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HAVAS DÁVID ANDRÁS*–BALÁZS LÁSZLÓ**

Humanoid Robots In Service At Universities

Cross-Regional Review of Humanoid Robot Adoption in Higher Education

Összefoglalás: A humanoid robotok megjelenése a felsőoktatásban, mint egy lehetséges oktatói eszköz, egyre meghatározóbb jelenséggé válik világszerte. A tanulmány betekintést nyújt ázsiai, észak-amerikai és európai példákon keresztül az egyetemeken alkalmazott humanoid robotok felhasználási céljairól és további felhasználási lehetőségeikről.
Kulcsszavak: Humanoid robot, felsőoktatás, oktatási robotika, áttekintő tanulmány.

Abstract: The emergence of humanoid robots in higher education as a potential teaching tool is becoming an increasingly significant phenomenon worldwide. This article provides insight into the current uses and emerging applications of humanoid robots in universities, drawing on examples from Asia, North America, and Europe.
Keywords: Humanoid robot, higher education, educational robotics, exploratory review.

Introduction

Imagine a three-meter-high humanoid robot coming toward you in a university corridor. The first thing you do is check for the escape route. Seriously. Where could you go if something happens? How could you help others get out? Something triggers in your survival instinct that says this is strange and not normal. Now imagine a robot the size of a small child, friendly face, approaching instead. Completely different feeling. Similar technology. Similar underlying logic. Different body. Physical appearance is not a secondary detail. It is the first thing that shapes how people react [1].

* *AI transformation consultant*
Email: havasdav@gmail.com
ORCID: 0009-0001-9000-4085

** *University of Dunaújváros, Associate Professor*
Email: balazsl@uniduna.hu
ORCID: 0000-0001-9784-4768

[1] Ekström, S.–Pareto, L. (2022): The dual role of humanoid robots in education: As didactic tools and social actors. *Education and Information Technologies,* 27., (9.), pp. 12609–12644.

[1] Masoni, I.–Pagliccia, B.–Thalmann, G. (2019): *The Use of Drones for Innovative Seismic Acquisition: A Change of Paradigm for HSE.* International Petroleum Technology Conference, Beijing, China, 26–28. March 2019.

[2] Belpaeme, T.–Kennedy, J.–Ramachandran, A.–Scassellati, B.–Tanaka, F. (2018): Social robots for education: A review. *Science Robotics,* 3., (21.), eaat5954. https://ww.science.org/doi/10.1126/scirobotics.aat5954 [Open access – Q1 AAAS]

Luckily, we are not seeing such enormous machines in universities nowadays. But the question of size, appearance and the feeling they produce in a room is real, and it matters.

What actually is a humanoid robot, and what makes the AI-enabled version different from what came before? Think of it like a moving industrial machine with the shape and size of a human, the different components, junctions, energy store and wiring are parts of the many components, only hardware. On its own it does one thing. To make this machine smart enough to respond to what is happening in its environment in the way it was purposely built for, we need to apply advanced AI technologies – not only a preprogrammed, fixed sequence of commands. The key difference between a pre-programmed industrial robot and an AI-enabled humanoid [2] lies in the capacity to respond to unexpected situations that were never anticipated in advance. Our world is very colourful, and not everything can be put into an if-then cycle. This is, in many cases, the game changer that AI brings to robotics.

The question that comes up often is simple. Why not just use a chatbot? For many tasks, honestly, a well-designed screen-based solution will do the job just as well and at a fraction of the cost. But whenever you need to move into the three-dimensional physical environment, the screen stops working. Take a physical education course. How do you learn to stand on your hands? A robot could demonstrate the movement step by step. It could observe the student attempting the exercise, see what is happening, identify which muscles need to be stronger first, and suggest a preparation plan before the student even tries the full movement. A chatbot cannot do this. Not in reality. Anything that needs to be shown and adjusted in a physical three-dimensional space – that is where the humanoid belongs [2].

