Co-teaching with Robots, A New Pedagogical Partnership

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Abstract
Fast changes in artificial intelligence along with machines have reshaped how education works today, leading to new ways of teaching like using robots alongside teachers. Instead of taking over from people who teach, these robots are now seen more as teammates inside classrooms. Looking at past studies plus big ideas helps show how teamwork between humans and robots can make lessons clearer, draw students in deeper, strengthen attention, and adjust to individual styles of learning. Focus lands on blending robots into school settings as helpers during instruction, bridges for social interaction, flexible supports that meet varied student demands. Looking closer at how teaching ideas shape this method, it explores beliefs like learning by doing, picking up skills through others, and what students achieve with guidance — showing how machines help build understanding step by step. Robots stepping into roles beyond instruction come up too, especially in checking progress, giving responses, and helping keep lessons running smoothly, yet questions about fairness, personal information, and keeping teachers central stay important. Hurdles pop up around tools that fall short, educators needing more training, schools not being ready. Evidence pulled from real-world research across different countries suggests teamwork between people and robots works best when clear teaching goals and moral rules guide the way. Far from swapping out instructors, these helpers fit alongside them, adding value in classrooms shaped by digital change.

Keywords: **Educational Robotics, Co-teaching, Human–robot Interaction, AI in Education, Smart Learning Environments**

Introduction

A classroom today might include a robot standing beside the teacher. Technology now steps into lessons not as backup but as an active presence. Instead of simply assisting, machines take part in teaching moments alongside educators. This shift changes how students experience learning. Human instructors work together with robotic helpers during daily activities. These partnerships shape new ways knowledge gets shared. Some schools already use this blend of person and machine. The teamwork happens naturally, fitting into routines without disruption. Robots do not replace teachers yet they add another layer to instruction. Learning becomes a joint effort where both guide student progress. This method doesn't aim to replace teachers but to support them in ways that make teaching more efficient and engaging. Empirical studies indicate that interaction with educational robots enhances students' understanding of robotics, computer science, and problem-solving skills (Keane et al., 2020). It was also effective in playing the role of tutor in virtual teaching environments (Velentza et al., 2021). Robots are smart machines with distinct capabilities and personalities that can assist individuals with dull tasks (Mohanty et al., 2023). It has been established that programming synergistically enhances the learning of STEM subjects and that its education should begin as early as possible in school at all levels and ages (Macrides et al., 2022). Robotic teaching assistants' role is to provide new educational content in lieu of human instructors. Presence of both the human and the robot at the same time in the classroom and both engaging with the students is known as co-teachers (Rosanda et al., 2020). Social robots as teaching assistants can guide and counsel students by assisting the classroom, management and responding to arising issues (Yoshino et al., 2020).

Robots stepping into classrooms alongside teachers aren't just about new gadgets — ideas from long-standing education theories back their role. Because these approaches shape how students grasp ideas, machines work best when they team up with people instead of taking over. When guided by concepts that explain learning, robotic helpers fit naturally within lessons without overshadowing human presence. Their usefulness grows not from flashy features but from alignment with how teaching actually works. Rather than standing alone, such tools gain meaning through connection to proven methods behind student growth. What makes them effective isn't speed or novelty — it's roots in what we already know shapes understanding. Used wisely, they reflect insights from decades of classroom research more than engineering breakthroughs. Learning improves not because robots are involved, but because theory supports their thoughtful inclusion. They mirror principles seen in successful instruction, simply wearing a different face. Human-led teaching stays central, while machines follow cues drawn from educational psychology. Several learning theories provide a conceptual foundation for understanding the pedagogical value of robots in classroom settings.

Constructivist Learning Theory

Learners build knowledge by doing things themselves, especially when working within a setting that responds to their actions. Because of this, robots in shared teaching roles act more like partners than tools — inviting trial, error, and discovery. As students write code for machines, watch them move, or adjust steps after seeing results, they live through cycles of thinking and redoing. These moments of trying, pausing, then changing fit well with how people naturally make sense of new ideas. Working directly with physical systems pushes them to question guesses, notice patterns, and reshape what they believe one step at a time (Wang et al., 2020; Berenguel et al., 2016).

