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Research article

Preservice Teachers' Perceptions of Using Educational Robots in Primary School

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Abstract

Educational robots represent one of the most innovative developments in modern education, offering new opportunities for interactive, creative, and experiential learning. By combining programming, collaboration, and problem-solving, educational robotics helps students develop computational thinking, critical reasoning, and digital competence from an early age. In the context of 21st-century education, their integration into the instructional process supports a shift from traditional teaching toward active, student-centered learning. This study explores preservice teachers' perceptions of using educational robots in the teaching–learning–assessment process. Using a quantitative research design based on a structured questionnaire, the study examined participants' views on the pedagogical potential of educational robotics. The results reveal that future teachers perceive robots as effective tools that enhance engagement, creativity, and collaboration, while promoting competence-based and formative approaches to learning. Participants also demonstrated a strong sense of methodological preparedness and openness toward technological innovation in education. Overall, the findings emphasize that educational robotics serves not merely as a technological aid, but as a catalyst for pedagogical transformation. Integrating robotics into teacher education can help prepare future educators to design interactive, inclusive, and innovative learning experiences aligned with the needs of contemporary education.

Keywords:
educational robotics, preservice teachers, primary education, active learning, digital competence, pedagogical innovation

1. Introduction

Technology is advancing rapidly, new generations are thinking differently than they used to, and students must feel well equipped to use skills that will be applied in the 21st century. This is precisely what the modern-day education system has failed to address. Within this framework, including educational robots in learning and assessment has become an important path for innovative pedagogy. The use of educational robots in primary schools enhances the development of digital skills and logical thinking and creativity and ultimately fosters a more profound understanding of the learning process itself (Gerosa et al., 2022; Wang et al., 2022). At a school that believes in active learning and the importance of real-world experiences, robots help students learn by doing, exploring, and contemplating what they did. When children are thinking predominantly in concrete terms, which primarily occurs during their primary school years, using educational robots becomes quite necessary, as they need to learn simultaneously from many senses. Robots offer a way of turning abstract concepts in the curriculum—tour angles in mathematics, our solar system, and the mystery of logic, to name just three—into real-life experiences that are fun for kids. Educational robotics activities are found to help promote computational thinking and improve the school learning of elementary students based on recent studies (Ching & Hsu, 2023; Ouyang & Xu, 2024; Tang et al., 2025). The effects of teaching methodological training levels and teachers' attitudes on educational innovation have a direct relationship with these results (Grani, 2022). Thus, it is important to investigate the expectations of future educators regarding the use of educational robots to determine the necessary level of professional development they should receive for these pedagogical practices. The present study helps to understand future educators' conceptions of the role of robots in learning, teaching, and assessment and suggests interventions to develop university training programs suitable to the emerging needs for digital education.

2. Theoretical foundation

2.1. Educational Robots—Interactive Resources for Active Learning

One of the most exciting new developments in contemporary educational technology is called robots that can teach. They are tools that help kids learn by making them do things, contemplate what they're doing, and apply what they've learned. Robots in the classroom are a fantastic way to educate kids, as they learn best when shown what to do and actively engaged. Kids ages 6 to 11 can play with things like Bee-Bot, Blue-Bot, Lego WeDo, Ozobot, mTiny, and Edison. These gadgets contain games that may assist in their mental and emotional development (Alimisis, 2022). So, educational robots are not the point; they're just tools to get kids to figure out how to learn math and science and Romanian and art, and civics all at the same time. In a study led by Chionas & Karampinis (2021), the inclusion of Bee-Bot in math and language classes significantly increased the attention, motivation, and academic achievement of first-graders. Kids can learn to think like computers by playing with robots that teach them to "do" things. This approach allows children to solve problems and generate algorithmic answers that machines can process (Wing, 2006). Ching and Hsu (2023) agree that showing kids how to think like a computer with robots is genius because it takes something abstract like learning to program and turns it into a hands-on, engaging activity. Educational robots may also be beneficial in teaching children how to manage their emotions as well as others. They learn to communicate, cooperate, and care for each other while programming a robot. This task makes students negotiate, solve problems, and help one another—activities stemming both from civic competences and collaboration (Alimisis & Kynigos, 2019; Demetroulis et al., 2023). Gerosa et al. (2022) and Barak & Zadok (2009) argued that through the robotics activity, kids observe themselves collaborating, continue to try out possibilities for solving problems, and want to know more.

