EDUCATION FOR INDUSTRY 5.0: PREPARING HIGHER EDUCATION FOR SUSTAINABLE DEVELOPMENT AND AI INTEGRATION CHALLENGES

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Abstract: The transition to Industry 5.0 requires a deep alignment between technological innovation, environmental responsibility, and high-quality education. This study investigates sustainability competency, perceived barriers to AI adoption, and curricular needs among 296 respondents (91 academics and 193 students) from four European countries. Using structured questionnaires and Mann–Whitney U tests, the analysis reveals significant differences ($p < 0.001$) in favour of students regarding sustainability competency (62% familiar with the role of AI in sustainability vs. 42% of academics). Both groups report substantial barriers to AI adoption – 51.6% of academics and 60.8% of students. Academics more frequently identify curricular needs (58.2%) related to curriculum updating and AI–sustainability integration, whereas only 21.6% of students explicitly comment on these aspects. The findings point to an urgent need for curricular reform, emphasising the integration of AI into circular business models, ESG-oriented education, and practice-based training for sustainable entrepreneurship. The paper proposes concrete recommendations for higher education institutions and European policy-makers to support a coherent educational response to Industry 5.0.

Keywords: Industry 5.0; sustainability competency; AI barriers; curricular needs; sustainable entrepreneurship; ESG education

1. INTRODUCERE

Industry 5.0 is not merely a new stage in technological evolution but a profound rethinking of the relationship between economy, society, and the environment in the context of major global challenges such as climate change, resource depletion, and rising social inequalities. This paradigm calls for the advanced integration of digital technologies with

sustainability and social responsibility objectives so that economic progress becomes compatible with environmental protection and community cohesion. Within this framework, higher education plays a strategic role, as universities are expected to prepare a new generation of professionals and entrepreneurs able to use artificial intelligence (AI) not only for efficiency and innovation, but also for developing circular and responsible business models.

However, the literature highlights significant gaps between the ambitious vision of Industry 5.0 and the current state of educational and entrepreneurial practices. First, there is a clear deficit in sustainability-related competences among both students and academics, particularly regarding the connection between AI and environmental and governance objectives (ESG). Second, the adoption of AI is hindered by technical and institutional barriers such as high costs, solution complexity, lack of adequate infrastructure, and organisational resistance to change. Third, many study programmes remain anchored in traditional curricular models, with few consistent modules devoted to applied sustainability, green entrepreneurship, and the integration of AI into socially responsible business models.

This study aims to quantify these deficits and provide empirical evidence to support curricular and institutional reforms in European higher education. It focuses on three complementary dimensions: Sustainability Competency, defined as the perceived level of understanding of the role of AI in addressing sustainability challenges; Barriers to AI Adoption, capturing perceived obstacles to integrating AI into education and entrepreneurship; and Curricular Needs, referring to perceived gaps and expectations regarding the alignment of study programmes with the Industry 5.0 agenda. The sample comprises 296 respondents, including 91 university academics and 193 students from four European countries – Romania, Greece, Italy, and Poland – offering a transnational perspective on the transformations required in education for sustainability and AI.

2. THEORETICAL BACKGROUND

2.1. Industry 5.0, sustainability and ESG

The sustainability component of Industry 5.0 is closely linked to the transformation of business models and to the achievement of ESG (Environmental, Social, Governance) objectives, through the integration of emerging technologies into production, governance, and reporting processes. Asif, Searcy, and Castka (2023) show that blockchain, machine learning, artificial intelligence, digital twins, IoT, and cloud computing can respond to challenges related to traceability, customisation, retrospective reporting, and cost efficiency, provided that clear governance frameworks exist. In the same vein, Madanaguli et al. (2024) highlight the potential of AI for the design and implementation of circular business models, aimed at reducing waste, reusing resources, and creating regenerative value chains. Al Amin and Baldacci (2024) also underline the role of blockchain in reconfiguring value chains and trust mechanisms between actors, facilitating transparency and accountability in collaborative ecosystems.

