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It's a Global Issue: AI, Digital Transformation, and Governance - Mapping the Landscape for the Future of the Higher Education Communities

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Abstract

The development of AI, at an above-benchmark pace, has become a worldwide worrying issue and a central narrative in the tertiary level learning institutions. Digital transformation, on the other hand, is updating the educational systems, which necessitates effective governance to steer these improvements. This paper provides an integrated overview of these three pillars – AI, digital transformation, and governance – and explores their interplay in reshaping the landscape of higher education. Drawing on key insights from the EUNIS 2024 conference and recent global studies, the paper examines AI's transformative potential in optimizing learning and administration, the role of digital transformation in enabling scalable and innovative educational services, and the urgent need for governance frameworks to ensure ethical, equitable, and sustainable practices. The analysis highlights current gaps, such as the lagging development of regulatory frameworks amid rapid tech progress, and it sheds light on emerging needs, barriers, and innovations (including the use of AI and XR in teaching and learning, strategies for digital readiness, and models for ethical leadership). The argument provided by AI, digital transformation, and governance is of particular interest, which justifies the need for a Global Compact on AI in education that would foster international collaboration and standards. This all-encompassing tracking and mapping of trends, challenges, and opportunities provides higher education institutions a blueprint for strategic decision-making concerning technological integration and guides policymakers in reforming higher learning education.

1 Introduction

Integrating Artificial Intelligence (AI), digital transformation (DT or DX), and governance (GOV) in Higher Education (HE) are hot topics at every educational conference and summit worldwide. Higher Education Institutions (HEIs) worldwide are implementing AI-powered tools to improve teaching, streamline administration, and improve student experiences, while digital transformation is redefining how institutions manage data, optimize learning environments, and foster global collaboration (Bates et al., 2020; Crompton & Burke, 2023). Many studies show that rapid advances in AI, DT and GOV are radically reshaping the landscape of HE at both the European and global levels and that the rate of these developments is much faster than the rate of development and establishment of the necessary regulatory frameworks. As a result, these advancements bring new challenges, particularly in terms of governance (Pedro et al., 2019; European Commission, 2019; Bates et al., 2020; UNESCO, 2020; EDUCAUSE, 2020; Sanchez-Carrillo et al., 2021; EDUCAUSE, 2024; EDUCAUSE, 2024).

AI, digital transformation, and governance - were also major topics during the EUNIS 2024, highlighting their growing relevance to shaping the higher education landscape (Roussos et al., 2025). Among others, those discussions during the conference emphasized the importance of successfully managing AI when executing digital transformation initiatives and the requirement for a unique

governance framework. In the Chat-GPT and DeepSeek era, this paper builds on these discussions but also expands based on research on global trends about AI in HE and analyzing how HEIs can adapt to these developments while maintaining ethical standards and fostering inclusive innovation.

2 The context & Problem Statement

AI technology evolves faster than rules, resulting in governance, ethics, and data security gaps (Neumann et al., 2023). The higher education community is still seeking common ground on how AI should and should not be utilized for learning, and employment, etc. (EDUCAUSE, 2024). Year after year, the growing digital divide due to the uneven adoption of emerging technologies like AI further exacerbates these challenges and is becoming increasingly noticeable (Aithal & Aithal, 2023).

For instance, in education, the applications of AI in grading, admissions, and attendance raise concerns about bias and fairness. Without unified governance, institutions implement different policies, resulting in discrepancies in the implementation of AI and its control (Filgueiras, 2024; Roussos et al., 2025). This study aims to show that global cooperation and better rules are needed to align technology with long-term educational goals. Additionally, the study aims to map the current landscape of AI, DT and GOV in HE, presenting key insights from the EUNIS 2024 proceedings and mostly recent global literature. While our study acts as a background, overview and positioning paper, it also proposes actionable steps for HEIs to adapt to and fully leverage these technologies, emphasizing the importance of rapid adoption and sustainable practices to meet future demands. Specifically, this will address three main questions:

- **New Changes and Governance Response**: Which trends in AI and digital transformation appear to have the most significant impact on higher education, and how do these rapid developments require the modification of governance frameworks?
- **Using AI for Innovation Equity:** How can higher education institutions exploit AI and other digital technologies to provide quality teaching, learning, and administrative services while achieving equity, academic integrity, and data protection?
- **Global Working Together and Policies:** What international efforts and their policy frameworks should be put in place for the satisfactory ethical and sustainable use of AI in education at all levels across the globe?

