RETHINKING UNIVERSITY TEACHING WITH AI: INSTRUCTIONAL INNOVATION, IMPACTS, AND PERSPECTIVES

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ABSTRACT
Artificial intelligence (AI) is reshaping higher education, affecting not only how information is accessed but also teaching-learning processes, assessment practices and the organisational models of and universities. Adopting a narrative-argumentative, theoretical-critical approach based on a selective review of the international literature on Artificial Intelligence in Education (AIED), this paper examines AI as a lever for instructional innovation in university teaching. Drawing on the Four-Dimensional Education model, it analyses how AI can enhance knowledge, skills, character and meta-learning, and reviews the main technologies and applications (intelligent tutoring systems, learning analytics, automated feedback, generative AI and immersive environments) together with their impact on teaching processes and on the changing role of the university teacher. The ethical, social and cultural challenges raised by these tools, including algorithmic bias, data privacy, surveillance and inequalities of access, are also discussed. The paper argues that AI should not be treated as an end in itself but as a tool to be governed consciously and responsibly through teacher-mediated pedagogical designs, in order to foster permits higher-order skills and AI literacy and to support the quality and equity of university education.

KEYWORDS
artificial intelligence; higher education; university teaching; instructional innovation; AI literacy.

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1. Introduction

In recent years, artificial intelligence (AI) has established itself as one of the main drivers of transformation in contemporary society, profoundly affecting sectors such as medicine, industry, communication and, increasingly, higher education. The spread of technologies based on *machine learning, natural language processing* and neural network algorithms is helping to redefine not only the ways in which information is accessed, but also the teaching-learning processes, teaching practices and organizational models of universities (Holmes & Tuomi, 2022; Crompton & Burke, 2023; Zawacki-Richter et al., 2019).

In the academic context, AI is progressively explored as a tool for educational innovation, capable of supporting the personalization of training pathways, improving the effectiveness of assessment and expanding opportunities for inclusion (Luckin et al., 2016; Chen et al., 2020). At the same time, its dissemination raises relevant questions on a pedagogical, ethical and social level, in relation to the quality of learning, the role of teachers, data management and possible inequalities of access. The university thus finds itself at the center of a tension between opportunities for renewal and the need to critically govern the adoption of emerging technologies (UNESCO, 2021).

Numerous studies show that AI tools are now widely adopted among university students, particularly to support information search, academic writing, and content synthesis (Bughin et al., 2018; Jereb & Urh, 2024). However, in the face of this diffusion, a significant gap emerges between the actual use of technologies and the

possession of critical and conscious skills, highlighting the need to strengthen AI literacy and to integrate these tools in a structured way into university curricula (Holmes, Bialik & Fadel, 2019). This discrepancy prompts a broader reflection on the role of the university not only as a place of technological adoption, but as a space for critical and responsible training.

In this scenario, AI contributes to questioning two fundamental questions of university teaching: what to teach and how to teach. On the one hand, the increasing automation of basic cognitive tasks reduces the exclusive value of static knowledge transmission; on the other hand, the need to develop higher-order skills, such as critical thinking, problem solving, collaboration and ethical responsibility is reinforced (Center for Curriculum Redesign, 2015; Rivoltella, 2019; Nuzzaci, 2025). The university is therefore called upon to rethink its educational objectives, orienting itself towards educational models capable of integrating disciplinary knowledge, transversal skills and meta-skills.

This paper aims to analyze the role of artificial intelligence as a lever of educational innovation in higher education, highlighting its potential, applications and limitations. In particular, the impact of AI on teaching-learning processes, the main educational technologies and applications, the change in the role of the university teacher and the ethical, social and cultural implications related to its adoption are examined (Panciroli & Rivoltella, 2023; Baker & Hawn, 2021). The goal is to outline a critical and integrated vision, in which AI is not considered as an end in itself, but as a tool to be governed in a conscious and responsible way, at the service of the quality and equity of university education.

The paper adopts a narrative-argumentative theoretical-critical approach, based on a selective review of the international literature on Artificial Intelligence in Education (AIED). The analysis integrates pedagogical, technological and ethical

contributions, with the aim of building an interpretative framework useful for university teaching design.

2. New goals of higher education in the age of AI

The advent of artificial intelligence marks a significant discontinuity, at university level, in traditional teaching models. Historically, the university has had the primary task of building and transmitting disciplinary knowledge and training professionals who could virtuously enter the labor market. Today, however, this mission alone is no longer sufficient to fully fulfil its social function, and the speed of technological change, the automation of entire categories of tasks and the increasing complexity of society require a redefinition of the objectives of higher education. The university can no longer, therefore, limit itself to providing a static body of knowledge, but must become the interpreter and promoter of a continuous learning process, capable of developing critical, transversal and updatable skills over time, in such a way as to prepare students to face the complexity and changeability of the contemporary world.

The ability to access information through search engines and intelligent assistants reduces the unique value of storage. National data confirm this scenario: while almost all students use AI tools to support their studies, the ability to produce autonomous solutions remains very limited. This gap between widespread use and actual skills reinforces the need for universities to update their educational objectives, including data literacy, critical understanding of algorithms, and the ability to design intelligent applications (Holmes, Bialik & Fadel, 2019; Luckin et al., 2016; Bughin et al., 2018). Therefore, what becomes crucial is the ability of students to:

- attribute meaning to knowledge, linking it to real and interdisciplinary contexts;

- develop transferable skills, such as critical thinking, creativity, effective communication and collaboration;
- cultivating meta-skills, higher-order skills, resilience and the ability to learn continuously.

This step is consistent with the *Four-Dimensional Education model* (Center for Curriculum Redesign, 2015), which identifies four key dimensions of education:

1. *Knowledge* – the understanding of fundamental concepts and up-to-date knowledge.
2. *Skills* – the ability to apply knowledge and skills critically and creatively.
3. *Character* – the development of values, ethics, resilience and social responsibility.
4. *Meta-learning* – the awareness of one's own learning processes and adaptability to changing contexts.

Figure 1 conceptualizes the literature-informed potential of AI to enhance 4D competencies in higher education, assuming structured pedagogical mediation.