From a marketing perspective, Acatrinei et al. (2025) show that the use of AI in digital strategies oriented towards sustainability can increase both the relevance of messages addressed to consumers and the engagement of stakeholders with ESG objectives, thus contributing to the strengthening of organisational reputation and to long-term commitment to social responsibility. At the same time, the literature draws attention to the risk of imbalances between the economic, social, and environmental pillars of sustainability. Leng et al. (2022) observe that Industry 5.0 initiatives tend to privilege the economic and technological components, leaving social and ecological dimensions in the background, which can generate negative effects on equity and collective well-being. On the other hand, Rame et al. (2024) and other studies oriented towards the green transition argue that Industry 5.0 can effectively contribute to reducing the ecological footprint through circular production models, resource optimisation, and the integration of ESG criteria into strategic decisions, if adequate institutional incentives and coordination mechanisms between the public, private, and academic sectors are in place.

2.2. Education for sustainability and Industry 5.0 competences

The need to adapt educational programmes to the requirements of Industry 5.0 is argued by Broo, Kaynak, and Sait (2022), who propose four major directions: lifelong learning and transdisciplinary education; understanding the impact of emerging technologies on sustainability and resilience; extending digital literacy towards data literacy; and developing communication and collaboration competences for human–intelligent-systems interaction. Competence models for the initial training of teachers in vocational and technical education support this vision, highlighting the need to explicitly integrate digital and transversal competences – adaptability, teamwork, competence-based instructional design – into teacher preparation, in order to ensure the effective transfer of these abilities to students (Ianoș & Tebeanu, 2018).

Other recent studies, such as those by Góis (2025), Mytra et al. (2021), and Koch et al. (2025), confirm the need to align university curricula with Industry 5.0 competences, especially in the fields of entrepreneurship and engineering, insisting on innovation, leadership, and systems thinking. Cotet and Balgiu (2017) propose a "constellation" model of personal capabilities – creativity, resilience, critical thinking, autonomous learning – as the core of soft skills for Industry 4.0, a model that can be extended to cover the more complex requirements of Industry 5.0, which is oriented towards the human factor. In the same direction, Balgiu et al. (2024) show that students' emotional intelligence can be systematically assessed and developed, strengthening the human-centric and collaborative dimension of new work ecosystems.

Kusetogullari et al. (2025) underline the importance of generative-AI literacy for innovation ecosystems and for new forms of entrepreneurship, including green entrepreneurship, highlighting that understanding how GenAI works is becoming a basic competence in the design of products and services. This technological literacy must, however, be complemented by ethical, transparency, and social-responsibility dimensions of AI, as well

as by skills for critical evaluation of its impact on the environment and society, as suggested by integrative competence frameworks for Industry 5.0 in education and the labour market

2.3. Barriers to AI and Industry 5.0 adoption

The literature on barriers to AI adoption and Industry 5.0 highlights a wide spectrum of social, technical, and institutional obstacles that can slow down or distort the transformation process. Lu et al. (2020) identify challenges related to acceptance, trust, and changing team dynamics, as well as the need for continuous development of employees' competences in order to cope with automation and collaboration with intelligent systems. Mukherjee, Raj, and Aggarwal (2023) emphasise costs, lack of funding, and perceived managerial risks as the main barriers to AI adoption at organisational level.

Kour, Karim, Dersin, and Venkatesh (2024) analyse the cybersecurity challenges associated with Industry 5.0 architectures, highlighting vulnerabilities linked to the integration of IoT, cloud, and edge computing, while Fitsilis et al. (2024) and Kusetogullari et al. (2025) discuss ethical issues such as lack of transparency, data security, and algorithmic bias in AI applications, including in entrepreneurship and investment decision-making. From an institutional perspective, Ghobakhloo et al. (2023) underline that achieving Industry 5.0 objectives depends on cooperation between companies, trade unions, governments, regulators, and technology providers, as well as on the existence of coherent public policies and predictable regulatory mechanisms.

Chigbu and Makapela (2025) emphasise that the integration of AI into education and the labour market depends on such policy frameworks, which support competence development, curriculum adaptation, and institutional transformation. It is noted that government interventions – through funding programmes, digital infrastructure, and regulations favourable to responsible innovation – can act as critical enablers of Industry 5.0 implementation, especially in high-technology sectors. Studies on school resilience also underline that teacher leadership is a key factor in institutions' capacity to manage change and to support deep transformation processes. Dogaru (2019) shows that teacher-leaders contribute to the creation of resilient learning communities capable of responding constructively to contextual challenges, a perspective that is relevant for understanding their role in adopting the Industry 5.0 paradigm in education.