Social Learning Theory

Watching others helps people learn new things, especially when they copy actions during shared activities. Machines designed for schools add a fresh layer to group learning by interacting with students like partners. These devices speak, look where they are pointing, make facial expressions, and move in ways that show how tasks get done. When kids see them work through problems step by step, it sticks in their minds more easily. Sometimes, just having a robot nearby gets classmates talking, sharing ideas, working together

instead of staying quiet. Studies show these social robots boost attention and drive in kids, especially young ones plus those needing extra help at school.

Zone of Proximal Development

Right where a student struggles — yet can grow with support — is what experts call the Zone of Proximal Development. Robots step in there, giving clues, fixes, or structure based on how each child responds during lessons. Static tools stay fixed. These machines shift aid levels on the fly as pupils answer, act, react. That shifting keeps learners right inside their personal stretch zone without tipping into confusion. Teachers gain breathing room. Routine tips get handled. Energy shifts toward deeper teaching, emotional connection instead. This team-up — human plus machine — balances load while lifting both learning precision and care presence.

Cognitive Load Theory

Thinking takes effort, especially when new ideas pile up fast. Robots standing beside teachers offer steady guidance, say things the same way every time, never grow tired of answering questions. Because they repeat clearly, students feel less mental strain trying to keep up. Some minds thrive best with routines — those who learn differently, or process information in unique ways. Instead of rephrasing rules again and again, human educators gain space to shape richer lessons. Tasks that drain attention get handled quietly by machines, freeing adults to support real comprehension. Studies show this mix helps balance what brains must handle during learning (Cabibihan et al., 2013; Belpaeme et al., 2018).

Learning-by-teaching Paradigm

When students take time to teach someone else, they tend to understand things better. Instead of leading lessons, robots usually act like learners during these sessions. Pupils walk the machine through ideas, point out where it goes wrong, because speaking aloud helps them sort their thoughts. Swapping roles — learner becomes teacher — makes kids notice how they think, stay more engaged, hold on to what they learn longer. Research from Ekström and others in 2022, along with work by Cersosimo in 2024, found benefits when people instruct robots, especially in building language skills, logical thinking, tackling problems.

Human–Technology Complementarity

A shared idea across these theories: people and machines work better together. Not instead of teachers, robots boost their impact. Because machines bring steady performance, broad reach, responsive adjustments — teachers still handle empathy, moral choices, real-world nuance. Together, this mix fits modern teaching approaches where live instructors team up with smart tools. Outcomes improve. Students engage more. Evidence backs it (Belpaeme et al., 2018; Zhao & Yang, 2024).

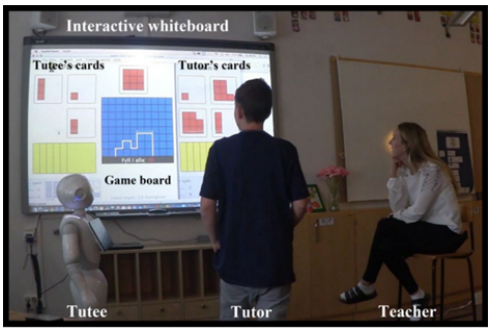

Figure 1 The Learning Activity with the Child Tutor, The Robot Tutee, and The Teacher

Robots working alongside teachers won't succeed just because the tech works well. Teacher willingness matters just as much as software or sensors. Often, it's the educator who shapes how kids interact with new tools in class. If instructors feel uneasy, see risks, or doubt their place when machines join, they might push back quietly or outright reject the idea. How comfortable a teacher feels using robotic helpers can make or break long-term classroom use. Without grasping these personal reactions — fears, pride, routine disruptions — the rollout of robot aides could stall despite strong engineering.