3 Background and Related Literature

This section provides an overview of AI, digital transformation, and governance in higher education landscape, drawing insights from EUNIS 2024 and global literature. This section discusses existing studies to understand how these technologies are reshaping teaching and learning environments, supplemented by administrative processes.

This section also highlights opportunities for AI to drive personalized learning and efficiency, while addressing ethical, regulatory, and infrastructure challenges. Finally, it elaborates on governance frameworks for ensuring ethical AI implementations, data privacy, and equitable access to digital resources. Synthesizing recent research and industry reports, this review sets the stage for more refined exploration into the challenges and best practices for AI and digital transformation in higher education.

3.1 AI in Higher Education

Artificial Intelligence or AI refers to the simulated human intelligence in machines or computers that are programmed to undertake tasks usually thought to require human cognitive processes and

decision-making capabilities (EDUCAUSE, 2024). AI has been in use in HE for some time, and common uses of AI span across the campus including personalized learning, virtual assistants and chatbots, learning analytics, grading, language translation, content and syllabus creation, research, and the admissions process (EDUCAUSE, 2024).

It is clear, world over, that AI innovations are shaping and continue shaping the world of higher education just as they are shaping the rest of life. With the advent of the new era of the generative AI, the world of higher education is witnessing revolutionizing transformation toward more personalized and efficient education processes. Both the capability of AI for the development of more engaging learning environments and the challenge of the need for regulations for the ethical use of AI are addressed by (Michel-Villarreal et al., 2023). AI capability for enhancing administrative and education delivery efficiency and the likelihood that the institutions are going to become more flexible are addressed by (Crompton & Burke, 2023). Along with it, the implementation of AI tools such as ChatGPT marks a dramatic shift away from traditional teacher roles toward more guiding and supportive roles with the objective of maximizing personalized learning experiences (Aithal & Aithal, 2023). The shift however, comes with challenges of academic integrity, new assessment methods, and the management of digital transformation processes (Filgueiras, 2024).

The studies by (Crompton & Burke, 2023; Chan, 2023) emphasizes the necessity of adapting instruction and assessment methods to uphold integrity while effectively using AI for education. Along with it, the capability of AI to give feedback and assessment at the point of need can revolutionize student assessment and education management procedures with more tailored learning experiences for the student (Michel-Villarreal et al., 2023). The above advancements underscore the need for HEIs to seek mechanisms of effectively integrating AI technology while at the same time coping with the possibilities of the ensuing risks and ethical consequences it entails (Aithal & Aithal, 2023; Michel-Villarreal et al., 2023; Roussos et al., 2025)

Numerous papers from the EUNIS 2024 conference proceedings demonstrate AI's capability to streamline processes and enhance efficiency. For example, (Gilch et al., 2025) showed how well technologies like the AI Module Matcher and Chatbot enabled student mobility and can lower the administrative load and increase the institutional interoperability. Similarly, another worth mentioning research by (Orel & Bajić, 2025) leveraged convolutional neural networks (CNN) to enhance digital student cards, enabling more secure identification and seamless user experiences. Notably, the role of AI extends to academic operations, as (Kivimaki et al., 2025) highlighted, who introduced a curriculum-based course scheduling system that optimizes resource allocation while addressing logistical challenges.