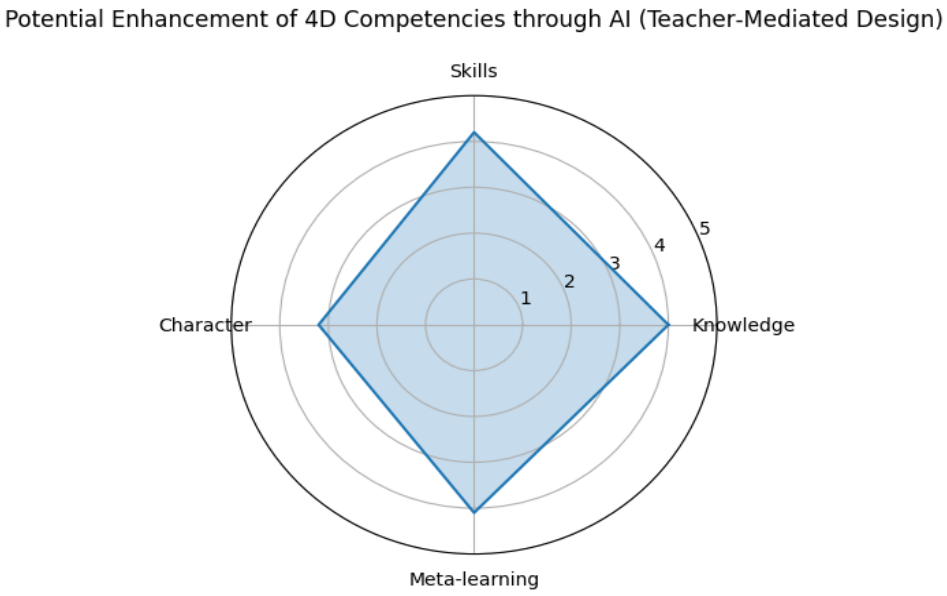


Figure 1. Potential enhancement of 4D competencies through AI (teacher-mediated university learning design).

The chart represents a literature-based exploratory scale of AI contribution to formative educational processes, emphasizing pedagogical supervision rather than technological determinism.

Table 2. Impact of AI on 4D competencies in higher education (literature-informed framework)

4D Dimension	Specific competencies enhanced by AI	How AI contributes	Key references
Knowledge	Conceptual understanding and synthesis	Support for the processing and synthesis of large academic corpora	Holmes & Tuomi (2022); Zawacki-Richter et al. (2020)
Skills	Problem solving, collaboration, academic writing	Adaptive tutoring systems, AI writing assistants, conversational agents for cognitive scaffolding	Jeon (2021); Yan (2023); Rudolph et al. (2023)
Character	Responsible use of sources, digital ethics, critical decision-making	Support for informed choices when integrated with human governance and explicit articulation of system limitations	Crompton & Burke (2023); Kasneci et al. (2023)
Meta-learning	Self-regulation, reflection, autonomy, agency, and inferential reasoning	Immediate feedback, support for reflective prompting, metacognitive monitoring	Lim et al. (2023); Chen et al. (2020); Wang et al. (2021)

As synthesized in Table 1, educational literature suggests that AI can support university students' conceptual knowledge development, applied academic skills,

ethical-responsible digital character, and meta-learning processes. Importantly, empirical research emphasizes that these gains emerge when AI is integrated through teacher-mediated designs, rather than through fully automated or unregulated implementations.

In light of the above, the university is called upon to pursue three fundamental objectives (Holmes, Bialik, & Fadel, 2019). On the economic side, it must prepare students capable of adapting to an ever-changing job market, in which digital skills, data literacy and the ability to collaborate with intelligent machines will become increasingly essential. From a civic point of view, the university is called upon to form aware citizens (Luckin, George, & Cukurova, 2022; Bertoncini, Matsushita, & Da Silva, 2025), able to understand the social and political impact of technologies and AI and to participate responsibly in democratic life. Finally, on a personal level, it must promote individual well-being, intellectual curiosity and a passion for continuous learning, elements that represent the basis of sustainable educational, professional and human growth.

These objectives cannot be achieved without a deep reflection on university teaching. In recent decades, in fact, there has been a trend to build encyclopedic lessons and curricula, full of details and information that students often quickly forget. In a context where AI is now able to manage and process huge amounts of data, it becomes necessary to redefine teaching priorities, shifting the focus from the mere accumulation of notions to the construction of critical, disciplinary, methodological, ethical and interdisciplinary skills (Bughin et al., 2018; Rivoltella, 2019; Biggs & Tang, 2011).

In this perspective, university teaching should reduce redundant content (Bughin et al., 2018) and easily automatable, such as procedures that can be carried out by software; update curricula by including new areas such as AI ethics, data literacy

and soft skills (Rivoltella, 2019); focus teaching on key concepts that enable students to interpret and connect knowledge in a critical and durable way. Only in this way will it be possible to fully exploit the potential of AI and at the same time preserve the centrality of human thought in university education.

The specific contribution of AI is to foster integrated training, in which technology and the human dimension are mutually reinforcing. The university must, therefore, ensure that students acquire:

- technical and digital skills needed to critically use AI tools;
- ethical sensitivity to understand implications such as bias, privacy and social impact;
- interdisciplinary collaboration skills, since future challenges will require the integration of scientific, humanistic and technological knowledge.

In this scenario, the university is configured as a dynamic ecosystem, where knowledge is continuously created, reworked and applied in real contexts. AI thus becomes not only an object of study, but also a tool and learning companion, capable of radically transforming the very meaning of university education.

To understand how these objectives can be translated into concrete practices, it is necessary to link pedagogical reflection to the technological tools that AI makes available and to observe how these principles find concrete application in the university reality.

Educational goals – development of transferable skills, meaningful learning, ethical responsibility – cannot be pursued solely by redefining curricula or changing content. It is a matter of integrating solutions capable of personalizing pathways, supporting continuous evaluation and promoting inclusion. In this sense, AI technologies represent not only an operational support, but real educational

mediators that allow the outlined training objectives to be shaped. The transition from theory to practice therefore implies an analysis of the operating logic of the main AI techniques and their possible applications in university contexts.