Teacher Attitudes and Acceptance of Educational Robots

When classrooms lack tech practice, doubt about robots grows stronger. Where teachers once used similar tools, comfort usually runs deeper. Early wins with machines tend to open doors to new teaching styles. Regions slow to adopt digital aids see steeper resistance appear. Familiarity built over time softens hesitation noticeably. Exposure shaped by local habits affects how quickly ideas spread. Trust forms faster when support arrives before problems do.

Professional Training and Pedagogical Readiness

When teachers help shape how classroom robots work, they tend to feel more prepared and invested (Pnevmatikos et al., 2022). Because of this teamwork in training, educators find it easier to match robot activities with lesson goals and student requirements. Resistance drops off as a result. Long-term use becomes more likely when the tools fit naturally into teaching practice.

Impact on Teacher Workload and Role Transformation

Still, shifting things around means educators must step into different jobs — guiding, shaping, setting up tech-powered classrooms. Far from weakening their influence, strong shared-teaching setups actually highlight the educator as the key person deciding how lessons unfold, making sense of information, grounding knowledge in real-life settings, offering support that's both human and principled (Burbank et al., 2021; Zhao & Yang, 2024).

Professional Identity and Ethical Concerns

The introduction of robots into classrooms raises important questions regarding teacher professional identity. Education is fundamentally relational, relying on trust, empathy, and moral responsibility between teachers and students. Some educators express concern that increasing reliance on robotic systems may undermine these relational dimensions or redefine teaching in overly technical terms. Ethical scholarship emphasizes that maintaining teacher professional identity requires clear boundaries between human and robotic roles. Robots should be designed and deployed to support instructional goals without assuming authority over sensitive evaluative or disciplinary decisions. Ensuring transparency in robot behavior and preserving teacher autonomy in pedagogical judgment are critical for sustaining professional identity and ethical integrity in robot-assisted classrooms (Léna et al., 2021; Singh et al., 2022).

Institutional Support and Policy Implications

A single strong robot means little without a system behind it. When policies shift slowly, teachers often set the machines aside. Training gaps show up fast in classroom routines. One misstep here, another there, then disuse follows. Real change happens only when rules, learning methods, and staff skills move together. Policy, equity, and global south perspectives in robot-assisted co-teaching

While robot-assisted co-teaching offers promising pedagogical advantages, its large-scale adoption raises critical questions related to educational policy, equity, and global accessibility. The benefits of educational robotics are not uniformly distributed, and without deliberate policy frameworks, robot-supported classrooms risk reinforcing existing educational inequalities. Addressing these broader systemic dimensions is therefore

essential for ensuring that robot-assisted co-teaching contributes to inclusive and sustainable educational development.

Educational Policy and Institutional Readiness

Effective integration of robots into classrooms requires coherent educational policies that align technological innovation with curricular goals, teacher training, and ethical standards. Many education systems currently lack clear guidelines regarding the pedagogical role of robots, assessment responsibility, data governance, and accountability. In the absence of such frameworks, schools may adopt robotic technologies in fragmented or experimental ways, limiting their long-term impact. Policy-oriented research emphasizes the need for national and institutional strategies that define robots as pedagogical support systems rather than autonomous teaching authorities. Such policies should address procurement standards, infrastructure requirements, and professional development pathways to ensure responsible and consistent implementation (Pozzi et al., 2021; Zhao & Yang, 2024).

Equity, Access, and the Digital Divide

Equitable access remains one of the most pressing challenges in robot-assisted education. Educational robots and associated infrastructure — such as reliable internet connectivity, maintenance support, and analytics platforms — are often concentrated in well-funded schools and urban regions. This uneven distribution risks widening the digital divide between students from different socioeconomic backgrounds.

Beyond shiny gadgets, learning tools often stick around only if someone can afford them. When new tech shows up in classrooms, kids with fewer resources might get left behind — Singh's team spotted this gap recently. So fairness needs to lead the way, not follow after. Price tags matter, sure, but so does how easily systems adapt to real places and lives.

Machines helping teach — that idea works better when it fits everyone, not just a few. Otherwise, one step forward becomes two steps back.