2.4. Curricular Needs for Sustainable Entrepreneurship

Curricular reform oriented towards Industry 5.0 and sustainability presupposes a holistic approach that coherently articulates technical, ethical, economic, and social dimensions. Vyhmeister and Castane (2024) highlight the importance of transdisciplinary learning, which connects engineering, economic sciences, the environment, ethics, and communication, in order to prepare students to manage complex and interdependent systems. Research on the use of social networks and digital media in education shows that these can function both as learning tools and as spaces for the development of professional identity and collaboration competences,

thereby strengthening preparation for entrepreneurship and innovation (Oproiu, Ianoș, & Litoiu, 2019).

For sustainable entrepreneurship, specific competences are needed regarding the design and implementation of circular and regenerative business models, the use of ESG metrics and sustainability reporting, leveraging AI for resource optimisation and the identification of "green" opportunities, as well as understanding AI ethics, corporate responsibility, and the main environmental policies and regulations. Studies show that these domains are still insufficiently integrated into university curricula, which generates a gap between labour-market requirements – especially in Industry-5.0 ecosystems oriented towards the green transition – and the level of preparedness of graduates.

3. METHODOLOGY

The study uses an empirical design with both descriptive and inferential components, with the objective of comparing university academics' and students' perceptions regarding the role of artificial intelligence and Industry 5.0 in education, barriers to AI adoption, and curricular needs for sustainable entrepreneurship. The research is based on standardised online questionnaires administered to two independent groups, in which each theoretical concept was operationalised through specific items constructed in line with the relevant literature.

The first concept, Sustainability Competency, targets the level of knowledge about the role of AI in addressing sustainability challenges, in developing circular business models, and in implementing ESG criteria; it is measured through four-point Likert-type items formulated, for example, as "How familiar are you with the role of AI in addressing sustainability challenges?", based on the contributions of Madanaguli et al. (2024) and Rame et al. (2024). The second concept, Barriers to AI Adoption, captures perceived obstacles to applying AI – lack of resources, knowledge, trust, as well as security and ethical concerns – through group-differentiated questions: an open-ended item for academics ("Are there any barriers to applying AI to entrepreneurship?") and a binary (yes/no) item for students, inspired by the analyses of Lu et al. (2022) and Kour et al. (2024). Finally, the concept Curricular Needs aims to identify themes and modules considered necessary for integrating Industry 5.0 and sustainable entrepreneurship into university programmes, through open questions such as "What gaps in existing curricula would Industry 5.0 courses address?", built on the framework proposed by Broo et al. (2022).

The research was conducted in accordance with ethical standards specific to educational studies, based on the approval of an ethics committee and the informed consent of participants. Respondents were informed about the purpose of the study, the voluntary nature of participation, the way data would be processed, and their right to withdraw at any time without consequences for their academic or professional status. Anonymity was ensured by avoiding the collection of personally identifiable data, and confidentiality by secure storage of responses and restricted access limited to authorised members of the research team.

The sample consists of 296 respondents, of whom 91 are university academics and 193 are students, coming from four universities in Romania, Greece, Italy, and Poland, which gives the study a transnational coverage. Data were collected via online questionnaires administered between March and May 2025, with participation being voluntary and anonymous. Data analysis was carried out in two complementary stages using IBM SPSS v27: in a first, descriptive stage, frequencies, percentages, and measures of central tendency were computed for the Likert-scale items; in the inferential stage, non-parametric Mann–Whitney U tests for two independent groups were applied to compare academics' and students' responses. The choice of the Mann–Whitney U test was justified by the ordinal nature of the data and the absence of a normality assumption; the significance threshold was set at $\alpha = 0.05$, with reporting of U values, p values, and effect sizes.

The limitations of the study include the use of a non-probabilistic, self-selected sample, which restricts the generalisability of the conclusions to the entire population of European academics and students. In addition, relying on self-assessment may introduce perception errors through tendencies to over- or underestimate one's own competences and levels of familiarity. Cultural and structural differences between the countries included – in terms of educational systems, economic context, and pace of digital-technology adoption – could not be fully controlled and may influence the response profiles. The timing of data collection (March–May 2025), in a context of rapid development of AI, particularly generative AI, may also affect respondents' awareness levels and attitudes, while potential response bias, through over-representation of individuals already interested in AI and Industry 5.0, constitutes another limitation.

