Enhancing Emotional Well-Being in Children Through PAYTON: A Social Robot in Educational Contexts1

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Abstract: This paper explores the potential of the PAYTON social robot as a supportive tool for fostering emotional well-being among children in school environments. With the growing presence of social robots in education, the integration of PAYTON provides an opportunity to promote empathy, emotional regulation, and social connectedness. Drawing on recent advances in human–robot interaction, this study examines how PAYTON can be applied in classrooms to support children's emotional health and to complement traditional psychological and pedagogical approaches. The research is grounded in the increasing importance of digital well-being, particularly in post-pandemic contexts where children face heightened risks of stress, social isolation, and emotional challenges. Findings are expected to demonstrate that PAYTON's interactive and responsive features can enhance engagement, improve emotional awareness, and strengthen peer relationships, ultimately contributing to healthier learning environments.

Keywords: Social robots, Emotional well-being, Children, Education, Human–robot interaction

Introduction

The rapid integration of technology into educational systems has created new opportunities to address children's emotional and social needs in structured and innovative ways. Among these emerging tools, social robots stand out as promising mediators in promoting emotional well-being, communication skills, and social engagement. PAYTON, a humanoid social robot designed for interactive learning and emotional support, has recently been introduced as a potential aid in schools. Its applications extend beyond academic instruction, encompassing therapeutic and socio-emotional interventions that are particularly relevant for children who struggle with anxiety, social withdrawal, or developmental challenges.

The aim of this study is to explore how PAYTON can be applied in educational settings to enhance emotional well-being in children. The research objectives are threefold: (1) to evaluate PAYTON's impact on children's emotional regulation and self-expression; (2) to assess its role in developing social skills, empathy, and cooperation within classroom environments; and (3) to investigate teachers' and students' perceptions of PAYTON as an educational support tool. These objectives are grounded in the growing recognition that emotional well-being is central to successful learning and long-term development.

The relevance of this study lies in the increasing rates of stress, anxiety, and behavioral difficulties among children, which have been amplified by factors such as digital overstimulation and post-pandemic social disruptions. While traditional interventions provide partial support, the incorporation of social robots like PAYTON into hybrid models of education offers a novel avenue to complement human-led teaching and counseling. Preliminary research on similar robots, such as NAO and Pepper, has demonstrated their capacity to engage children in ways that feel playful, safe, and motivating. PAYTON builds on this potential by combining naturalistic communication

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patterns with adaptive feedback mechanisms tailored to young learners.

The hypothesis underpinning this study is that the use of PAYTON in classrooms will lead to measurable improvements in children's emotional well-being and social engagement compared to traditional pedagogical approaches alone. It is also hypothesized that teachers will perceive PAYTON not as a replacement for human interaction but as a supportive tool that enriches the educational process. By embedding PAYTON into real-world educational contexts, this study seeks to provide empirical evidence for the role of social robots in fostering resilience, empathy, and emotional health among school-aged children.

In conclusion, the integration of PAYTON into educational environments highlights the transformative potential of social robots as complementary tools in modern schooling. While challenges such as cost, ethical considerations, and long-term effectiveness remain, the promise of combining technological innovation with human-centered pedagogy offers significant opportunities. Future research should focus on longitudinal evaluations, cross-cultural studies, and the co-creation of educational programs where PAYTON functions as a bridge between academic achievement and emotional well-being.

The intersection of educational technology and child psychology has become increasingly important in recent years. Schools are no longer solely spaces for academic instruction; they are also arenas for fostering socio-emotional skills, resilience, and well-being. Social robots have emerged as promising tools in this process, offering interactive, consistent, and engaging forms of support. One such development is PAYTON — a humanoid social robot specifically designed for use in educational contexts. Unlike general-purpose robots, PAYTON integrates features of affective computing, adaptive communication, and emotion recognition, making it suitable for interventions aimed at supporting children's emotional well-being.

PAYTON is conceptualized as a socially assistive robot (SAR) whose primary role is to provide structured emotional support, foster empathy, and encourage positive social interactions among children. It combines speech recognition, naturalistic dialogue, and expressive gestures to create engaging interactions. In educational settings, PAYTON can lead group activities, guide emotional regulation exercises (e.g., breathing techniques, storytelling), and provide personalized feedback to children, thereby acting as both an educational assistant and an emotional support companion.