Ethical Governance and Data Protection

Robot-assisted co-teaching relies heavily on data collection, including student performance metrics, interaction logs, and behavioral indicators. Inadequate data protection policies can expose students — particularly minors — to privacy risks and misuse of personal information. Ethical governance frameworks must therefore ensure transparency in data usage, informed consent, and strict limitations on data sharing. These concerns are especially salient in contexts where regulatory frameworks for data protection are underdeveloped. Scholars argue that ethical oversight should be integrated into educational policy from the outset, rather than treated as an afterthought once technologies are deployed (Langer et al., 2023; Tolksdorf et al., 2020).

Benefits of Human Robots in Co-teaching

The pandemic of Covid-19 surprised us and made us alter our customs. The educational sector was influenced as well and academicians were made to think differently on how they could deliver their lessons. Fortunately, research in technology had reached the level of maturity in terms of the online lessons and there existed a range of hardware and software options (L. Rai, 2019). Concurrently, there was wide debate on the educational issues and challenges (M. Kebritchi et al., 2017).

Studies exploring the use of social robots in real classroom settings have revealed exciting and encouraging results. The most prevalent educational functions carried out by social robots were as students' or teachers' assistants or autonomous tutors (A. J. C. Sharkey et al., 2016). Social robots that worked as tutors managed to have identical teaching competencies with humans, particularly for limited tasks, improving simultaneously the cognitive performance of students (T. Belpaeme et al., 2018). The humanoid robot NAO

easily functioned as a university professor in a live classroom (J. Xu et al., 2014), teaching engineering principles, improving level of the students and in a few instances their learning outcome when compared to that of a human instructor. Students' interaction with a robot appears to improve their computational thinking and enable them to learn the basics of robotics and computer science (T. Keane et al., 2020). The robot has also been equally effective in playing the role of the tutor in online learning environments (Velentza et al., 2021). It is about providing new learning content (Rosanda et al., 2020). Human and robot teachers coexist in the classroom at the same time and both communicate with the students. Teaching assistants in the form of social robots can help and guide students by assisting the classroom, providing management and responding to arising issues (Yoshino et al., 2020). Artificial intelligence applied in an immense variety of systems, like smartphones, computers or robots, is increasingly encroaching on nearly all spheres of life. Education is already worried by this revolution, as is medicine or care for old individuals. Education is quite a special case, since it is essentially founded on the relation, encompassing love and feelings as much as knowledge, between a vulnerable child and an adult (Léna et al., 2021).

Challenges and Limitations in Co-Teaching with Robots

Despite the obstacles in undertaking large long-term investigations about Child-Robot Interaction (CRI), very little is known about the influence of CRI on the socio-emotional development of children. The group of empirical literature examines CRI and its influence on children's social behavior and emotional expression (Langer et al., 2023). A robot that is socially interactive not only has the ability to recognize and utilize social cues (gaze and gestures) but can also cognitively learn to remember experiences gained through social interaction and learn from it. Identification of people — i.e., with whom the robot is interacting and what and how the individual is interacting — is required so that a robot can learn and is an essential pre-condition to successful interaction (Tolksdorf et al., 2021).

The deployment of Socially Assistive Robotics (SAR) technologies also poses ethical challenges, especially in resource-poor contexts. There are various ethical challenges that arise with SAR deployment into real-world contexts; the majority of research has mostly focused on resource-rich contexts — mostly in developed countries in the "Global North" — and with respect to the educational context is limited (Singh et al., 2022). Limitations of a telepresence robot include challenges in capturing the nuances of the classroom environment necessary to evaluate, coach, or provide supervisory support. Those who use a telepresence robot must be cautioned when using a robot that could raise privacy and safety issues for children and their families, particularly for vulnerable or marginalized communities (Burbank et al., 2021). Robotics is now faced with deploying newly developed devices in human spaces, and for successful deployment and use, societal acceptance and uptake of robots is necessary (Pozzi et al., 2021). The variety, activity and interactions of the communities involved in social robotics, education, robot design and even psychology has enabled specific studies and applications addressing the dimensions previously listed. However, influential factors still need to be addressed so that robots can operate actively in education in the future. In effect, social robots have a long way to go before they reach a level of maturity in the very interactive environments of education, before they can be used in every day real environments.