4. AI technologies and functioning for teaching

The transition from theory to practice implies an analysis of the operating logics of the main AI techniques and their possible applications in university contexts. Talking about AI does not mean evoking a mysterious or autonomous entity, but rather recalling a set of algorithms and mathematical models capable of analyzing large amounts of data, recognizing patterns, formulating predictions and adapting to new situations. This set of techniques, born from the convergence of computer science, statistics and neuroscience, translates into concrete applications that have already begun to change the way we teach and learn in universities.

One of the most popular techniques is *machine learning*, in which computers learn from data without being explicitly programmed. In educational settings, this translates into systems that observe students' interactions with teaching materials, analyze the most frequent errors, and propose targeted activities to reinforce areas of greatest difficulty. More advanced is the branch of *deep learning*, based on multi-layered artificial neural networks, which has made possible applications such as natural language recognition or the analysis of complex texts. It is thanks to these techniques that today we can have virtual assistants able to hold a conversation with the student, answer questions, correct draft essays or provide suggestions for improvement. In Italy, 76% of university students say they use AI in generative form (e.g. ChatGPT or similar tools), while 64% use it as a virtual or personal assistant (ANSA, 2025).

Natural Language Processing (NLP) represents a further crucial element for the university (Chen et al., 2020). Through natural language processing, machines are

able to read and generate text, interacting in increasingly fluid ways with humans. In academia, this translates into chatbots that accompany study, platforms that automatically correct written texts, and systems capable of analyzing the coherence of a topic or the quality of reasoning. No less important is *computer vision*, which allows images and videos to be analyzed: in a medical laboratory, for example, AI can monitor students' movements during a surgical simulation and return immediate feedback on the accuracy of procedures (Pang, Kootsookos, & Cheng, 2024).

It is useful to distinguish between *EdTech* in a broad sense and *AIED* (Artificial Intelligence in Education). While EdTech encompasses all educational technologies – from e-learning platforms to online classroom management systems – AIED refers specifically to those applications that leverage AI in the strict sense, i.e. algorithms capable of adapting, predicting, and learning from data. This distinction is essential so as not to confuse a simple digital tool (such as an electronic manual) with much more sophisticated systems, capable of dynamically interacting with students and teachers. In this sense, AI does not limit itself to offering additional technological support, but introduces a real methodological change, which makes it possible to observe and interpret students' interactions with educational platforms, identify patterns of behavior or recurring difficulties, and on the basis of these analyses propose personalized paths and immediate feedback. This is a constantly evolving process, because the algorithm progressively refines its ability to adapt as it collects new data. Then, for example, the student's interaction with a platform – a completed test, the time spent reading a text, the mistakes made in an exercise – constitutes a valuable source of information. This data is then analyzed to identify patterns, such as persistent difficulty on a given concept or propensity for certain learning styles to tackle specific tasks. Based on these analyses, personalized activities are proposed and immediate and diversified feedback is provided.

All this offers significant advantages. AI is able to support the educational intervention, following thousands of students at the same time; it can adapt learning paths to individual needs and provide instant feedback that drastically reduces the waiting time between exercise and correction and allows the realization of timely compensatory forms. However, there is no shortage of limits to its use. AI depends on the quality of the data available (if the data is biased, the algorithm's decisions will be too) and, as sophisticated as it is, it cannot replace the human relationship between teacher and student. In addition, there are the costs of implementation, which can widen the inequalities between universities with more resources and less equipped institutions.

In short, AI cannot be interpreted as an autonomous or self-referential device, it does not configure an automatic replacement of the role of the teacher, but rather a functional redefinition of it, starting from a set of powerful tools that, if used consciously, can transform university teaching by innovating its structures and design forms. Understanding how its basic technologies work is the first step towards responsible integration, capable of enhancing both the algorithmic potential and the human dimension of the educational process.

5. Concrete applications of AI in universities

If artificial intelligence technologies provide the theoretical basis, it is their practical applications that make the transformative impact on university teaching evident. In recent years, numerous higher education institutions have experimented with AI-based tools that aim to personalize learning, improve teaching efficiency, and expand the possibilities for interaction between students and faculty. Some of these tools are already widespread, while others remain in the research or experimental implementation phase, but all offer an interesting perspective on what the university of the future could look like.

One of the most developed fields is that of intelligent tutoring systems. These are software that adapt content and feedback based on student performance, functioning as personalized virtual tutors. An emblematic example is Squirrel AI, very popular in Asia, which builds individualized study paths by progressively filling the gaps of each student. In university contexts, similar tools can support the study of complex disciplines, such as mathematics or physics, accompanying the student step by step in his learning process and modulating the difficulty of the exercises in real time.

Alongside adaptive tutors we find dialogue-based systems, such as AutoTutor, capable of interacting with the student in natural language. These tools simulate a conversation with a human teacher, asking questions, suggesting avenues of reasoning and helping to construct reasoned answers. In the university they can be used to stimulate critical capacity in the humanities or to practice the resolution of complex cases in law and medicine.

Another booming sector is that of automated assessment. Platforms such as Gradescope, already used in many US universities, allow you to correct written assignments, exercises and even open-ended tests with the support of algorithms. This does not mean delegating evaluation completely to the machine, but rather speeding up processes, reducing consistency errors and offering timely and constructive feedback to students (Holmes et al., 2019; Tlili et al., 2023) in a regulatory perspective of teaching-learning processes. Similarly, tools such as Turnitin have extended their functions from detecting plagiarism to assessing the quality of the text, supporting teachers in correcting essays and theses.

Universities are also experimenting with educational chatbots and virtual assistants that answer students' questions, provide clarification on programs, or guide them in organizing the study. One of the most famous cases is Jill Watson, developed at

the Georgia Institute of Technology, initially used as a teaching assistant in online courses without students knowing they were interacting with an artificial intelligence. Today, similar chatbots are used to reduce the bureaucratic burden of teachers and ensure constant support for students, especially in courses with a large number of students.

Applications are not limited to individual support. Learning analytics tools are used to analyze large amounts of data on students' interactions with digital platforms. This makes it possible to identify early on those who risk dropping out of university or to highlight thematic areas that are particularly difficult for the majority of students. In this way, the teacher can intervene promptly with targeted support strategies, transforming the assessment from a final moment into a continuous and dynamic diagnostic and training process.