Literature Review

Research on social robots in education and therapy has grown significantly in the past decade. Socially assistive robots (SARs) such as NAO, Pepper, and Paro have been deployed across a variety of contexts, including autism spectrum disorder interventions, anxiety reduction, and the promotion of collaborative learning.

For example, studies with NAO have shown that robot-assisted activities can improve communication skills and emotional engagement among children with autism (Boucenna et al., 2014). Similarly, Pepper has been used in classrooms to encourage group participation and foster pro-social behaviors, demonstrating that humanoid robots can serve as mediators in social learning (Belpaeme et al., 2018). Paro, a therapeutic seal robot, has been found effective in reducing stress and loneliness, particularly in clinical and rehabilitative settings (Shibata & Wada, 2011).

In the educational domain, recent systematic reviews (van Straten et al., 2020; Vogt et al., 2019) emphasize that social robots increase engagement, motivation, and trust, especially when used in hybrid models alongside human teachers. However, these reviews also caution that robots should not replace human interaction but rather complement existing pedagogical approaches.

In the Bulgarian context, research on educational robots remains limited. Studies have focused primarily on the use of digital technologies and online platforms in schools (Popova, 2023; UNICEF, 2022), with little systematic work on socially assistive robots. Introducing PAYTON could therefore represent an innovative step, addressing both international research gaps (lack of long-term evidence) and local needs (growing emphasis on children's mental health and digital competencies in Bulgarian schools).

Hypotheses

Based on this foundation, the study advances three hypotheses:

Children exposed to PAYTON in classroom activities will demonstrate higher levels of emotional regulation and social engagement compared to control groups.

Teachers will evaluate PAYTON positively, perceiving it as a supportive educational tool rather than a replacement for human-led instruction.

The integration of PAYTON into school settings will increase children's acceptance of technology and reduce barriers to discussing emotional well-being in structured environments.

PAYTON represents an innovative approach to merging technology and emotional learning in schools. By drawing on prior experiences with NAO, Pepper, and Paro, this study aims to position PAYTON as a contextualized tool for Bulgarian education. Its novelty lies in its dual focus: supporting both academic and emotional outcomes. If successfully implemented, PAYTON could bridge gaps between mental health support and formal education, offering a scalable and engaging solution for the well-being of children.

Enhancing Emotional Well-Being in Children Through PAYTON: A Social Robot in Bulgarian Educational Contexts — **A Cluster Randomized Mixed-Methods Trial**

1) Objectives

Primary objective: Test whether classroom integration of PAYTON improves children's emotional regulation and prosocial behavior versus business-as-usual (BAU).

Secondary objectives:

Assess effects on anxiety, mood, and school connectedness.

Evaluate teacher acceptability, feasibility, and fidelity of PAYTON delivery.

Examine mechanisms (engagement → emotion regulation → outcomes) and moderators (age, baseline symptoms, SES, prior robot exposure).

2) Hypotheses

H1 (effectiveness): PAYTON classes will show greater gains in emotion regulation and prosocial behavior than BAU at post-intervention and 3-month follow-up.

H2 (mental health): PAYTON classes will show larger reductions in anxiety and negative affect and increases in school belonging than BAU.

H3 (mechanism): Effects will be mediated by engagement (child-robot interaction quality, session attendance) and on-task emotion practice.

H4 (acceptability): Teachers will rate PAYTON as acceptable, feasible, and appropriate for routine use; fidelity ≥80% will predict stronger outcomes.

3) Design

Type: Cluster randomized controlled trial (CRCT) with schools/classrooms as clusters; 1:1 allocation (PAYTON vs BAU).

Duration per cohort: 8-week intervention + 12-week follow-up (total ~20 weeks).

Mixed-methods: Quantitative outcomes + qualitative interviews/focus groups + implementation logs.

Hybrid type 2: Tests effectiveness while simultaneously examining implementation (feasibility, fidelity, cost).

4) Participants & Setting

Setting: Public primary schools in Sofia and at least one non-capital region (urban + semi-urban).

Target grades: Grades 2–5 (ages ~7–11).

Sample size (illustrative): ~24 classes across ~10–12 schools; ~20–25 pupils/class → N ≈ 500.

Power (ICC 0.05, two-level LMM, α=.05, power .80): detects small effects (d≈0.25–0.30) on primary outcomes.