Future of Co-Teaching: Towards Human–AI Synergy

Artificial Intelligence (AI) is one of the top transforming drivers, having deep implications for economic, political, and social realms, part of what has come to be known as the Fourth Industrial Revolution. Realizing AI potential, its incremental incorporation in educational environments, curricula, and pedagogical practices, step by step, comes to be more and more necessary. Co-teaching has emerged as a powerful pedagogical practice, and its integration with AI-driven robotic systems presents new opportunities for collaborative, adaptive, and personalized learning environments. Research highlights how it improves classroom instruction, sparks changes in course design, builds welcoming spaces for learners, while lifting both participation and results (Sessa et al., 2024).

Teachers working alongside digital tools find new ways to blend web-based methods with time-tested approaches: smart systems back fresh ideas in teaching, resources get used more fairly across settings, learning paths adjust to individual needs, though roles shift slightly to aid teacher growth (Zhao et al., 2024). The capacity for succeeding in the 21st century demands increasingly that the next generation of students acquire problem-solving, critical thinking, and collaborative skills. The use of technology supports the integration of many of these skills. For example, robotics, one of the many new forms of technology, engages learners and offers challenges and possibilities for learners to develop innovative ideas, critical thinking and higher-order thinking skills (Ali et al., 2023).

Conclusion

The social robots may serve as co-tutors for teaching engineering courses to students in universities such as a human co-tutor. With regard to their future activities, we propose that teachers and researchers strive to integrate social robots as co-tutors in online classes and even more significantly, capitalize on the various aspects of robots e.g., from personality characteristics, to various storytelling techniques and modes of movements (Velentza et al., 2021) to software characteristics such as voice recorder, and note taker etc. We are also following the same line of work by evaluating various robot attributes and we also have plans to try to take all the findings to actual classrooms. The co-tutored lecture in this study was cautiously structured in terms of the body of work in education and psychology regarding co-teaching. The two co-tutors had different roles, interacted with the students the same, introduced new knowledge, and provided different viewpoints of the topic. Furthermore, both co-tutor pairs successfully passed their basic knowledge from the course to the students, demonstrating that humans and robots could be productive co-teachers, especially with a fully planned lecture for co-teaching (E. Stein 2017).

While there has been increasing interest in the use of robots as teachers, there are still many areas where empirical research is lacking with regard to the long-term effects of robot-assisted education, social-emotional development and how best to optimize the roles of both teachers and robots. In particular, future research should focus on conducting longitudinal studies and using ethical design frameworks.

References

1. Keane, T., Chalmers, C., Williams, M., & Boden, M. (2020). The impact of humanoid robots on students' computational thinking. Australian Council for Computers in Education 2016 Conference: Refereed Proceedings, 93–102.
2. Velentza, A.-M., Fachantidis, N., & Pliasa, S. (2021). Which one? Choosing favorite robot after different styles of storytelling and robots' conversation. Frontiers in Robotics and AI, 8, 244. https://doi.org/10.3389/frobt.2021.700005
3. Rosanda, V., & Istenic Starcic, A. (2020). The robot in the classroom: A review of a robot role. In Emerging Technologies for Education, 347–357. https://doi.org/10.1007/978-3-030-38778-5_38
4. Yoshino, K., & Zhang, S. (2020). Evaluation of teaching assistant robot for programming classes. International Journal of Information and Education Technology, 10(5), 327–334. https://doi.org/10.18178/ijiet.2020.10.5.1384
5. Berry, C. A. (2017). Robotics education online flipping a traditional mobile robotics classroom. IEEE Frontiers in Education Conference (FIE), 1–6. https://doi.org/10.1109/FIE.2017.8190719
6. Jung, S. (2013). Experiences in developing an experimental robotics course program for undergraduate education. IEEE Transactions on Education, 56(1), 129–136. https://doi.org/10.1109/TE.2012.2213601
7. Berenguel, M., Rodríguez, F., Moreno, J. C., et al. (2016). Tools and methodologies for teaching robotics in computer science and engineering studies. Computer Applications in Engineering