2.2. Dimensions of the Application of Educational Robots in Primary School

We should reconsider the application of primary school education robots from three perspectives in the step-by-step process: teaching, learning, and assessment. These dimensions are interconnected to each other, and they reflect the tendency for educational robots to also become a means for first-grade pupils to develop, in addition to basic competencies and motivational and critical thinking skills (Ouyang & Xu, 2024; Tang et al., 2025). From the learning perspective, the educational robot introduces a new teaching modality that transforms the standard lesson into an experimental format, making it available as an interactive and interdisciplinary subject. The teacher can use the robot to demonstrate for students, as a simulation of doing things, or as educational games. This allows students to experience theoretical concepts in a more hands-on manner. One such is math, where a Bee-Bot can be programmed to follow a trail to solve math puzzles. This is how kids can pretend to understand sequencing and reach the right place in space. A robot in science can be a body moving, the blowing wind, or planets circling. In civic education, children may work together to program a robot to act or to traverse symbolic pathways (Demetroulis et al., 2023). Through it, students can question and thus be more motivated to learn the natural sciences. The professor is the facilitator of information, and as an intermediary between the knowledge and the learner, the robot comes closer to bringing abstraction in direct touch with reality (Alimisis, 2022). In learning, educational robots are like real buddies helping with exploring and finding new stuff. They stimulate the mind, encourage unconventional thinking, assist in problem-solving, and foster teamwork. When students play with robots, they are able to try and see what happens and then learn by doing it now-that's experiential learning (Kolb, 1984). Working as a team, sharing the load, and talking things out to get things done are skills that students can bring with them offline. These experiences help kids develop social and civic skills and also support computational thinking-like breaking down problems into logical steps and making algorithms for solving them. Students could program a bot to traverse a map or interpret a collectively created story. Thus, learning becomes more real and lively, and everyone is part of the victory, with each student contributing significantly to the team score.

Ching and Hsu (2023) found that when robots are used in a classroom, girls perform better at the learning game; they are on task more frequently, especially younger ones. Kids think this stuff is super fun. Robots provide instant feedback, so students need to plan, do, reflect - perfect for independent learning edu-robots are really cool when tailor-learning. Students can take on suitable challenges, while teachers can track their progress and offer personalized help. This system enables each student, irrespective of their pace-fast or slow-to meet the same milestones by taking a unique path. In terms of assessment, the concept of sounding like an educational robot enables new ideas about formative and real assessment. These allow data collection on the process of learning and provide immediate feedback to students, which supports self-regulation and metacognition (Wang et al., 2022). If a student programs a robot that doesn't go where they want it to, then the mistake is an opportunity to learn, rather than a cost or penalty, for example. The student reflects on the error, corrects it, and modifies his or her algorithm. It's a beneficial way for them to take stock. The instructor can evaluate the final product, cognitive strategies, group collaborations, and students' learning attitudes. Robots can also be employed to test cross-cutting skills such as creativity, critical thinking, and teamwork through "project-based" tasks in which students work together in groups to identify a solution and then present it. Tang et al. (2025) found that when using robots in assessment, students' confidence increases and their test anxiety decreases by using feedback through a playful manner and positive tone of voice. In Romania, the E-ROBOT project (2022) demonstrates that robot assistance in assessment can also be operational at primary schools, as students are involved with "learning through play" activities in which their work needs to be constantly evaluated.

3. Research methodology

3.1 Methodology

The article employed a quantitative research approach to explore how preservice teachers perceive the use of educational robots in primary and preschool education.

To achieve the purpose of the research, the following questions were formulated:

1. What are the perceptions of teachers and future teachers regarding the integration of educational robots into the teaching process, considering the three fundamental dimensions: teaching, learning, and assessment?
2. What is the level of preparedness and awareness among future teachers concerning the use of educational robots in primary education, with an emphasis on the skills required for their effective implementation in classroom activities?
3. What is the role of educational robots in the instructional process, both as a support tool for teachers and as an innovative resource for enhancing students' learning?

The research hypotheses are as follows:

H1: Students, as future teachers, are methodologically prepared to integrate educational robots into the instructional process, being familiar with the necessary strategies for their application, including organizational forms, teaching tools, and methods.

H2: Students perceive that educational robots can be used as interactive tools in the teaching process and can be integrated into instructional activities aligned with the school curriculum.

3.2. Participants

For this study, a quantitative research method was used. The participants were students specializing in Primary and Preschool Education Pedagogy at *Lucian Blaga University of Sibiu* - preservice teachers and preschool educators. The sample consisted of 98 students from the first, second, and third years of study: 73 enrolled in the full-time (undergraduate) program and 25 in the distance learning program.