Concerning the governance applications of AI are also emerging. For example, (Bouras et al., 2025) discussed tools that automate reporting and grading in research monitoring systems, significantly improving decision-making processes and one additional application comes from (Radas et al., 2025) presented the UniGPT, a large on-premise language model tailored for university-specific applications, illustrating the potential of customized AI solutions for HEIs.

Except for those studies, we also have the fast incorporation of Extended Reality (XR) and AI into HEIs, which is also a critical component of digital transformation, impacting the method and quality of teaching, and also governance practices (Ilić et al., 2021) Why? When XR technologies like Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) are combined with AI, they provide dynamic, adaptable learning environments. The inclusion of these technologies presents substantial governance concerns too so HEIs must also adopt strong policies to address data privacy, security, and ethical concerns related to AI and XR.

3.2 Digital Transformation in Higher Education

Many argue, and not without reason, that digital transformation is the cornerstone of HEIs' modernization because it can certainly create scalable, robust, resilient, stable, and sustainable

infrastructures to meet the evolving demands of institutions worldwide. However, what is the real definition and meaning of DT? Digital transformation is "a series of deep and coordinated culture, workforce, and technology shifts that enable new educational and operating models and transform an institution's operations, strategic directions, and value proposition" (EDUCAUSE, 2020).

For instance, previous studies have demonstrated the critical importance of cloud migration, as explored by (Geßner et al., 2025) who showed the challenges and successes of the transition of federal educational infrastructures to the cloud. Among other things, their findings highlight the importance of collaboration and scalability during such transitions. Another study by (Dittrich et al., 2025) highlighted the value of multi-source and IT collaboration to promote digital ecosystems that optimize resource use.

Continuing to keep digital transformation in mind, energy-efficient technologies are increasingly an integral part of digital transformation strategies. For example, (Roussos et al., 2025) presented the implementation of LoRaWAN to improve campus connectivity while achieving sustainability goals according to the University's and the European practices. DT also supports lifelong learning as highlighted very specifically by (Fridell et al., 2025) who demonstrated integrating educational data into the One-Off Technical System (OOTS) via EMREX, streamlining data access and improving inter-institutional collaboration. (Vangen & Haugen, 2025) in turn further highlighted the role of national registries in managing lifelong learning infrastructures, providing centralized and efficient access to educational records.

An additional important contribution was made by (Roussos et al., 2025) who demonstrated the importance of leadership in the context of digital transformation, emphasizing the need for vision, adaptability and stakeholder collaboration to ensure smooth and effective transitions. Complementing this again at the conference, (Maltusch & Suominen, 2023) introduced in a very efficient way the Higher Education Capability Model (HERM) as a structured approach to managing DT in HEIs. Their model integrates business capabilities, data reporting frameworks and value stream mapping to provide institutional leaders with strategic and operational insights. The HERM framework aligns the technology infrastructure with organizational strategy, ensuring that digital transformation efforts are data-driven and sustainable.

Similarly, the National Education Lab AI (NOLAI) highlights a best practice example of how responsible AI applications can enable effective management of digital transformation in education (Kennisnet & SURF, 2021). The NOLAI project, which incorporates ethics in the ethics of the development of tools, fits the values of leadership and adaptability presented by (Roussos et al., 2025). NOLAI is an initiative that focuses on embedding and applying ethical considerations to AI technologies, empowering educational practices and instilling trust in these technologies through respect for data privacy, human agency, and equality in their development. Further, it illustrates how governance frameworks can go beyond conventional enterprise architecture to integrate ethical dimensions in technology, with this work being a jointly led effort among schools, scientists, as well as tech companies (European Commission, 2019; Directorate-General for Education, Youth, Sport and Culture (European Commission), 2022; Molenaar, 2022).

DT is a long-term process, but with a clear approach, organizations can grasp the complexity and consequences of the changes it may introduce. In fact, very few organizations have a cohesive view of their entire functions (Maltusch & Suominen, 2023). Enterprise architecture as a discipline may assist in creating the holistic approach down by employing used practices, but document something in an easily mapped and portable coherent manner between services, functions, and collaborate sides (e.g., with other partners in the alliance) and pursue a structure. The corresponding HERM and NOLAI insights into the use of the tool can serve as multiple excellent examples of capability frameworks in use, beneficial for considering impacts across functions in a variety of HEIs.