Humanoid robots are not a new idea. Personal experience from 2019, in Hungary at that time, SoftBank's Pepper humanoid solution was already being discussed as a potential tool for enterprise and educational environments. However, the opportunities offered by humanoid technology were welcomed with significant doubts in many boardrooms, and a drone-based technology was rather accepted for testing than a humanoid trial. At that moment humanoid robotics simply were not able to represent established industry practices, documented use cases, a developed legal framework. The investment decision for such proofs of concept many times resulted in drones winning over humanoids. By the year 2026 such decisions look different. Many board members know that they need some kind of AI, but a type of AI that positively affects the company's EBITDA-generating capabilities.

This approach made decision makers much more open to humanoid technologies that are entering not only companies but universities as well, across very different regions.

The reason to cover multiple regions in this article is to give a global insight by showing how different cultures and universities around the world are handling this technology. Decision makers at universities who read this might start thinking about how humanoid robots could be utilised in their own institutions, in their own context, to increase student and professor satisfaction. Those countries that do not have world-wide known robotics manufacturer companies and that are not on the developer side, still can be leaders on the adoption side. It is one thing to create the tool. It is another thing entirely to know how to populate it with content and embed it properly into an educational system [3]. From that point of view, there is a real opportunity here and now.

Conceptual Framework

In 2025, a video circulated showing humanoid robots performing a kung fu demonstration for the German Chancellor during a visit to China. The machines moved like athletes. They jumped, balanced, executed precise physical sequences with speed and accuracy. Honestly, it might have been a bit of a fearful moment for many. Robots are now basically capable of doing anything. One might think the only real limitation is their energy source and consumption of the humanoid. It might simply occur to one that a robot could be much stronger than a human. What if the AI software that directs the metal humanoid body goes beyond the intended boundaries? Naturally, this is a question posed by many, and it is one of the general concerns that advanced AI robotics raises [4]. Worth keeping on the table. Because the humanoid we are talking about in 2025 is not only the small friendly Pepper anymore. That picture has changed.

On the software and training side, NVIDIA has created a special virtual environment where the driving algorithms can practise real-life situations before the robot ever enters a physical space. The cost of failure is much lower in a virtual environment. No expensive humanoid crashes into another one and causes damage.

[3] UNESCO (2021): *AI and Education: Guidance for Policy-Makers.* Paris: UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000376709 [Open access]

[4] UNESCO (2021): *Recommendation on the Ethics of Artificial Intelligence.* UNESCO General Conference, 41st Session, Paris. https://unesdoc.unesco.org/ark:/48223/pf0000381137 [Open access – 193 member states]

[2] Belpaeme, T.–Kennedy, J.–Ramachandran, A.–Scassellati, B.–Tanaka, F. (2018): Social robots for education: A review. *Science Robotics,* 3., (21.), eaat5954. https://ww.science.org/doi/10.1126/scirobotics.aat5954 [Open access – Q1 AAAS]

[5] NVIDIA (2024): Isaac Lab – GPU-Accelerated Simulation Framework for Robot Learning. *NVIDIA Developer.* https://developer.nvidia.com/isaac/lab [Open access – used by Stanford, ETH Zurich, Boston Dynamics, Figure AI]

[6] Donnermann, M.–Schaper, P.–Lugrin, B. (2022): Social robots in applied settings: A long-term study on adaptive robotic tutors in higher education. *Frontiers in Robotics and AI,* Vol. 9, 831633. https://www.frontiersin.org/journals/robotics-and-ai/articles/10.3389/frobt.2022.831633/full [Open access – Frontiers/SCIE]

No real harm to anything around. Most use cases can be tested and fine-tuned in this virtual world first, and only then brought into the three-dimensional real environment [5]. The two main advantages are physical safety, since nothing real is at risk, and cost efficiency, since virtual crashes carry no financial consequence. The fine tuning happens in the real world only after the basics are already working.