The participants varied in age, with the majority belonging to the 20-25 age group (50 participants). Additionally, 22 students were under 20 years old, 6 were between 26 and 30, and 20 were over 30 years old - some of whom were already employed in the field of education.

3.3. Data Collection

The data were collected using a five-point Likert-scale questionnaire consisting of 24 questions. Among them, 22 were closed-ended items, where participants rated their agreement on a scale from *"1 - Strongly Disagree"* to *"5 -Totally Agree"*, and three were open-ended questions (items 4, 24, and 25) that invited participants to share their own opinions on the research topic.

The questions were designed not only to capture participants' perceptions of using educational robots in the teaching process but also to assess their understanding of this process in all its pedagogical, methodological, and managerial dimensions. Students were encouraged to draw upon their theoretical and practical knowledge when responding, in order to provide well-founded views on how educational robots can be integrated into classroom activities.

The questions were divided into three dimensions, each highlighting different aspects of the topic, including both the application of new technologies in teaching and the understanding of pedagogical strategies for their implementation. Since some of the students participating in the study were already working as teachers or preschool educators, many of them had taken part in various activities organized within projects conducted by the faculty members of the Department for Teacher Training at Lucian Blaga University of Sibiu. These activities focused on the use of educational robots.

The first group of questions addressed teaching experience with educational robots (questions 1–5).

The following groups explored the impact of educational robots on the teaching process, specifically on learning (questions 6), assessment (questions 7–9), and their use in teaching (questions 10–15). The final category, considered particularly important, referred to general opinions and perspectives regarding the use of educational robots in the teaching process (questions 16–25).

4. Results

For the analysis of the data collected in the study, statistical methods appropriate to the type of variables and the purpose of the investigation were used. The analysis was conducted using the PSPP program, the open-source equivalent of SPSS.

Data analysis included the examination of kurtosis and skewness values to determine the normality of the distributions. The descriptive indicators showed that the score distribution was slightly left-skewed, within normal limits, with a skewness value of -0.71 and slightly leptokurtic, with a kurtosis value of 0.85. Both values fall within the accepted range (-2 to +2), and the standard deviation was 0.57. Therefore, the assumption of normality was considered met, allowing the application of the ANOVA test.

Descriptive indicators were calculated, showing small differences between the means (a maximum of 0.36 points). The assumptions for applying parametric tests were verified, namely the normality of distributions and the homogeneity of variances between groups, with Sig. = 0.245 (> 0.05) and Levene's Statistic = 1.43. After confirming these conditions, a one-way ANOVA test was applied (Table 1).

Table 1

The ANOVA test

Model		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	1.02	2	.51	1.59	.208
	Within Groups	30.25	95	.32		
	Total	31.26	97			

The ANOVA test, with results of F = 1.59 and p = 0.208, indicates that there are no statistically significant differences between the groups of students (based on their year of study: first, second, and third year) regarding their perceptions of the use of educational robots and digital technologies in the teaching–learning–assessment process. The results are presented and interpreted below from both a statistical and educational perspective.

The descriptive analysis shows that participants hold a generally positive perception of the idea that educational robots can be used as interactive tools in the teaching process. With a standard deviation of 0.57 (Min = 1.93, Max = 5.00, M = 3.99), it can be observed that the responses are fairly consistent across participants.

The analysis of teachers' and future teachers' perceptions by age category is presented in Table 2. The highest mean value was recorded for the group "Under 20 years" (M = 4.18), indicating a more positive perception. The other age groups showed very similar scores (M ≈ 3.8–3.9). A one-way ANOVA test was applied to examine differences between age groups regarding perceptions of the use of educational robots. The results showed that these differences were not statistically significant, F(3, 94) = 1.63, p = 0.188.

Table 2

Analysis of Teachers' and Pre-service Teachers' Opinions According to Age Group

Age	N	Mean	St. dev.	Std. Error	Min.	Max.
Under 20 years old	23	4.18	.55	.11	2.79	4.97
20-25	50	3.97	.39	.07	2.87	5.00
26-30	5	3.80	.37	.17	3.54	4.46
Over 30 years old	20	3.80	.74	.17	1.93	4.76
Total	98	3.99	.57	.06	1.93	5.00

Table 3

Analysis of Teachers' and Future Teachers' Perceptions of the Use of Educational Robots by Year of Study

Age	N	Mean	St.dev.	Std.Error	Min.	Max.
Year 1	43	4.04	.63	.10	1.93	5.00
Year 2	35	3.68	.49	.08	2.45	4.61
Year 3	20	4.12	.52	.12	3.19	4.76
Total	98	3.99	.57	.06	1.93	5.00