A particularly promising chapter is that of immersive experiences that integrate virtual reality (VR) and augmented reality (AR) with AI. In the medical field, for example, some universities have introduced surgical simulations in which students can practice in virtual environments, receiving automatic feedback on the precision of movements. In archaeology or art history, AI allows historical sites and works of art to be reconstructed in 3D, allowing students to explore environments that would otherwise be inaccessible.

Finally, the role of AI in fostering inclusivity and accessibility should not be underestimated. Some university platforms integrate systems that automatically transcribe lectures, translate texts into multiple languages, or offer simplified explanations for students with learning disabilities. Tools such as LearningRO or intelligent translation applications help to reduce language and cognitive barriers, opening the doors of higher education to an increasingly wide and diverse audience.

These examples show how AI is now a reality that is already transforming university teaching. The impact concerns both micro-teaching – the relationship between teacher and student – and the organizational macro-dimension, with potential benefits in terms of efficiency, personalization and inclusiveness. However, these opportunities come with complex challenges that require careful governance and deep ethical reflection. As summarized in Table 2, the impact of AI in university teaching can be analyzed through a plurality of quantitative and qualitative indicators, identified by educational research as relevant for the evaluation of technological and pedagogical effectiveness. Integrated into precise research designs, these indicators make it possible to evaluate not only performance, but also self-regulation, engagement and ethical awareness of students, ensuring the pedagogical centrality of teaching-learning processes and providing a solid conceptual and operational basis for exploratory empirical studies or *mixed-methods.*

Impact Area	Proposed Indicator	Data Type	Possible Measure Example	Pedagogical Value
Teaching Feedback	Feedback turnaround time	Quantitative	Minutes/hours/days (AI vs. teacher)	Timeliness of instructional intervention
Study Autonomy	Perception of dependence/self-efficacy	Quantitative + Qualitative	1–5 scale + open-ended comments	Student self-regulation and agency
Engagement	Rate of interactions on the platform	Quantitative	Average number of prompts/questions per session	Active participation in learning processes
Written Assessment	Correction accuracy	Quantitative	% agreement AI/teacher (inter-rater)	Reliability and grading consistency
Higher-Order Thinking	Activation of inferential processes	Qualitative	Analysis of responses to cases/problems	Quality of critical reasoning
Inclusion	Use of accessibility features (summaries, transcriptions)	Quantitative + Qualitative	% usage + perceived usefulness	Educational equity and support for students with special needs
Data Ethics	Level of concern about privacy	Quantitative + Qualitative	1–5 scale + recurring themes	Critical awareness and responsibility

Table 2. Empirical indicators of the impact of AI in higher education Empirical indicators of AI educational impact emerging from the literature

Recent systematic reviews and empirical studies indicate that AI-assisted feedback systems can enhance the immediacy and personalization of feedback, support self-regulated learning (Lan & Zhou, 2025), and increase student engagement, while also improving the quality of peer feedback processes. At the same time, educators

report productivity gains and more tailored instructional support, alongside persistent concerns related to algorithmic bias, data privacy, and the relational dimension of teaching. In particular, a systematic review of 129 peer-reviewed studies (Ba et al., 2025) shows that adaptive AI feedback—by modulating complexity and focus in real time—can positively influence learner perceptions, engagement, and learning outcomes, highlighting the potential benefits of integrating AI systems into university formative assessment processes.

To clarify how these empirical effects emerge within university teaching practices, Figure 2 illustrates a teacher-mediated AI-supported feedback loop, highlighting the role of pedagogical governance in regulating data use, feedback processes, and instructional redesign.

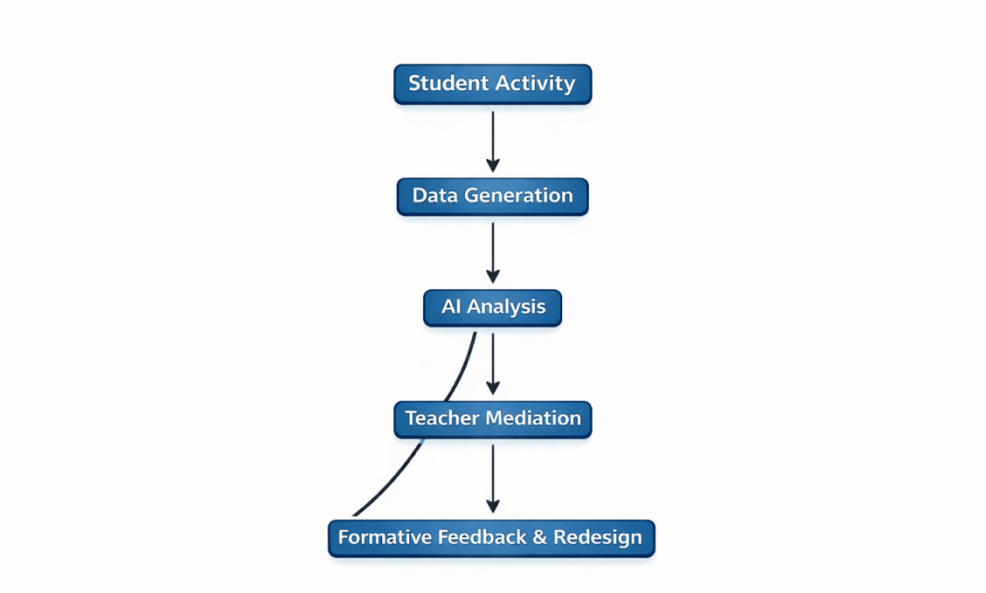


Figure 2. Teacher-mediated AI-supported formative feedback loop in higher education

The diagram illustrates a cyclical feedback process in which AI supports data analysis and adaptive feedback, while pedagogical interpretation, ethical oversight, and instructional redesign remain under teacher governance.

The model emphasizes that AI functions as a mediating tool rather than an autonomous agent, with teachers retaining responsibility for interpretation, decision-making, and ethical oversight throughout the feedback cycle.

While Figure 2 focuses on the micro-level dynamics of AI-supported formative feedback under teacher governance, Figure 3 extends this perspective by illustrating the broader methodological relationships between data inputs, AI techniques, educational outputs, and impact indicators in university teaching.