3.3 Governance in Higher Education

Governance (GOV) frameworks play a pivotal role to ensure the success of AI and DT initiatives. Seminal contributions have highlighted the necessity of adopting FAIR (Findable, Accessible, Interoperable, Reusable) principles, as advocated by (Kesäniemi et al., 2025), to enhance data interoperability and align with international standards. Governance should also address the ethical implications of AI a challenge explored at EUNIS by (Dittrich et al., 2025) who emphasized the importance of transparency, bias mitigation, and stakeholder trust. Sustainability also remains a pressing concern within governance and regarding that (Harjuniemi & Tenhunen, 2025) proposed a process-oriented approach for long-term research data management, ensuring that sustainability goals are met without compromising operational efficiency. Similarly, (Roussos et al., 2025) underscored the importance of energy-efficient policies within GOV frameworks for digital ecosystems that balance technological advancement with environmental responsibility something crucial due to climate change.

Another point of view regards the interoperability across institutions, which is also another critical challenge. Concerning to this**,** (Kesäniemi et al., 2025) highlighted the need for harmonized governance models to facilitate seamless data exchange and collaboration among HEIs and stakeholder engagement is also essential (Bouras et al., 2025) also emphasized the role of inclusive governance frameworks that actively involve both academic and administrative stakeholders, fostering adaptability and inclusivity. Last but not least, according to EUNIS 2024 contributions, leadership strategies for governance according (Roussos et al., 2025) mentioned the importance of ethical practices, sustainability, and collaboration in navigating the complexities of digital transformation. These contributions provided a roadmap for addressing governance challenges and capitalizing on opportunities in higher education.

In today's fast-paced higher education landscape, institutions must navigate complex challenges as they embrace digital transformation. A strategic framework that connects operational capabilities with transformative initiatives is essential to address these challenges.

4 Frameworks and Models about AI, DT, and GOV in Higher Education

The development of several frameworks and models in recognition of the rapid, steady changes in higher education involves the integration of AI, DT and GOV. Although this section mentions three notable examples-HERM, NOLAI, and UniGPT-it is important to realize that they represent only a tiny subset of the whole climate of initiatives and strategies being explored worldwide (Nauwerck et al., 2022; Maltusch & Suominen, 2023; Kennisnet & SURF, 2021; Radas et al., 2025). Those examples sketch various approaches to AI ethics governance, interoperability, and institutional efficiency, which also shed some light on possible implementation pathways by HEIs.

4.1 The Higher Education Reference Models (HERM) approach for Enterprise Architecture

The HERM, as previously mentioned in Section 3.2, serves as a sector-specific mapping tool, providing institutions a straightforward method to identify and align the effects of digital strategies with specific organizational capabilities.

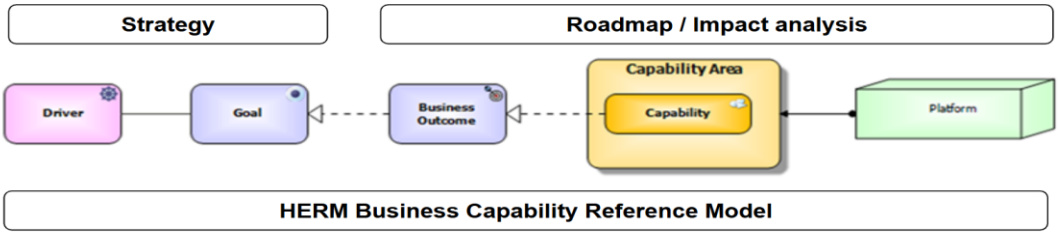

Figure 1 – HERM: Meta model of organizational strategy impact and context

This model (Figure 1) helps stakeholders identify key areas, like governance, data management, and interoperability, where thoughtful investments and solid frameworks are essential for lasting progress. Within this framework, strong governance plays a vital role in achieving success (Maltusch & Suominen, 2023). HERM enables institutions to effectively map strategic digital transformation initiatives to specific capabilities. This alignment enhances operational efficiency and stakeholder trust and ensures that every capability within the model is well-supported to address current and future challenges. Moreover, the necessity for interoperability among HEIs underscores this critical issue.