An analysis was also conducted based on the year of study, providing detailed results (Table 3) regarding the overall perception mean, which was highest among third-year students (M = 4.12; SD = 0.52), followed by first-year students (M = 4.04; SD = 0.63). Second-year students recorded the lowest mean (M = 3.68; SD = 0.49). To verify whether the general perception differed significantly by year of study, a one-way ANOVA test was applied. The results indicated that the differences between the means of the three groups were not statistically significant, $F(2, 95) = 1.59$, $p = 0.208$. Therefore, it can be concluded that the year of study does not have a significant influence on students' perceptions of the use of educational robots in the instructional process.

The descriptive statistics analysis highlights a high level of agreement among participants regarding the use of educational robots in teaching, learning, and assessment activities (Table 4). The mean values, ranging from M = 3.92 to M = 4.14, indicate a generally positive perception of their role in the educational process. The moderate standard deviations (SD = 0.67–0.74) suggest a relatively homogeneous pattern of responses.

The distributions show a slight negative skewness (Skewness = -0.21 to -0.98), confirming a tendency among respondents to give higher ratings (partial or total agreement). The kurtosis values indicate a greater concentration of responses for the teaching and learning dimensions, and a slightly higher dispersion for assessment, reflecting a generally positive but not unanimous openness toward integrating educational robots into the evaluation process.

Table 4

Perception of the Influence of Educational Robots on the Teaching, Learning, and Assessment Process of Students

	N	Mean	Min	Max	Skewness		Kurtosis		Std. Dev.
					Statistic	Std. Error	Statistic	Std. Error	
Teaching dimension	98	3.92	1.55	5.00	-.94	.24	1.50	.48	.67
Learning dimension	98	4.14	1.00	5.00	-.98	.24	1.93	.48	.74
Assessment dimension	98	3.93	2.03	5.00	-.21	.24	-.59	.48	.69

The Pearson correlation analysis (Table 5) revealed positive and statistically significant relationships among all the dimensions of the educational process examined. The overall perception of using educational robots was strongly correlated with the teaching dimension ($r = 0.933$, $p < 0.001$) and with the assessment dimension ($r = 0.899$, $p < 0.001$). Likewise, perceptions of the influence of robots on the learning process showed positive and significant correlations with the other dimensions ($r = 0.503$–0.669, $p < 0.001$).

These results indicate a high level of attitudinal coherence among participants, suggesting that educational robots are perceived as useful and complementary tools across all stages of the instructional process-teaching, learning, and assessment.

Table 5

Pearson Correlations Between the Dimensions of the Educational Process

		All Questions	Learning dimension	Learning dimension	Rating Dimension
All questions	Pearson Correlation	1.000	.629*	.899*	.933*
	Sig. (2-tailed)		.000	.000	
Teaching dimension	Pearson Correlation	.669	1.000	.629*	.503
	Sig. (2-tailed)	.000		.000	.000
Learning dimension	Pearson Correlation	.899	.629*	1.000	.792
	Sig. (2-tailed)	.000	.000		.000
Assessment dimension	Pearson Correlation	.933*	.503*	.792*	1.000
	Sig. (2-tailed)	.000	.000	.000	
N		98	98	98	98

*. Correlation is significant at the 0.05 level

5. Discussions

The study revealed a generally positive perception among students specialising in Primary and Preschool Education regarding the integration of educational robots into the teaching process. The high mean values for the two hypotheses ($M\_IP1 = 3.92$; $M\_IP2 = 4.00$) indicate an interaction between the motivation shown by future teachers, a satisfactory level of methodological preparedness, and a genuine openness toward the use of modern educational technologies in teaching, learning, and assessment activities.

The high coefficient of internal consistency ($\alpha = 0.93$) for H1 confirms that students perceive themselves as methodologically prepared to integrate educational robots into the teaching process. This finding also suggests that future teachers show a willingness to adapt technology to the instructional context—a tendency associated with familiarity with interactive teaching methods and the use of technological tools during their university training.

At the same time, the positive perception reflects the belief that the use of robots can diversify traditional teaching methods and support students' active learning, addressing the core competencies outlined in the school curriculum. This result is consistent with the studies of Gerosa et al. (2022), Ching and Hsu (2023), and Demetroulis et al. (2023), which showed that educational robots foster computational thinking, collaboration, and discovery-based learning.