The difference between a pre-programmed robot and an AI-enabled one becomes very clear when something unexpected happens. And in a university environment, unexpected things happen all the time. It also depends on culture. In a very well organised and structured society most things are quite predictable. But as soon as you move into a less formal environment, more and more unpredictable situations occur. One can remember from his time of being a student at university that a bird flew into the classroom. Big shock. Everybody wanted to save the bird at the same time, which of course made things worse. The professor stayed calm, told everyone to settle down, opened all the windows, and in a couple of minutes the bird found its way out.

A simple example. But you simply cannot simulate everything. If you tried to program a robot for every possible situation that could happen in a university room, the storage and processing requirements would be enormous, and our own creativity might run out before we could cover all potential scenarios. An AI-enabled humanoid does not need to have foreseen every situation. It can generate a response to something it has never encountered before [2]. That is the game changer. For universities, this capacity to handle the unexpected is what opens brilliant application opportunities of humanoids as an educational tool.

How to imagine a humanoid robot at university? A robot available around the clock repeats the same explanation the thousandth time with exactly the same patience and kindness as the first [6]. For students who need to ask the same question multiple times, for students with different capabilities who need the same approach every time without any sign of frustration, this patience is a real advantage. The robot does not get tired. It does not make a student feel slow for needing repetition. Beyond the assistant role, there is another use case that is less obvious but more interesting. A student is assigned the task of teaching the robot a subject they are learning. If you are able to teach something to somebody else, you must have a much deeper understanding of it.

You have to be able to explain it with your own logic, not just recall it. It leaves a much deeper connection to the material than just reading it once [1].

The full range of use cases for humanoid robots at universities has not yet been discovered. It is simply where the technology is. When the first iPhone appeared, nobody mapped out in advance that it would become a banking terminal, a navigation device, a healthcare monitor and a social platform. The applications emerged because people found them. With humanoids at universities, the same logic applies. Currently, our creativity can be freely applied to explore how these machines could best support universities' daily operations.

Regional Overview: Asia

Asia Pacific has a long and documented history with robotics in education. Japan and South Korea were among the earliest adopters globally, and this has something to do with how these societies are organised. Japan's manufacturing approach has, for decades, been built around structured, process-based thinking. The just-in-time production system that emerged from Toyota is a good example. At its core it is a set of human-executed rules: if this happens, do this. Workers following a procedural logic long before robots existed. That kind of step-by-step algorithmic thinking is deeply embedded in the society and its institutions. The robot is, in many ways, the physical version of that same logic. From that perspective, it is understandable that Japan and South Korea were among the first to deploy robots in educational settings. Where the evidence is strongest at university level is in language learning. Robot-assisted language learning has been studied extensively in East Asia, and the findings are consistent. Students are more willing to speak, make mistakes and try again when they are interacting with a robot rather than a human teacher or a peer [7]. The reason, based on what the literature shows, is simple. There is no social judgment. The robot does not raise an eyebrow when you say something wrong. It just responds and gives you another chance. There is a warmth that a well-designed humanoid can generate, and even if the student does not know exactly what software is running in the background, that feeling of being met without judgment can matter. This is particularly relevant for students learning a foreign language, where the concern about making mistakes in front of others is a commonly cited obstacle [7].

[1] Masoni, I.–Pagliccia, B.–Thalmann, G. (2019): *The Use of Drones for Innovative Seismic Acquisition: A Change of Paradigm for HSE.* International Petroleum Technology Conference, Beijing, China, 26–28. March 2019.