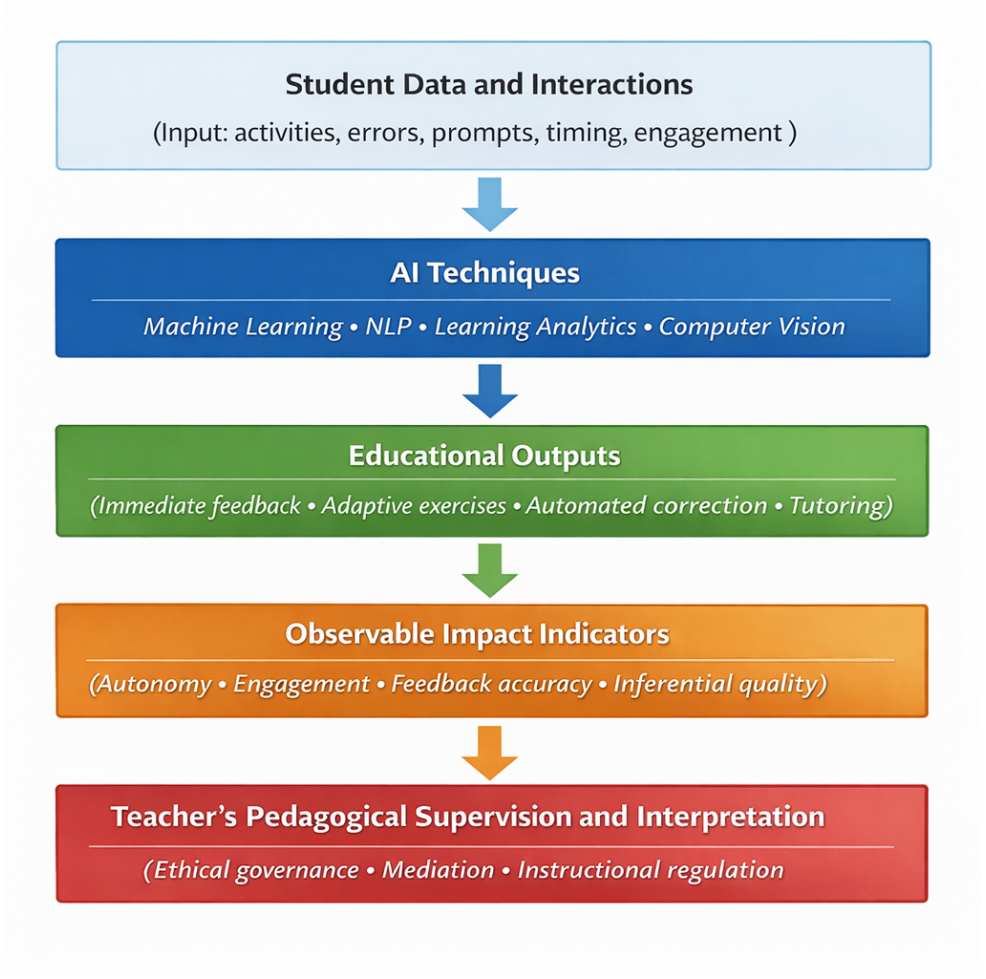


Figure 3. Methodological model of the impact of AI in university teaching

Figure 3 illustrates the methodological connection between student data inputs, core AI techniques, educational outputs, measurable impact indicators, and the essential role of teacher pedagogical supervision and mediation.

In the light of the applications described, it is clear that the impact of artificial intelligence in university teaching does not depend so much on the technology adopted, but on the alignment between tools, training objectives, cognitive levels involved and the pedagogical role assumed by the teacher.

Table 3. Relationship between AI applications and university educational objectives

AI Application	Learning Objective	Cognitive Level (Revised Bloom)	Ethical Risk	Teacher Role
Intelligent Tutors	Conceptual consolidation	Understand / Apply	Medium	Supervisor
Automated Feedback	Self-regulation	Analyze / Evaluate	Medium-High	Mediator
Generative AI	Critical thinking	Evaluate / Create	High	Critical Guide
Learning Analytics	Dropout prevention	Analyze	High	Decision-maker
VR + AI	Experiential learning	Apply / Create	Medium	Designer

Table 3 shows how the different applications of AI are located on different cognitive levels and require specific teaching roles, confirming that the pedagogical impact of AI does not depend on the technology itself, but on the methods of didactic integration.

6. Impacts and innovations in teaching processes

Taken together, these transformations redefine not only learning outcomes but also the broader societal role of higher education institutions. Against this backdrop, the following section examines how AI concretely reshapes teaching practices and instructional processes. The arrival of AI in universities is not only changing the way students learn, but it is also profoundly affecting the daily practices of teachers. For many university professors, AI has become an ally in instructional design, in the management of assessment activities and even in reflecting on their pedagogical approach. This change implies a redefinition of the profile of the teacher and his functions, which increasingly configure him as a facilitator, guide and director of learning processes, as well as as a manager of strengthening contingencies and learning processes.

One of the first areas where AI has brought innovation is the creation of educational content. Generative tools such as ChatGPT or Oboe allow you to quickly prepare tests, summary sheets, examples and exercises adapted to the level of competence

in the classroom. In some universities, history professors have experimented with the possibility of generating summaries on certain periods, accompanied by multiple-choice questions to stimulate critical understanding. In biology or medicine courses, applications such as Synthesia make it possible to produce short animated videos that illustrate complex processes, such as DNA replication, while giving students immediate visual support. This type of tool does not eliminate the creative work of the teacher, but amplifies its possibilities, reducing the time spent on repetitive tasks.

A second field of great impact is the personalization of teaching. Platforms such as Squirrel AI or Knewton analyze student learning data and propose individualized paths, identifying areas of greatest weakness and suggesting targeted activities. In college math courses, for example, one student who shows difficulty with algebra receives additional exercises and simplified explanations, while another, more advanced, is encouraged to tackle complex problems of logarithms or integral calculus. Thanks to these solutions, the teacher can manage very heterogeneous classes without sacrificing attention to individual needs.

Evaluation has also been revolutionized by AI. Systems such as Gradescope (Hansel et al., 2024) make it possible to correct hundreds of papers in a few hours, ensuring uniformity and consistency in the evaluation criteria.