4. RESULTS

4.1. SUSTAINABILITY COMPETENCY

The descriptive analysis of sustainability competency highlights clear differences between academics and students regarding their familiarity with the role of artificial intelligence in addressing sustainability challenges. The distributions of response categories are presented in Table 1, separately for academics and students.

Table 1. Level of familiarity with the role of AI in sustainability (Sustainability Competency) among academics and students

Level of Familiarity	Faculty (n=91)	% Faculty	Students (n=193)	% Students
Very Familiar	4	4,4%	41	21,3%
Familiar	34	37,4%	79	41,0%
Slightly Familiar	37	40,7%	57	29,7%
Not Familiar	16	17,6%	16	8,3%
Total	91	100%	193	100%

Most academics are concentrated in the "Slightly familiar" and "Familiar" categories (78.1%), which mainly indicates a conceptual understanding of the role of AI in sustainability,

without consistent applied experience in projects or educational activities. The very small proportion of respondents who declare themselves “Very familiar” (4.4%) suggests that advanced expertise regarding the use of AI in ESG and circular-economy contexts is still marginal among academics. At the same time, the share of academics who consider themselves “Not familiar” (17.6%) signals the existence of a relevant segment that is still at an introductory stage, for whom topics related to Industry 5.0 and the green transition remain peripheral

Among students, the distribution is more favourable, with 62.3% declaring themselves “Familiar” or “Very familiar” with the role of AI in addressing sustainability challenges, compared with only 8.3% “Not familiar”. This structure indicates more intense exposure and a heightened sensitivity to topics related to ESG, resource optimisation, and circular economy, reflecting both the influence of the educational context and of digital media and public discourse on the green transition. Overall, the results presented in Table 1 outline an intergenerational gap: academics have a conceptual base with limited practical depth, whereas students display a higher level of familiarity and a stronger orientation towards applying AI in the field of sustainability.

Beyond the descriptive profile, the inferential analysis statistically confirms the differences between the two groups regarding Sustainability Competency. The Mann–Whitney U test for independent samples yielded a U value of 5386.5 and a significance level of $p = 0.000093$ ($p < 0.001$), indicating a highly significant difference between academics’ and students’ scores. The effect size ($r = 0.38$) falls in the medium–large range and suggests that this difference is practically meaningful, not only statistically significant. Students thus exhibit a significantly higher level of sustainability competency than academics, which justifies targeted continuous-training programmes for academics focused on integrating AI and ESG principles into the curriculum and teaching practice

4.2 BARRIERS TO AI ADOPTION

To identify barriers to the adoption of artificial intelligence, items differentiated by group but operationalised in a binary way (yes/no) were used. For academics, an open-ended item asked about anticipated or current challenges in integrating Industry 5.0, AI, and sustainability practices into teaching, with responses subsequently coded into two categories: explicit mention of at least one barrier or absence of such a reference. For students, the barrier was investigated through a direct item (“Are there any barriers to applying AI to entrepreneurship?”) with “Yes” or “No” responses. The distribution of responses is summarised in Table 2.

Table 2. Proportion of academics and students who perceive barriers to applying AI

Category	Faculty (n=91)	% Faculty	Students (n=193)	% Students
Perceived barrier / Yes	47	51,6%	118	60,8%
No barrier/ No	44	48,4%	76	39,2%

Total	91	100%	193	100%

The analysis shows that approximately half of academics (51.6%) explicitly mention barriers to integrating AI, Industry 5.0, or sustainability into teaching, while 48.4% do not indicate specific obstacles. Barriers extracted from textual responses frequently refer to lack of specific training in AI, insufficient technical and digital resources, lack of time for training and experimentation, reluctance to adopt new technologies, the conceptual complexity of Industry 5.0, and the difficulty of adapting traditional teaching methods.

These elements suggest that academics perceive both institutional barriers (limited resources, rigid policies) and personal ones (insecurity, lack of advanced competences), which may slow down the pace of curricular and pedagogical transformation.