[7] Huang, G.–Moore, R. K. (2023): Using social robots for language learning: are we there yet? *Journal of China Computer-Assisted Language Learning,* 3., (1.), pp. 208–230. https://www.degruyterbrill.com/document/doi/10.1515/jccall-2023-0013/html [Open access – De Gruyter]

[8] Buchem, I. (2023. June 13.): Meet Humanoid Robots NAO, FURHAT & PEPPER: An Interview with Humanoid Robots Expert Professor Ilona Buchem. *AACE Review.* https://aace.org/review/ilona-buchem/ [Open access]

Regional Overview: North America with focus on the United States of America

The United States has built a well-funded university robotics research environment, and this shows in how humanoid robots are being used and studied at university level. Stanford, MIT and Carnegie Mellon are among the institutions where significant humanoid robot research is concentrated. These institutions attract substantial investment and work in a very competitive environment. For a university leader, deploying a humanoid robot can be both a research decision and a signal about where the institution positions itself. Depending on the approach and the intention of the university leadership, humanoid robots can become a tool for improving visibility, attracting talent, and differentiating the institution in a competitive landscape.

The more interesting question is what happens outside the elite institutions. Efforts to extend access beyond flagship research centres mean that underfunded universities are increasingly encountering this technology as well. But giving the tool is not enough. It is equally important to ensure that professional robot maintainers are in place, with a full understanding of the usage opportunities and technical limitations. A clear idea of the purpose the tool will serve, and how it can be properly applied within the educational programme, is also a crucial element for embedding humanoids into the daily life of universities. If those parts are missing, the robot could become a very expensive clothes hanger. It appears in the budget books as a significant investment. But it never starts generating value because the embedding and the culture part were never addressed. This is not a hypothetical risk. It happens in industrial environments many times. Very expensive software gets purchased, but there is not enough budget left to train the operators. The same can happen with humanoids if the tool arrives to the Universities without the thinking behind it.

Regional Overview: Europe

The integration of humanoid and social robots into European university education has gained significant momentum over the past decade. Institutions such as the Berlin University of Applied Sciences (BHT), the University of Plymouth, and HU University of Applied Sciences Utrecht are among the leading pioneers in this field. At BHT, Professor Ilona Buchem has developed classroom projects utilizing NAO, Pepper, and Furhat robots to support various instructional contexts [8].

In Utrecht, the Social Robotics exchange programme introduces students to platforms including NAO, Pepper, RUBI, and Keepon [9]. At the University of Lübeck, a Pepper robot was connected to the ChatGPT large language model and deployed in a classroom setting [10]. The University of Plymouth's Centre for Robotics and Neural Systems operates with iCub, NAO, and Pepper platforms for tutoring experiments and human-robot interaction studies [11]. In France, the LAAS-CNRS laboratory at the University of Toulouse has developed the TALOS humanoid robot, with its Gepetto team focusing on anthropomorphic movement generation [12].

The robots deployed across these institutions serve a broad range of educational purposes. At BHT, NAO, Pepper, and Furhat support students in languages, mathematics, business, and project management [8]. The Utrecht programme specifically investigates how robots can assist primary school teachers and improve children's learning performance [9][13]. At the University of Lübeck, the Pepper robot guided small student groups through a subject in an interactive dialogue format, handling structured lesson delivery autonomously [10]. The LAAS-CNRS Gepetto team applies its humanoid platforms toward movement research that could form the foundation for future educational and assistive applications [12].

The recurring challenge across institutions is that current robot capabilities limit their potential role in education, due to insufficient contextualised speech recognition and a limited understanding of nuanced social interaction. Therefore, the teaching assistant role could be an initial first step for robots rather than an independent instructor role [11]. Looking ahead, researchers aim to develop more adaptive robotic tutors. The goal is to increase robots' capability of personalising their behaviour in real time. Their behaviour adjustments are tailored to individual learner profiles and emotional states [13]. The LAAS-CNRS Gepetto team is working toward equipping humanoid platforms with movement memory powered by artificial intelligence, which could eventually enable more natural and responsive educational interactions [12]. The broader consensus across these institutions is that the most effective outcomes arise from blended human-robot teaching models, where robots handle structured, repetitive tasks while human educators focus on complex and relational aspects of learning [8][10].