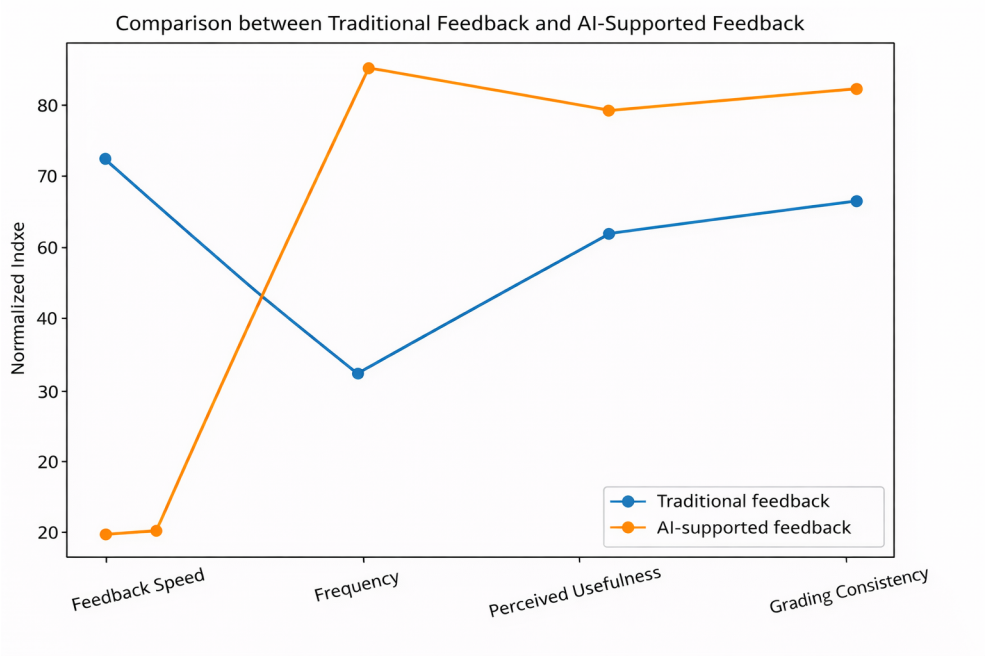


Figure 4. Conceptual comparison between traditional educational feedback and AI-supported feedback in university settings

As shown in Figure 4, comparing traditional feedback to AI-supported feedback shows significant differences in timeliness, frequency, and perceived usefulness. The representation is built on the basis of evidence from the scientific literature on formative feedback, automated assessment and AI in education (Holmes et al., 2019; Pang et al., 2024; Selwyn, 2023), and uses normalized values with an illustrative and comparative function.

The integration of AI into evaluation processes does not replace teacher judgment, but enhances its educational function, making feedback more continuous, consistent and oriented towards student self-regulation. It's all about freeing up valuable time for qualitative comments and personalized feedback. In addition, predictive tools make it possible to identify students at risk of dropping out or failing at an early stage, allowing the teacher to intervene with tutoring and targeted support. This approach transforms evaluation from a conclusive and

punitive act to a continuous process of accompaniment, in a formative key, with positive effects on both teaching and learning.

AI has also had important effects on interactive teaching. Platforms such as Wooclap and Mentimeter, which integrate AI to analyze responses and data in real time, allow teachers to modulate the lesson according to the level of understanding of the class. In a course in docimology, psychometrics or statistics, for example, the professor may propose a survey during the explanation of a complex concept: if the majority of students show difficulties, the explanation is reformulated on the spot. This makes the classroom more dynamic and participatory, reducing the distance between teacher and students.

Another innovation concerns the continuous training of teachers themselves (Antonietti et al., 2022). AI is not only a tool that serves students, but it can help educators improve their practices. Systems such as Edthena AI analyze video recordings of lectures and provide suggestions on aspects such as the time spent on explanations, the clarity of deliveries or the distribution of interactions between class members. In this way, professors receive objective, data-driven feedback, which helps them refine their methodologies.

Finally, the contribution of AI in reducing the administrative burden should not be forgotten. Tasks such as managing attendance, collecting grades, or writing statistical reports can be automated, allowing faculty to spend more time interacting with students and researching. This shift of energy is crucial to restore centrality to the human dimension of teaching, i.e. motivation and support, which cannot be replicated by an algorithm, but require time and attention from the teacher.

AI is therefore radically redefining the “job” of the university professor. If used critically and consciously, it can enrich teaching, allowing teachers to focus on activities with greater added value: accompanying, motivating and training citizens and professionals capable of facing the challenges of an increasingly complex future.

7. Ethical, social and cultural challenges

While artificial intelligence opens up fascinating prospects for universities, it also raises sensitive questions that cannot be ignored. AI-based educational technologies are not neutral, but reflect the data on which they are trained, the intentions of the designers and the conditions of use in institutions. For this reason, alongside the enthusiasm linked to innovation, a critical reflection on the social, ethical and cultural consequences of their use in academic contexts is indispensable.

One of the most discussed issues concerns algorithmic biases (Baker & Hawn, 2021; Barocas et al., 2019), as algorithms learn from historical data, risk reproducing and amplifying biases already present in society. An automatic handwriting grading system, for example, can unknowingly penalize non-native speakers, generating discrimination rather than reducing it. The same applies both to platforms that classify students based on precise learning styles and to university student profiling systems that allow the analysis of data collected on students – such as grades, class participation, interactions with digital platforms and study behaviors – to create detailed profiles of their skills, preferences and potential. AI uses machine learning algorithms to identify patterns and correlations that may not be obvious to the human eye. This makes it possible to recognize specific educational needs, identifying students at risk of dropping out or with difficulties in certain disciplines, personalizing study paths (suggesting courses, training activities or tailor-made

learning strategies), optimizing university resources, or improving the distribution of tutors, materials and supports according to the needs of students.

However, all of this is not without risk. If the starting data were incomplete or partial, the algorithms could risk rigidly labeling students, underestimating potential not yet expressed.