The three-in-one (3in1) approach can be universally modeled with a standardized perspective on higher education institutions. Existing mappings can identify opportunities for use-case scenarios and be assessed using the three-in-one methodology.

Capability Grouping	Process	Data	Resources	Technology
Curriculum Management	- AI-driven curriculum design and optimization - Automated content creation and updates	- Student learning data - Labor market trends - Curriculum standards	- AI tools for curriculum mapping and analysis - Faculty expertise in AI pedagogy	- Learning Management Systems (LMS) with AI integration - Adaptive learning platforms
Student Recruitment	- AI-powered personalized marketing campaigns - Predictive modeling for identifying potential students	- Student demographics and interests - Enrollment trends - Marketing campaign performance data	- AI-driven recruitment platforms - Marketing and outreach teams	- CRM systems with AI capabilities - Chatbots for student inquiries
Student Admission	- AI-assisted application screening and evaluation - Predictive analytics for admissions decisions	- Application data - Academic records - Admissions criteria	- AI tools for document processing and analysis - Admissions staff	- Admissions management systems with AI integration - Natural Language Processing (NLP) for application review
Student Retention & Success	AI-powered early warning systems for at-risk students, automated academic advising, AI-driven well-being monitoring	Student engagement metrics, attendance records, mental health and well-being indicators, academic performance data	AI-powered retention dashboards, virtual student mentors, AI-assisted academic advisors	AI-powered platforms that analyze student behavior, engagement, and academic performance to predict at-risk students

Table 1 - Capability (HERM) Grouping by AI viewpoint of opportunities

The table above (Table 1) examines key capabilities within Learning & Teaching. We can identify clear AI scenarios and anticipate that these changes will drive digital transformation, influencing processes and data, while stressing the need for human oversight as automation advances in handling learner and staff information activities.

Having explored the structured approach of the HERM to manage digital transformation effectively within higher education institutions, it is imperative also to consider how specialized initiatives like NOLAI integrate responsible AI into education.

4.2 The National Education Lab AI (NOLAI's) Approach to Responsible AI in Education

The National Education Lab AI (NOLAI), based at Radboud University in the Netherlands, is a real case of a university that promotes responsible AI integration. The co-creation program brings together

schools, scientists, and companies to develop AI-driven educational tools, while the scientific program focuses on AI's pedagogical, technical, and ethical aspects, another three-in-one approach. This approach ensures that AI solutions are both educationally effective and ethically sound (Kennisnet & SURF, 2021). Some key Insights from NOLAI's Implementation

- Collaborative Development: NOLAI emphasizes collaboration between educators, researchers, and technologists to create practical AI solutions for education.
- Ethical Integration: Ethical considerations are embedded throughout AI development, ensuring data privacy & protection, as seen in projects that ethically visualize student data.
- Human-Centered AI: NOLAI promotes AI tools that support rather than replace educators, ensuring that human agency remains central to teaching processes.
- Alignment with European Standards: The initiative adheres to the European Commission's Ethical Guidelines for AI in Education, focusing on fairness, privacy, and human agency.
- Strategic Collaborations: Partnerships with organizations like SURF and Kennisnet help integrate the Value Compass framework, emphasizing autonomy and justice in digital education.

4.3 The UniGPT: A Customizable On-Premise LLM-Solution for Universities

The fields where HE and research institutions can apply AI tools and systems comprise all the core activities – research, teaching and learning, administrational and infrastructure processes and also transfer. The AI systems and tools themselves have very different characteristics, levels of maturity and impact on students and employees at the universities.