[8] Buchem, I. (2023. June 13.): Meet Humanoid Robots NAO, FURHAT & PEPPER: An Interview with Humanoid Robots Expert Professor Ilona Buchem. *AACE Review.* https://aace.org/review/ilona-buchem/

[9] HU University of Applied Sciences Utrecht (n.d.): *Social Robotics – Exchange Programme.* https://www.internationalhu.com/exchange-programmes/social-robotics

[10] Sievers, T. (2025): *A Humanoid Social Robot as a Teaching Assistant in the Classroom* [Preprint]. arXiv. https://arxiv.org/abs/2508.05646

[11] University of Plymouth (n.d.): *Robots Will Never Replace Teachers but Can Boost Children's Education. Centre for Robotics and Neural Systems.* https://www.plymouth.ac.uk/news/robots-will-never-replace-teachers-but-can-boost-childrens-education

[12] LAAS-CNRS (n.d.): *Robotique – Équipes de Recherche. Laboratoire d'Analyse et d'Architecture des Systèmes.* Université de Toulouse. https://www.laas.fr/fr/recherche/rob/ [Open access]

[13] Smakman, M. (2022): *Robots in Education: Implementing Robot Tutors in a Morally Justified Way.* [Doctoral dissertation, HU University of Applied Sciences Utrecht]. https://www.hu.nl/-/media/hu/documenten/onderzoek/projecten/matthijssmakman_thesis.pdf

The broader EU digital education policy context is established by the Digital Education Action Plan 2021–2027, which provides a strategic vision for high-quality, inclusive and accessible digital education across member states and calls for education systems to adapt to the digital age [14]. Building on this foundation, Europe also adopted two binding instruments in 2024 that together create a more specific regulatory framework. The first is the EU Artificial Intelligence Act, Regulation (EU) 2024/1689 [15]. The second is the Council of Europe Framework Convention on Artificial Intelligence and Human Rights, CETS No. 225 [16]. They are not the same thing, they work together, but they cover different ground [17]. European universities have to consider this legal framework when planning humanoid robot deployments. The EU AI Act takes a risk-based approach, placing every AI system into one of four categories: unacceptable risk, high risk, limited risk, and minimal risk [15]. AI systems used in education that may influence a student's access to education or their professional pathway are explicitly classified as high risk under Annex III of the Act. High risk does not mean prohibited. It means regulated. Before deployment, a conformity assessment is required. A risk management system must be in place. Data governance must be documented. Human oversight must be built in. And staff and students must have sufficient AI literacy. In practice, this can be followed by universities. These institutions are already used to operating under strict internal regulations, ISO certifications and government quality standards. The AI Act obligations – risk documentation, staff training, operational procedures – are in many cases similar to what universities are already doing for other certifications. The key is embedding the new AI-specific requirements into the existing operation manual. That is normal compliance work. It requires effort, but it is manageable. On the practical side, this approach also requires university staff and students to build AI-related knowledge. This is the competence that will be required for navigating the opportunities of an AI-shaped world. The window for deployment is open, but the compliance work must come first.

[14] European Commission (2021–2027): *Digital Education Action Plan 2021–2027.* Publications Office of the EU, Luxembourg. https://education.ec.europa.eu/focus-topics/digital-education/action-plan [Open access]

[15] European Parliament and Council of the EU (2024): Regulation (EU) 2024/1689 – Artificial Intelligence Act. *Official Journal of the European Union,* 12 July 2024. https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai [Open access]

[16] Council of Europe (2024): Framework Convention on Artificial Intelligence and Human Rights, *Democracy and the Rule of Law. Council of Europe Treaty Series* No. 225, Vilnius, 5 September 2024. https://rm.coe.int/1680afae3c [Open access]

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Barriers and Ethical Considerations

The biggest barrier is not the technology. The technology is advancing fast. The biggest barrier is what happens after the robot arrives. A humanoid robot is an expensive investment. It looks impressive in a brochure and it appears in the budget as a significant line item. Finding the right purpose and role in pedagogy will be a crucial element in embedding humanoids into university life. Universities face the same risk as any organisation that invests in technology without a clear implementation plan. The tool and the thinking behind the tool must arrive together.