Among students, 60.8% state that there are barriers to using AI in entrepreneurship, while 39.2% do not perceive such obstacles. Open comments indicate as main barriers the lack of specific technical competences, limited access to advanced AI tools, concerns about ethics and algorithmic bias, the high costs of technological solutions, and the absence of sustained practical guidance.

Compared with academics, students seem more aware of the concrete difficulties of applying AI in real projects, which reflects stronger involvement in the actual use of these tools and a more nuanced perception of the associated risks and limitations.

To test group differences in barrier perception, responses were harmonised on a binary scale (0 = no barriers mentioned, 1 = barriers mentioned) and analysed using the Mann–Whitney U test. The results indicate a U value of 4501.0 and a p-value of 0.042 ($p < 0.05$), evidencing a statistically significant difference between academics and students.

In practical terms, students tend to report barriers more frequently than academics, which can be interpreted as an effect of their direct exposure to attempts to use AI in projects and entrepreneurial contexts.

Although moderate in magnitude, the difference confirms that both groups face real obstacles in adopting AI, but students perceive them more acutely and associate them with technical, ethical, and financial dimensions – an aspect that should be considered when designing educational interventions.

4.3 CURRICULAR NEEDS

Curricular needs were investigated through open-ended items formulated differently for the two categories of respondents. For faculty, the question "What gaps in existing curricula would Industry 5.0 and sustainable entrepreneurship courses address?" aimed to identify perceived shortcomings in current study programmes, whereas for students, comments from the open section "If you have any additional comments, please share them below…" were analysed, coding those responses that explicitly signalled curricular needs, gaps, or expectations. Responses were classified into two categories – "Mentioned" (at least one curricular need indicated) and "Not mentioned" – and distributions are shown in Table 3.

Table 3. Proportion of faculty and students who explicitly mention curricular needs.

Category	Faculty (n=91)	% Faculty	Students (n=193)	% Students
Need mentioned	53	58,2%	42	21,6%
No need mentioned	38	41,8%	152	78,4%
Total	91	100%	193	100%

The results show that 58.2% of faculty explicitly indicate at least one curricular need, while 41.8% do not formulate such observations.

Qualitative analysis reveals several recurring directions: the need to integrate artificial intelligence into academic programmes as a transversal theme rather than as an isolated course; strengthening interdisciplinarity by connecting AI, entrepreneurship, sustainability, and engineering within an integrated perspective; developing applied content based on digital laboratories, practical projects, and real case studies; introducing practical modules, micro-credentials, and flexible, competence-oriented learning formats; updating outdated content that no longer reflects the Industry 5.0 paradigm; and systematically including courses on green and ESG competences.

This profile suggests that faculty have a high level of awareness regarding the need for curricular modernisation and see themselves as potential actors of reform, provided that adequate resources and training opportunities are available.

By contrast, only 21.6% of students explicitly mention curricular needs in open comments, while 78.4% do not formulate such observations. This situation can be explained, on the one hand, by the fact that the item did not directly ask about the curriculum and comments were optional, and, on the other hand, by the limited knowledge many students have about curricular architecture and the processes through which it is designed.

Where needs are expressed, they mainly concern the desire for more practice in using AI, access to real tools and sandboxes, courses dedicated to AI in entrepreneurship, explicit links between AI and sustainability, projects conducted in collaboration with industry partners, and training on AI ethics and algorithmic bias.

Thus, while faculty formulate primarily structural and strategic needs, students focus on applied components and contact with the real world.

Comparing the two groups reveals complementary profiles of curricular needs: faculty identify, to a significantly greater extent, systemic reform needs, whereas students mainly express expectations related to practice, projects, and connections with the professional environment. These differences are summarised in Table 4.

Table 4. Comparison of curricular-needs profiles between faculty and students

Aspect	Faculty	Students
Awareness of curricular needs	58.2% explicitly mention needs	21.6% mention needs in comments
Type of needs	Systemic, structural (curriculum, interdisciplinarity, resources)	Pragmatic, applied (practice, projects, people from industry)
Implication	Faculty are ready to support reform but need resources	Students need guidance and facilitated access to opportunities

Faculty describe shortcomings at the level of curricular structure, interdisciplinarity, resources, and content updating, suggesting that they are aware of the necessity to align study programmes with Industry 5.0 competences and sustainability objectives. Students, in turn, signal needs related to concrete learning experiences – effective use of AI tools, projects with industry partners, clarification of the link between AI, sustainability, and entrepreneurship – reflecting their pragmatic perspective on curriculum usefulness. Overall, the results suggest that reforming the curriculum towards Industry 5.0 and sustainable entrepreneurship must be simultaneously top-down and bottom-up: faculty can act as change agents at the level of curricular design and institutional strategy, while students' feedback and experiences are essential for configuring relevant, practice-oriented modules anchored in labour-market realities.