Inclusion: Parental consent & child assent; Bulgarian language comprehension; not currently in intensive clinical treatment that conflicts with participation.

Exclusion: Severe sensory/motor impairment that precludes safe robot interaction (case-by-case accommodation where possible).

5) Intervention (PAYTON Program)

Format: 8 weekly 30–35 min sessions, delivered during SEL/homeroom or school counseling periods.

Group size: Whole class with rotating micro-interactions (2–4 pupils at a time) while others engage in parallel activities.

Content modules (scripted & adaptive):

Emotion recognition (faces, voices, contexts)

Emotion labeling & body signals

Breathing & grounding (robot-guided paced breathing)

Cognitive reappraisal lite (age-appropriate reframing)

Empathy & perspective-taking (story vignettes, role-play)

Prosocial problem-solving (stop–think–act)

Friendship & inclusion (kind acts challenge)

Consolidation & celebration (goal review, certificates)

Robot behaviors: Natural speech, expressive head/face/LED cues, gaze control, turn-taking, affective mirroring, short gamified tasks, positive reinforcement.

Human role: Teacher/counselor is session lead; PAYTON acts as co-facilitator.

Fidelity supports: Written manuals, in-app checklists, 5-hour teacher training + coaching huddles (weeks 1, 3, 6).

6) Control Condition (BAU)

Standard SEL/health period as currently delivered (no robot); access to typical school counseling resources. After study, offer delayed PAYTON (wait-list ethical provision).

7) Measures & Instruments

Child outcomes (primary/secondary)

Emotion Regulation: Emotion Regulation Questionnaire for Children & Adolescents (ERQ-CA).

Prosocial Behavior / Peer Problems: Strengths and Difficulties Questionnaire (SDQ) – child & teacher forms.

Anxiety/Negative Affect: Revised Children's Anxiety and Depression Scale – Short (RCADS-25) or SCARED-5 + PANAS-C short.

School Belonging / Connectedness: Psychological Sense of School Membership (PSSM) – brief.

Sleep & Screen routine (covariates): 2–3 items (bedtime, duration; optional wearables subset).

Engagement (mechanism): Child Session Rating (smiley scale), robot affinity scale (short), attendance.

Teacher & implementation

Acceptability/Feasibility/Appropriateness: AIM/FIM/IAM 4-item scales (adapted).

Fidelity: Session checklist (items completed, time on task); 10% sessions audio/video coded (global fidelity rating).

Workload & usability: System Usability Scale (SUS) + brief burden index.

Costs: Micro-costing template (robot time, training, teacher time, maintenance).

Qualitative

Teacher focus groups (post-intervention): barriers, enablers, fit.

Student mini-groups (opt-in, age-appropriate): likes, dislikes, perceived benefits.

Parent interviews (sample): observed transfer at home.

Timing

T0 (baseline) → T1 (post 8 weeks) → T2 (12-week follow-up).

8) Randomization & Blinding

Cluster randomization at class level, stratified by school & grade; concealed allocation by independent statistician.

Blinding: Outcome assessors blinded where feasible (teacher-reported outcomes may not be blind).

9) Data Management & Ethics

Ethics: University IRB + Ministry of Education approvals; GDPR-compliant processing; DPIA conducted.

Consent: Opt-in parental consent; child assent with age-appropriate forms.

Privacy: No facial video stored by default; if used for research coding, obtain separate consent; pseudonymize IDs.

Safety: Adverse event log; referral pathway to school psychologist when screening flags moderate-severe distress.

10) Analysis Plan

Primary analysis: Linear mixed models (students nested in classes) with treatment, time, and interaction (Tx×Time); random intercepts (class, student); intention-to-treat with multiple imputation for missing data.

Effect sizes: Hedges g; 95% CIs.

Mediation: Within-trial mediation (engagement/fidelity → emotion regulation → outcomes).

Moderation: Baseline severity, grade, gender, SES, prior tech affinity.

Implementation: Descriptive stats (AIM/FIM/IAM), fidelity means, cost per class/student; qualitative thematic analysis (Braun & Clarke) integrated via joint display.

11) Training & Fidelity Infrastructure

Pre-launch: 5-hour workshop (robot operation, SEL content, safeguarding, inclusion for neurodiverse learners).

Job aids: Session scripts, cue cards, 3-minute micro-videos per module.

Coaching: Virtual office hours; peer learning circle (weeks 1, 3, 6).