On the technical side, there are real limits that the literature documents. Speech recognition accuracy remains a genuine challenge, particularly for non-standard accents [7]. The novelty effect is well documented, students are enthusiastic in the first session and noticeably less engaged by the third [6].

At the same time, a meta-analysis of 17 controlled studies confirms that educational robots produce a moderate but significantly positive effect on student learning outcomes overall, with the strongest gains observed at secondary and higher education levels [18]. These findings suggest that planning the deployment carefully, with realistic expectations, matters a lot. A robot that is available 24 hours a day and repeats the same explanation with the same patience every time can be genuinely useful. But the technical reliability needs to be there to make that value real.

Physical safety is a barrier that is easy to underestimate. A humanoid robot operating in a space with students is a different category of risk from a laptop or a projector. It moves. It has mass. If something goes wrong, the consequences are physical. In practice, the question of what happens when something goes wrong must be answered before deployment, not after.

One concern that comes up in every region is the role of the human teacher. A humanoid robot is not a replacement for a teacher. It cannot be. What the robot can do is handle the repetitive, the patient, the all-day-available parts of teaching support, freeing the human teacher to focus on what only a human can do. Keeping this in mind is important for any institution thinking about a deployment [4].

[4] UNESCO (2021): Recommendation on the Ethics of Artificial Intelligence. *UNESCO General Conference, 41st Session,* Paris. https://unesdoc.unesco.org/ark:/48223/pf0000381137 [Open access – 193 member states

[6] Donnermann, M.–Schaper, P.–Lugrin, B. (2022): Social robots in applied settings: A long-term study on adaptive robotic tutors in higher education. *Frontiers in Robotics and AI,* Vol. 9, 831633. https://www.frontiersin.org/journals/robotics-and-ai/articles/10.3389/frobt.2022.831633/full [Open access – Frontiers/SCIE]

[7] Huang, G.–Moore, R. K. (2023): Using social robots for language learning: are we there yet? *Journal of China Computer-Assisted Language Learning,* 3., (1.), pp. 208–230. https://www.degruyterbrill.com/document/doi/10.1515/jccall-2023-0013/html [Open access – De Gruyter]

[18] Wang, K. et al. (2023): The effectiveness of educational robots in improving learning outcomes: A meta-analysis. *Sustainability,* 15., (5.), pp. 46–37. https://www.mdpi.com/2071-1050/15/5/4637 [Open access – Q1 MDPI/SSCI]

Conclusions

This article set out to give a global overview of humanoid robot adoption in higher education, drawing on examples from Asia Pacific, North America and Europe. The goal was not only to document what is happening, but to show what it means for universities that have not yet decided whether and how to engage with this technology.

The argument for humanoid robots over screen-based solutions rests on the physical dimension. Anything that needs to be demonstrated, corrected and adjusted in a three-dimensional space is where the humanoid belongs. Asia, led by Japan and South Korea, has the longest deployment history, shaped by a cultural affinity with structured, process-based thinking. The strongest evidence from this region comes from language learning, where robots reduce the social pressure of making mistakes. North America has concentrated its humanoid robot research in elite institutions. Europe is active in terms of regulatory development, with a compliance framework now in place that universities must navigate before deployment. At the same time, several European universities are already running humanoid robot programmes.

Across all three regions, a consistent finding emerges. The biggest barrier to successful humanoid robot adoption is not the technology itself. It is what happens after the robot arrives. Purpose, embedding, training and institutional culture matter as much as the hardware.

Looking ahead, researchers are working toward more adaptive robotic tutors that can personalise their behaviour in real time based on individual learner profiles and emotional states. Platforms are being developed toward movement memory capabilities powered by artificial intelligence. These platforms are intended to make robot-human educational interactions far more natural and responsive.

Technology costs are falling, the regulatory framework is being implemented, and the use cases are still being discovered. The window for thoughtful, well-prepared adoption is open for all universities.