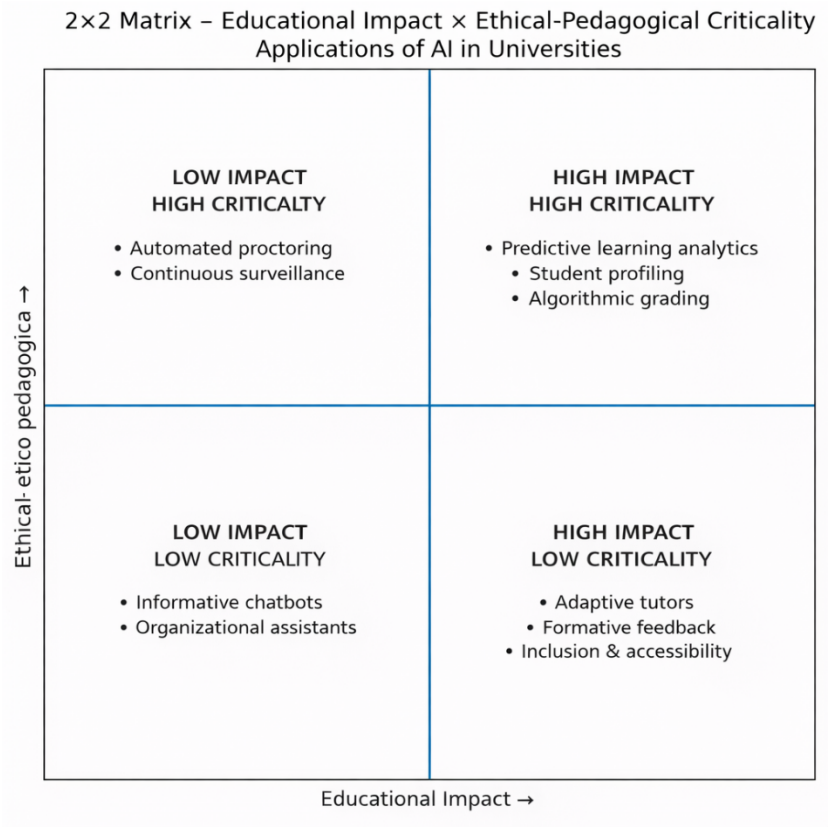


Figure 5. Conceptual matrix of the relationship between didactic impact and level of ethical-pedagogical criticality of the main applications of AI in higher education

As summarized in Figure 5, AI applications in universities can be read along two fundamental dimensions: their impact on teaching-learning processes and the level of ethical-pedagogical criticality that they entail. The matrix highlights that the solutions with the greatest impact do not necessarily coincide with those with the

greatest risk, but require more robust forms of governance, human oversight and institutional accountability. In this perspective, AI emerges as a non-neutral pedagogical device, whose value depends on the way it is integrated into educational contexts.

A second crucial issue concerns privacy, transparency of algorithms, data management, which can compromise the fairness of the process. AI-based platforms collect huge amounts of information: from test responses to time spent on an online form, to biometric and behavioral data in virtual reality contexts. Who controls this data? How long are they stored? And above all, for what purposes can they be used? The risk of sensitive data being exploited for commercial or undeclared purposes is real, and the university, in this sense, has the responsibility to ensure an ethical and secure use of information relating to its students. The protection of privacy therefore becomes not a marginal technical aspect, but a real question of educational democracy. Unsurprisingly, according to a global survey by UNESCO, less than 10% of universities have so far adopted formal guidelines on the use of generative AI, with only ~13% in Europe. (UNESCO, 2023). This aspect is also reflected in the level of knowledge: according to a survey, although 77% of Italians use AI tools, only 7% say they have an in-depth knowledge of them (La Stampa, 2025).

For this reason, it is essential that any form of AI profiling is accompanied by human supervision, bias control and continuous updating of models. Only in this way can it become an effective tool to support the individual development of students and not a limiting classification mechanism.

Another central issue concerns the role and identity of teachers. AI can automate corrections, provide explanations, and even simulate educational conversations. This generates the fear, on the part of some professors, of being reduced to simple

supervisors of algorithmic processes. The risk is real, but not inevitable. On the contrary, if well governed, AI can relieve teachers of repetitive tasks, giving them time back for activities with the highest human value: motivating, encouraging, developing relationships of trust and accompanying students in times of difficulty. This perspective is consistent with what Panciroli and Rivoltella (2023) argued, who propose an "algorithmic pedagogy" capable of critically questioning the relationship between artificial intelligence and educational processes, redefining the role of the teacher as a guide and mediator. In this line of interpretation, the university must commit itself to redefining the role of professors, valuing them as cultural and ethical mediators, as facilitators of the acquisition process, rather than as passive transmitters of content.

No less relevant is the problem of inequalities of access. Universities with high economic and technological resources can afford advanced platforms, immersive environments and virtual assistants, while others, especially in peripheral contexts or in low-income countries, risk being excluded from these changes. This scenario could accentuate the educational gap, creating a new "digital divide" between those who have access to universities enriched by AI and those who continue to move within the boundaries of use of traditional tools. In order for innovation not to become a factor of exclusion, it is necessary to promote policies of equity and universal access, including through international collaborations and the sharing of open source resources.

A further critical issue is the lack of clear regulation. There are currently no specific global guidelines for the use of AI in higher education. Without a solid regulatory framework, there is a risk of chaotic adoptions, driven more by technological trends than by real pedagogical evaluation.

AI governance in universities must involve not only professors and administrative staff, but also students, families, stakeholders and civil society, so that choices are shared and legitimized. In this sense, international cooperation that defines common standards of transparency, ethics and protection of rights is essential.

Finally, the cultural implications must be considered. The massive use of algorithmic tools can change the very idea of education, shifting the focus from the human process to the measurable result, inducing the use of quantitative indicators – such as the speed of completion of a module or the number of correct exercises – and risking neglecting essential dimensions of university education: critical thinking, creativity, responsibility, critical awareness, the ability to question certainties. A similar risk is also highlighted globally: the World Economic Forum's *Global Risks Report 2025* flags disinformation, amplified by generative AI technologies, as one of the main short-term dangers, set to grow in relevance by 2035. AI can and must become a support for these skills, not an obstacle.

AI in universities is therefore not only a technical opportunity, but a test bed for society as a whole. The ethical, social and cultural challenges that it brings with it require a conscious approach, capable of orienting technology at the service of social justice and the quality of education, as well as human dignity.