In some cases, AI tools are built into software products – especially in the ERP (enterprise resource planning) field there is a growing supply of AI tools for process support and automation – in general administration like finance, procurement, human resources, but also in facility and plant management – the SAP products Joule and Leonardo, integrated into the SAP Build framework and the Business Technology Platform is one example. As another example, the Microsoft Copilot is positioned to extend AI support into the office space all over the campus – but due to cost/licensing and data protection issues the actual deployment is still limited or even prohibited. Tools to support coding are also gaining popularity for software development in university IT departments. In all these cases, products with defined scopes of AI application are introduced – and the usual procedures for establishing new IT supported processes have to be followed: consulting information security and data protection offices and potentially invoking the labor council when employee rights might be concerned. With the recent EU AI act, regulations requiring the institutions using these AI systems (the "deployers") to provide for adequate employee training for the use of these AI based products. For the other regulatory obligations, in these cases of commercial AI products, their creators ("providers") have to take care (The_EU_Commission, 2024).

For research and development, AI tools with a wide range of characteristics are used - and have been for quite some time, many years before large language models like ChatGPT triggered the current hype. For data classification and analysis, specific machine learning tools with focuses on image analysis, time series, data clustering in the life sciences etc. are used – often on HPC systems with large compute requirements. But also generative AI tools – based on large language models (LLM) – are gaining increasing relevance. The models themselves are sometimes subject of research (eg. how psychology students interact with AI chats and what they can learn for their studies), but mostly they are used to sift through large knowledge bases to discover structures and connections elusive for the unaided mind. The key technology here is Retrieval Augmented Generation (RAG), where search results from these knowledge bases first augment the input prompts for LLMs (Yu-peng & Yu, 2023).

These techniques have already gained popularity amongst various research groups to organize the knowledge in their respective fields, as well as for the provision of scientific information in university libraries or in science management, to scout for potentials to intensify scientific collaboration. A very promising recent development in LLMs is the rise of Open Source models (like DeepSeek) on a par with the top commercial cloud based offerings, that make this technology more transparent and allow to host advanced AI on-premises of the universities, ready to be used also an highly confidential data and creating digital sovereignty for higher education and research in the future-oriented AI domain. Such activities related to AI research, testing, and development before it is marketed or put into operation is also exempted from the EU AI act obligations (Yu-peng & Yu, 2023).

In the field of teaching and learning, AI had its first and most prominent deep impact for universities – the to date unthinkable text generative capabilities of ChatGPT and friends disrupted the whole of examinations in the humanities, rendering long essays as the sole basis for grading useless and forcing the faculties to rethink the whole process. But AI now also helps with learning (eg. to use RAG to enable students to ask their questions on course content to an AI tutor) and holds the potential to support educators to monitor student success better. This field of AI enhanced student analytics is thought to hold promises for better outcomes at lower cost (especially by law makers and managers), but also connects to the considerations of the EU AI Act on education and training, where AI systems that used to "evaluate learning outcomes and steer the learning process and monitoring of cheating" are considered as high-risk use cases, requiring providers to make fundamental rights impact assessments, causing anxiety amongst university leaders.

With an eye on this situation, Münster University has created an on-premises LLM platform that provides data privacy aware confidential access to state of the art Open Source AI models and will take the lead in an upcoming German multi-state pilot project for the collaborative provision of on-premises AI for higher education and research. RAG technologies have been successfully used for extensive bibliographic analysis for strategic research planning and as a service that helps professors create tutoring chatbots for their courses (this TutorAI project also links to transfer with its potential for the market). The potential for using RAG for an IT services chatbot, and a chatbot to support the academic affairs office in answering student questions on curricula and exam regulations is currently analyzed in several student theses. And, of course, a range of training and discussion opportunities on AI tools in higher education have been set up to promote these services and support their adoption.