Education, 24(2), 202–214.
8. Robinette, M. F., & Manseur, R. (2001). Robot-draw, an Internet-based visualization tool for robotics education. IEEE Transactions on Education, 44(1), 29–34. https://doi.org/10.1109/13.912707
9. Bower, M. (2017). Design of technology-enhanced learning: Integrating research and practice. Emerald Publishing Limited.
10. Wang, W., Coutras, C., & Zhu, M. (2020). Situated learning-based robotics education. In 2020 IEEE Frontiers in Education Conference (FIE), 1-3. https://doi.org/10.1109/FIE44824.2020.9274168
11. Martínez-Tenor, A., Cruz-Martín, A., & Fernández-Madrigal, H-A. (2019). Teaching machine learning in robotics interactively: The case of reinforcement learning with Lego® Mindstorms. Interactive Learning Environments, 27(3), 293–306. https://doi.org/10.1080/10494820.2018.1525411
12. Al Hakim, V. G., Yang, S.-H., Liyanawatta, M., Wang, J.-H., & Chen, G.-D. (2022). Robots in situated learning classrooms with immediate feedback mechanisms to improve students' learning performance. Computers & Education, 182, Article 104483. https://doi.org/10.1016/j.compedu.2022.104483
13. Xia, Y., & LeTendre, G. (2021). Robots for future classrooms: A cross-cultural validation study of "Negative Attitudes Toward Robots Scale" in the U.S. context. International Journal of Social Robotics, 13, 703–714. https://doi.org/10.1007/s12369-020-00669-2
14. Khasawneh, M. A. S. (2024). Teacher opinions on the role of educational robots in enhancing programming skills among hearing-impaired students. International Journal of Learning, Teaching and Educational Research, 23(5). https://doi.org/10.26803/ijlter.23.5.16
15. Mohanty, A., Jothi, B., Jeyasudha, J., Ranjit, P. S., Isaac, J. S., & Boopathi, S. (2023). Additive manufacturing using robotic programming. In AI-Enabled Social Robotics in Human Care Services: Advances in Computational Intelligence and Robotics (pp. 259–282). IGI Global. https://doi.org/10.4018/978-1-6684-8171-4.ch010
16. Palts, K., Inns, M., & Young, M. (2021). Programming in early childhood education: A systematic review. International Journal of Child-Computer Interaction, 28, 100302. https://doi.org/10.1016/j.ijcci.2021.100302
17. Burbank, M. D., Goldsmith, M. M., Bates, A. J., Spikner, J., et al. (2021). Teacher observations using telepresence robots: Benefits and challenges for strengthening evaluations. Journal of Educational Supervision, 4(1), 68–93. https://doi.org/10.31045/jes.4.1.6
18. Pozzi, M., Prattichizzo, D., & Malvezzi, M. (2021). Accessible educational resources for teaching and learning robotics. Robotics, 10(1), 38. https://doi.org/10.3390/robotics10010038
19. Sessa, C., & Aiello, P. (2024). Can my co-teacher be a chatbot? In ICERI2024 Proceedings (pp. 8322–8329). Seville, Spain: IATED. https://doi.org/10.21125/iceri.2024.2049
20. Zhao, L., & Yang, H. (2024). Mathematically intelligent human–computer collaborative teaching: Opportunities, challenges and countermeasures. International Educational Research, 7(3), Article 11. https://doi.org/10.30560/ier.v7n3p11
21. Ekström, S., Pareto, L., & Ljungblad, S. (2024). Teaching in a collaborative mathematic learning activity with and without a social robot. Education and Information Technologies, 30, 1301–1328. https://doi.org/10.1007/s10639-024-12926-2