the importance of balancing technological integration with ethical safeguards, including issues of privacy, trust, and long-term psychological effects (Sharkey, 2016). Third, findings from Bulgarian contexts demonstrate that while research is still limited, initial studies confirm that digital technologies have significant potential in educational and therapeutic settings but require culturally adapted approaches (Popova et al., 2023; UNICEF, 2022).

A comparative review of methodologies shows that randomized controlled trials (RCTs) provide the strongest evidence for intervention outcomes, while longitudinal studies capture developmental trajectories, and systematic reviews map broader evidence landscapes (Orben, 2020; Werner-Seidler et al., 2024). The Delphi method complements these by forecasting trends and shaping policy recommendations, making it a bridge between empirical findings and practical applications.

Summary of Hypotheses

From the synthesis of literature and preliminary studies, several hypotheses can be outlined:

H1: AI-driven educational and therapeutic robots positively influence emotional well-being and social skills among children and adolescents.

H2: Expert consensus predicts that hybrid models (human + robot) will be more effective and socially accepted than fully automated systems.

H3: Ethical concerns such as privacy, dependency, and authenticity mediate the level of trust and adoption of AI and robotics in education.

H4: In the Bulgarian context, the lack of longitudinal and intervention-based studies limits generalizability, but existing evidence suggests that cultural adaptation is a key factor for successful implementation.

Conclusion

Overall, the analysis confirms that AI and robotics hold significant potential to transform educational and therapeutic practices for children and adolescents. However, their effectiveness depends not only on technological progress but also on ethical safeguards, cultural adaptation, and integration into broader human-centered models.

The Delphi method emerges as a crucial tool for building consensus and forecasting in this domain, particularly where empirical data remain scarce. The hypotheses outlined here provide a roadmap for future research, emphasizing the need for cross-national studies, longitudinal designs, and experimental interventions that can validate expert expectations. A multidisciplinary approach, combining psychology, pedagogy, computer science, and ethics, will be essential for ensuring that AI and robotics contribute meaningfully to education and mental health support.

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