5 Interconnections Between AI, Digital Transformation, and Governance

The terms AI, digital transformation, and governance are clearly interconnected each shaping and influencing the other within the HE landscape. It is important in some way to highlight the fact that they function as each other's environment—DT provides the necessary foundation for AI deployment, AI amplifies analytical capabilities and operational efficiency, and governance ensures these technologies are implemented strategically and ethically. Why this thinking?

DT lays the foundation for the effective functioning of AI, while AI enhances analytical capabilities, productivity, and efficiency at a pace like never before. Governance in turn should ensure that these technologies are deployed strategically and ethically. Therefore, a well-orchestrated synergy between the three enables universities to modernize their infrastructure, leverage AI within clearly defined boundaries, and rapidly improve their strategic governance models without the intervention of AI.

5.1 There Is Still Much To Be Done

While digital transformation and AI are often discussed together it is crucial to recognize that there is still much to be done in digital transformation itself, with no AI intervention.

HEIs around the world must continue consolidating and integrating databases, refining data generation and management processes, and designing user interfaces that ensure appropriate access and usability. AI should never manipulate information directly as a component of the information systems; instead, it must be carefully integrated one level above it, to support analysis and enhance decision-making. For instance, all we know is that for our tampering with LLMs and other cutting-edge tools, we have seen numerous risks of unchecked AI interventions such as whimsically granting course approvals or enrolling students in elective courses based on historical patterns rather than explicit choices and the AI system wouldn't tell us it had done so.

A well-structured digital ecosystem should have as number one priority that AI remains; and will remain a tool for insight generation rather than an autonomous actor making critical academic or administrative decisions. The public merely sees AI as a technological phenomenon closely linked to DT, but it should ultimately be viewed as an instrument serving university governance. Governing bodies must harness AI to derive strategic insights, ensuring decisions are based on well-structured, objective data rather than opaque algorithms. None of this of course diminishes the role of AI in software development, where generative models like Copilot or DeepSeek enhance productivity in requirement analysis, coding and system integration. However, these applications of AI are distinct from its role in governance, where its primary value lies in informing policy, strategic direction, and institutional oversight.

Lastly, we recognize that AI has posed challenges for higher education nearly everywhere regarding ethical perspectives, accountability, and the future of educational systems worldwide. It is indeed a global issue. As institutions explore AI and digital solutions to enhance operational efficiency and decision-making across the higher education sector, establishing a robust governance framework has become increasingly urgent and there is a strong need for a common perspective.

5.2 The Synergy Between Three Pillars

Most HEIs are increasingly dependent on the integration of AI, DT and GOV to improve decision-making and uphold ethical standards. These three pillars make up an interdependent ecosystem in which governance guarantees ethical oversight, AI improves data analysis, and digital transformation provides the infrastructure.

In our study, we present our approach to representing the interconnections between AI, DT, GOV and HO to highlight their dependencies and synergies (Figure 2). This formulation shows that AI supports GOV rather than interfering with it, while DT provides the necessary infrastructure for AI to function effectively. Strategic governance (SGOV) in HE is based on a combination of digital transformation (DT), artificial intelligence (AI_support), and human oversight (HO).

$$\text{Strategic Governance} = (DT + AI_{\text{support}}) \times \text{Human Oversight}$$

Figure 2 - Synergy of AI, Digital Transformation, and Governance in Higher Education

The meaning? Digital transformation creates infrastructure, while AI improves analysis and decision-making without direct intervention. And, what is AI's role? AI should not act autonomously within governance structures but should provide insights that help institutions optimize operations, predict trends and support evidence-based decisions. How it works? Human oversight plays an important role in the DT and implementation of AI in an ethical, transparent, and compliant manner in higher education institutions. Unless humans monitor, even the best and most sophisticated AI and

digital systems can be biased, ineffective, or yield unintended outcomes. This idea revolves around the point that good governance is not the introduction of AI, digital technology, and other emerging technologies, but rather the integration of such with great care and caution under the guidance of humans. Ideally, these will be high-level leaders. In that case, tech supports governance and does not substitute it, enabling university governance to retain control over strategic matters, with AI employed to further augment policymaking and boosting operational efficiencies.