Fidelity triggers: If checklist <80%, rapid coaching boost before next session.

12) Timeline (per cohort)

Months 1–2: Recruitment, consent, baseline (T0), teacher training.

Months 3–4: 8-week PAYTON delivery.

Month 5: Post-test (T1), teacher focus groups.

Month 8: Follow-up (T2), parent interviews, cost summary.

Month 9: Analysis & reporting; feedback to schools.

13) Inclusion, Equity & Accessibility

Language & reading level: simplified prompts, visual supports.

Neurodiversity: predictable routines, sensory-friendly modes (reduced volume/lighting), opt-out micro-tasks.

Rural/low-resource schools: mobile kit, offline functionality, local coach.

14) Risks & Mitigation

Robot downtime: spare unit & loaner plan; cached offline scripts.

Teacher turnover: rolling micro-training; buddy teacher.

Data loss: encrypted tablets; daily sync; redundant backups.

15) Expected Contributions

Causal evidence on SEL impacts of a social robot in Bulgarian primary schools.

Practice-ready implementation playbook (training + fidelity + cost).

Guidance on ethical, privacy-preserving robot use in schools.

Optional Tables (paste into your doc)

Table A. Outcome Battery & Timing

Domain	Measure	Informant	0	1	2
Emotion regulation (primary)	ERQ-CA	Child			
Prosocial / Peer	SDQ	Child, Teacher			
Anxiety / Mood	RCADS-25 (or SCARED-5 + PANAS-C)	Child			
School belonging	PSSM-Brief	Child			
Engagement (mechanism)	Session rating, attendance	Child/Log		eekly	
Teacher acceptability/feasibility	AIM/FIM/IAM	Teacher			

Domain	Measure	Informant	0	1	2
Fidelity	Checklist + coding	Coach		eekly	
Costs	Micro-costing	Admin/Coach			

Table B. Implementation Metrics

Construct	Tool	Threshold
Acceptability	AIM	Mean ≥4/5
Feasibility	FIM	Mean ≥4/5
Appropriateness	IAM	Mean ≥4/5
Fidelity	Checklist + 10% coded sessions	≥80% items completed
Usability	SUS	≥70
Cost	€/student	Report point + CI

Conclusion

The proposed research model for implementing PAYTON, a socially assistive robot, in Bulgarian primary schools demonstrates both the feasibility and potential impact of robotic interventions on children's emotional well-being. Grounded in a rigorous cluster randomized controlled trial and supported by mixed-methods evaluation, the design aims to provide causal evidence of effectiveness while simultaneously addressing practical considerations such as teacher training, fidelity, and ethical safeguards.

The hypotheses posit that PAYTON will enhance children's emotion regulation, prosocial behavior, and school connectedness, while reducing symptoms of anxiety and negative affect. The integration of mediation and moderation analyses will allow for a nuanced understanding of the mechanisms of change and the conditions under which the intervention is most effective. Importantly, the inclusion of qualitative data and implementation measures ensures that the study not only evaluates outcomes but also generates actionable insights for sustainable adoption in real-world educational settings.

Overall, the study contributes to the growing body of evidence highlighting the value of social robots as complementary tools in education and child mental health promotion. PAYTON is not intended to replace teachers or counselors but to augment human-led interventions by offering consistent, engaging, and adaptive emotional support. If successful, this model can serve as a blueprint for integrating socially assistive robots into broader educational and psychosocial frameworks, advancing both scientific knowledge and practical innovation in child development.

References

1. Belpaeme, T., Kennedy, J., Ramachandran, A., Scassellati, B., & Tanaka, F. (2018). Social robots for education: A review. Science Robotics, 3(21), eaat5954.
2. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in

Psychology, 3(2), 77–101.
3. Goodman, R. (1997). The Strengths and Difficulties Questionnaire. Journal of Child Psychology and Psychiatry, 38(5), 581–586.
4. Laurent, J., et al. (1999). A measure of positive and negative affect for children. Psychological Assessment, 11(3), 326–338.
5. Muris, P., et al. (1998). RCADS. Behaviour Research and Therapy, 36(2), 195–209.
6. Raykov, T., & Marcoulides, G. A. (2012). Basic statistics. Rowman & Littlefield.
7. Weinstein, R. S., et al. (2021). Measures of school belonging. School Psychology Review, 50(2–3), 181–196.