5. DISCUSSION

5.1. Summary of findings

The results highlight three major directions in the transition of university education towards Industry 5.0 and sustainable entrepreneurship.

First, there is a clear gap in sustainability competency: students report significantly higher levels of familiarity with the role of AI in addressing ESG challenges, whereas faculty are predominantly at a medium, mainly conceptual level. These differences are confirmed both descriptively, through the higher proportions of students in the "Familiar" and "Very familiar" categories, and inferentially, through a medium–large effect size.

Second, both groups perceive important barriers to AI adoption (51.6% of faculty and 60.8% of students), but students tend to report them more frequently, stressing technical, ethical, and resource-related aspects, while faculty emphasise lack of training, infrastructure deficits, and the conceptual complexity of Industry 5.0.

Third, faculty identify, in a high proportion, structural curricular needs related to the integration of AI, sustainability, and interdisciplinarity, whereas students mainly express applied needs oriented towards practice, projects, and collaboration with the socio-economic environment (58.2% of faculty vs. 21.6% of students).

5.2. Implications for educational and institutional policy

From the perspective of higher education institutions, the results suggest the need for urgent curricular reform that systematically integrates AI, sustainability, and entrepreneurship as transversal themes, rather than as isolated modules. Faculty emerge as key actors of this transformation, but they require consistent professional-development programmes focused on digital competences, the use of AI in instructional design, understanding ESG, and ethical data management.

The results also indicate that the transition towards Industry 5.0 and sustainable entrepreneurship requires both intelligent technological support for career guidance and the strengthening of faculty's role as change leaders. The proposal by Stănică, Hainagiu, Neagu, Litoiu, and Dascălu (2022) for a smart career profiler illustrates how AI-based systems can personalise educational and career pathways for pupils and students, contributing to better-informed career decisions. At the same time, Dogaru's (2019) study shows that teacher leadership is essential for developing school resilience and for institutions' capacity to sustain deep transformation processes, indicating that intelligent technologies must be accompanied by the development of educational-leadership competences in order to produce sustainable change.