The present study revealed, for H2, a mean value of 4.00 and very good reliability ($\alpha = 0.87$), confirming a positive association regarding the potential of educational robots as interactive tools compatible with the requirements of the school curriculum. Students consider that robots can be successfully used in teaching and assessment activities, contributing to increased motivation and enhanced student engagement. This perception aligns with recent research (Ouyang et al., 2024; Tang et al., 2025; Wang et al., 2022), which highlighted the positive impact of educational robots on the engagement and performance of primary school students.

There are no statistically significant differences between student groups (ANOVA analysis, $p > 0.05$) regarding perceptions of methodological preparedness and the usefulness of educational robots. This homogeneity of responses can be explained by the uniform nature of university training and the similar access to educational and technological resources within the study program. The results confirm that a positive attitude toward technological innovation does not significantly depend on the year of study but represents a shared characteristic among future teachers.

The strong correlation identified between two important dimensions ($r = 0.754$, $p < 0.001$) is particularly significant: the awareness of pedagogical preparedness, from a methodological standpoint, and the inclusion of educational robots in the process of applying theoretical knowledge. This indicates that the perceived level of methodological preparedness is directly proportional to the perception of the usefulness of educational robots. In other words, students who consider themselves more competent in terms of teaching skills also tend to show a more favourable attitude toward the use of robots in teaching and learning activities.

This result supports the conclusions drawn by Johnson et al. (2016), Demissie et al. (2021), and Granić (2022), who found that solid pedagogical preparation and digital competence are key factors in the acceptance and integration of emerging technologies in education.

Overall, the data obtained confirm the formulated hypotheses and highlight a significant relationship between methodological preparedness and openness to educational innovation. It is worth noting that this study identifies a meaningful influence on participants' acceptance of instructional modernisation through technology. This suggests that both initial and ongoing teacher training should include specific components related to the use of educational robots—not only as technical resources but also as pedagogical tools for developing students' critical thinking, collaboration, and creativity.

6. Conclusions

The results of this study indicate that educational robots in primary education are not only possible but also a highly recommended resource, according to trainee teachers. Experiences with robotic technologies were also reported to be of instructional interest to future teachers, with both methodological preparation and attitudes towards the use of educational robots being raised. The average scores for all three dimensions (teaching, learning, and assessment) suggest a consistent belief in educational robots as a useful cognitive artifact for achieving interactive, experiential learning and promoting competency-based teaching. This belief points out the advantages of integrating such technologies into modern classrooms. By fostering a collaborative environment, educational robots can enhance engagement and provide personalized learning experiences that cater to diverse student needs.

There were no statistically significant differences between study years or student ages, which means that all of the participants were equally aware of and open to using technology. Additionally, the strong interrelationships between the three dimensions of the educational process highlight that the use of educational robots is considered a comprehensive teaching model to improve learning effectiveness, accelerate learners' motivation to learn, and promote formative and authentic assessment.

Although the study brings value to the field, it also has certain limitations. Firstly, the study sample was minimal and localized—the students were from a single university-which could limit the generalizability of the results. Secondly, this study was based on participants' self-reported perceptions rather than direct classroom observations, which are subjective and open to interpretation. Consequently, a future study should include both pre-service and in-service teachers from various schools with different educational levels.

The research concludes that educational robotics should play a central role in contemporary teacher training programs. By developing digital skills and a positive attitude towards innovation, future teachers can be better prepared to implement interactive, inclusive, and creative learning environments, in line with the requirements of 21st-century education.

Authors note:

Mărășescu Maria-Cristina is a lecturer at Teacher Training Department, Lucian Blaga University of Sibiu, Romania. Her academic work lies at the intersection of early childhood education, cultural identity, and innovative teaching methodologies. Her research explores how children construct identity in multicultural and acculturative contexts and how teachers can foster inclusion and well-being through reflective and evidence-based practices. In recent years, her focus has expanded toward digital and blended learning in mathematics education, educational robotics, and teacher preparation for future-ready competencies.

Bîclea Diana is a lecturer at the Teacher Training Department, Faculty of Social Sciences and Humanities, Lucian Blaga University of Sibiu. Her research areas are related to the application of information technologies in education, the application of digital tools in teaching mathematics, in the field of pure mathematics: the study of Noetherian operators and various conditions of their application.

Bologa Lia is a lecturer in the Teacher Training Department, Faculty of Social and Human Sciences, Lucian Blaga University of Sibiu, with over 20 years of experience in the field of education. Her research interests include preschool and primary education, initial teacher training, educational and developmental psychology, school deviance, and inclusive education.

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