8. Future visions for university

Looking to the future of artificial intelligence in the university environment means going beyond already established applications and imagining scenarios that, although partly experimental, are rapidly taking shape. The speed with which technologies evolve requires universities not to limit themselves to a reactive attitude, but to adopt a proactive perspective: anticipating changes, guiding their implementation and governing their ethical and social effects.

One of the most discussed perspectives concerns the development of AI-based learning support systems, real digital mentors that support the student throughout the university career. Emerging perspectives concern the adoption of digital assistants available around the clock, capable of monitoring progress, suggesting personalized exercises, providing additional explanations and even remembering deadlines and goals. capable of introducing personalized support systems, operating throughout the student's entire educational path. These systems could integrate academic tutoring, motivational coaching and career guidance functions, becoming a constant bridge between students and universities. Some prototypes are already being tested and give a glimpse of a future in which learning will be increasingly continuous and personalized.

Equally promising is the idea of continuous formative assessments, which can replace traditional final exams. Thanks to the analysis of data collected throughout the course of study, AI could provide a dynamic and up-to-date picture of each student's skills. This would make it possible to evaluate not only the result of a single test, but to trace the evolution of the learning process over time, favoring a fairer and more representative approach. However, the downside is the risk of “constant surveillance” that could compromise the freedom and authenticity of the university experience.

Another strand of development concerns AI-supported collaborative learning. Through clustering algorithms and profile analysis, platforms could form groups of students balanced in skills, cognitive styles and interests, fostering more authentic and effective collaboration. This is because AI would be able to monitor interactions in group work, flagging any imbalances in participation or proposing strategies to improve team dynamics. While this optimization offers great benefits, there

remains the risk that excessive algorithmic interference will reduce the spontaneity and creativity that often characterize teamwork.

No less important is the potential of AI as an assistant for teachers. In addition to reducing the bureaucratic burden, AI can become a real-time teaching consultancy tool, suggesting teaching strategies, personalized materials or innovative methodologies based on the students' profile. The idea of a "digital co-teacher" does not replace the teacher, but amplifies his or her ability to adapt to the needs of an increasingly heterogeneous classroom.

In terms of research, AI also promises to revolutionize evidence-based teaching. By massively analyzing data from millions of teaching interactions, it will be possible to understand more precisely which teaching strategies work best, for which students and in which contexts. In this sense, the university can become a laboratory in which new learning science is produced.

Finally, the prospect of an “augmented university” is outlined, in which AI is no longer a simple external tool, but an integrated component of academic life (Kamalov et al., 2023; Barrot, 2024). This means hybrid lessons in which students interact with immersive virtual environments, digital libraries enhanced by algorithms, intelligent campuses capable of adapting spaces and resources according to the needs of users. This view is not without risks, as it exposes individuals to dependence on proprietary platforms, loss of spontaneity and widespread surveillance. On the contrary, if governed wisely, this situation that places AI at the center of educational innovation processes could make higher education more inclusive, flexible and adherent to the needs of a changing society.

In summary, the future of the university with AI appears as a terrain of open possibilities, a landscape in which personalization, collaboration and advanced

research coexist with ethical challenges and risks of inequality. The direction we take will depend on the ability of academic institutions to exercise an active, critical and responsible role, guiding technology instead of being subjected to it.

9. Perspectives and challenges of AI in higher education

The introduction of AI in higher education represents one of the most significant changes in recent decades. It acts as a catalyst for a profound transformation of educational processes, influencing objectives, contents, teaching methods and organization of university teaching practices, and inducing universities to rethink what to teach, how to do it and which skills to privilege (Luckin et al., 2016; Zawacki-Richter et al., 2024).

AI forces universities to question what is really important to teach in a world where machines can handle much of the information and procedures, and how to revamp teaching practices to make the most of the potential of students and faculty. From a content perspective, the need to go beyond encyclopedic curricula becomes evident, focusing on key concepts, transferable skills and lifelong learning skills. The university is called upon to train individuals capable not only of memorizing information, but also of critically interpreting it, dealing with complex problems and making decisions, including ethical ones, in uncertain contexts (Holmes et al., 2024; Chen et al., 2024). In this sense, AI can stimulate a broader reflection on the educational mission, favoring the integration of cognitive, social and value dimensions. From the perspective of teaching practices, AI applications show enormous potential, offering extraordinary tools — such as personalized tutoring, immediate feedback, immersive experiences and inclusion support — that free teachers from repetitive tasks and allow them to focus on the more human aspects of teaching, such as motivation, accompaniment and building meaningful relationships with students (Selwyn, 2023).

At the same time, AI helps to redefine the methodological skills of the university professor, including design, evaluation, communication, relationship, organization, management and support. Yet, technologies are not neutral: along with opportunities, concrete risks emerge, including algorithmic biases, data surveillance, access inequalities (Barocas et al., 2019; Floridi et al., 2018; UNESCO, 2023) and the risk of marginalizing the human factor.

The difference between a use of AI that impoverishes and one that enriches education depends on conscious choices, supported by clear, ethical and transparent governance, which promotes shared responsibility between teachers, students, administrative and technical staff, institutions and civil society (Barrot, 2024; Kamalov et al., 2023). For AI to truly be at the service of teaching, all actors in the university world must actively participate in this governance.

The future of the university is not determined by algorithms, but by the cultural, pedagogical, and ethical choices of academic communities.

AI can become either a shortcut to superficial learning or a strategic ally for meaningful education, capable of enhancing the quality, equity, inclusiveness, and relevance of higher education. The difference will depend on the ability to govern it consciously and responsibly. In this context, AI acts as a technological mediator of educational processes, without replacing the pedagogical responsibility of the teacher, whose role can be rethought as a guide and guardian of human centrality in education.

Universities can thus be configured as laboratories of innovation and spaces for critical experimentation, in which technology and the human dimension converge for the training of citizens and professionals capable of facing global challenges.

It is possible to outline an evolution of the university towards augmented training models, the relevance of which will depend on the ability to integrate AI without renouncing the fundamental task of cultivating higher-order skills – such as critical, hypothetical and predictive thinking – and of promoting knowledge while respecting the dignity of the human being (Luckin et al., 2016; Holmes et al., 2024).

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