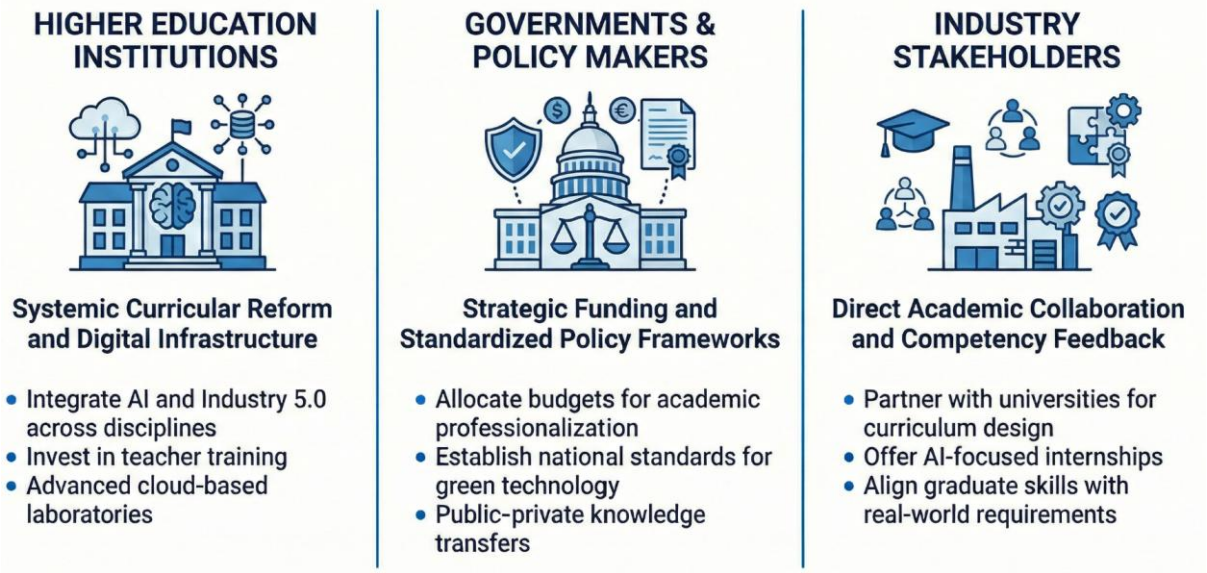

Figure 1. Strategic alignment for Industry 5.0. A Tripartite Framework

Curricular reforms should be accompanied by investments in digital infrastructure – access to AI tools, cloud platforms, virtual laboratories – as well as by institutional mechanisms that recognise and reward innovative integration of Industry 5.0 in teaching practice. At the same time, collaboration with the economic sector and with organisations involved in the green transition can accelerate knowledge transfer and create authentic contexts for developing students' competences

At the level of public policies, the results point to the importance of financial and regulatory support for curriculum modernisation and for the professionalisation of faculty in AI

and sustainability. National and European funding programmes can support the development of centres of excellence, university–industry partnerships, and co-created curricular initiatives oriented towards Industry 5.0 and ESG objectives. In addition, the development of competence standards for AI and sustainability, integrated into qualification frameworks, could facilitate the alignment of educational provision with labour-market demands and provide a common benchmark for institutions.

5.3. Limitations and future research

The methodological limitations of the study – a non-probabilistic, self-selected sample, reliance on self-assessment, and the influence of cultural differences between participating countries – call for caution in generalising the results to the entire European context. The timing of data collection, in a period of rapid development of generative AI, may also influence respondents' levels of awareness and reported attitudes. However, these limitations open fertile avenues for future research, such as longitudinal studies tracking the evolution of competences and perceptions after training interventions, in-depth qualitative analyses of curricular-reform processes in different universities, or systematic cross-cultural comparisons between educational systems. Extending investigations to other actors – institutional decision-makers, industry partners, non-governmental organisations – would allow a more comprehensive understanding of the conditions required for the effective integration of AI and sustainability into education for Industry 5.0.

6. CONCLUSIONS

The study shows that the transition towards Industry 5.0, understood as a combination of artificial intelligence, sustainability, and social responsibility, is primarily an educational and institutional challenge. The results indicate that students display a higher level of sustainability competency and greater familiarity with the role of AI in achieving ESG objectives and developing circular business models, whereas faculty are predominantly at a conceptual stage, with limited practical integration. At the same time, both faculty and students perceive real barriers to AI adoption – technical, ethical, financial, and institutional – but students report them more frequently and in a more nuanced way, reflecting their direct experience with these technologies.

Faculty contributions emerge as essential for defining and implementing the required curricular reforms, as they identify, to a significant extent, structural gaps related to the integration of AI, sustainability, and interdisciplinarity into study programmes. Students, for their part, stress the need for practical opportunities, projects with industry partners, and training in AI ethics and algorithmic bias, suggesting that effective reforms must combine the strategic perspective of faculty with the applied expectations of the direct beneficiaries of the educational process. From this perspective, transforming the curriculum in line with Industry 5.0 cannot be reduced to adding new courses; it requires a transversal rethinking of learning experiences,

human–AI collaboration, and the ways in which competences for sustainable entrepreneurship are developed.

The findings support the need for a set of convergent measures in the short, medium, and long term. In the short term, priority should be given to continuous-training programmes and micro-credentials for faculty in AI, sustainability, and digital ethics, as well as to the creation of working groups for curricular co-design. In the medium term, curriculum redesign is needed through the integration of AI and ESG objectives into existing disciplines, the development of digital laboratories and interdisciplinary projects, and the strengthening of partnerships with the economic sector. In the long term, establishing centres of excellence for Industry 5.0 and sustainable entrepreneurship, together with educational policies and accreditation mechanisms aligned with emerging competences, can ensure the coherence and sustainability of the transformation. Without such coordinated initiatives, higher education institutions risk falling behind the pace of technological and social change, losing their capacity to educate the generations that should lead the transition towards a green and human-centric economy.

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