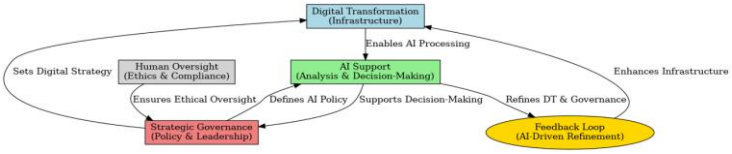

Figure 3 - Aligning Digital Transformation, AI Support, Strategic Governance, Human Oversight, and Feedback Loops for Ethical and Effective Decision-Making

The diagram below (Figure 3) shows how DT (Infrastructure) is the backbone for AI processing, which is supported by AI Support (Analysis & Decision-Making). This, in turn, sets in motion a feedback system whereby Strategic Governance (Policy & Leadership) sets the digital strategy and works in collaboration with AI support to establish policies for AI, while Human Oversight (Ethics & Compliance) puts in place the ethical standards. The continuous feedback loop (AI-Driven Refinement) strengthens infrastructure and governance in a mutually beneficial and synergistic environment that balances innovation with accountability.

5.3 Need for 3-in-1 view perspective

The 3-in-1 perspective can also be considered a capability. In other words, we see from the organization standpoint how the capability is executed, what are the processes employed, who does the processes, what data are being used, how is information flowing in the organization, and what information technologies are applied. These elements constitute the definition of a capability.

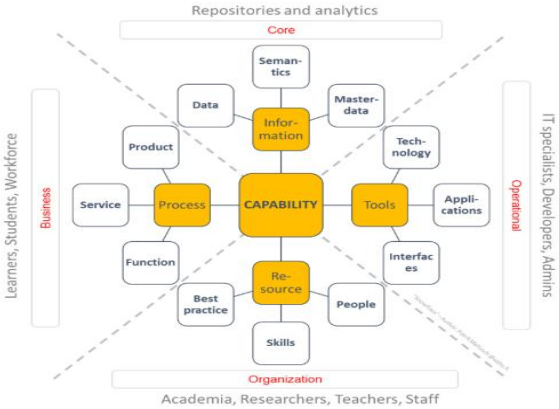

Figure 4 - The 3 in 1 perspective as a capability: Anatomy and relationship - The snowflake

There are processes, resources, tools, and information that enable the digital transformation in the HEIs in the global challenges. Figure 4 depicts the core anatomy of capability elements (information, tools, process, and resources) and semantic relationships with the most obvious user tribe and stakeholders. Placing the 3 in 1 at the center, viewed from the integration or embedded perspective, will

enable interchange links to apply directly the conceptual approach of using business capabilities as part of strategic governance as discussed in Sections 3.2 and 3.3 of this paper.

Within the 3 in 1 the human oversight has a critical role, or shall we say, is the significant multiplier in the equation. Addressing complexity and criticality from a human oversight perspective, one key factor is to understand also the underlying concepts of trust. The trust concept itself changes during the processing of data through technology and finally consuming of the data by machine or human.

To be noted that trust is not a capability by itself. Organizational trust is a cultural and relational asset—it's not a discrete business capability but rather the foundation upon which effective capabilities are built and sustained. By promoting an environment of reliability, open communication, and mutual support, trust enables the organization's capabilities to operate at their best, driving overall performance and strategic success. The simplified version of trust is 3 folded: inherited trust, relational trust and artefact trust. When viewing the path e.g. of machine learning or AI (especially AI agent scenarios) we can see the trust relationships move from one state to another as Figure 5 shows. Hence, implementing DT requires identifying this chain of trust and the governance model that can adhere to strict compliance requirements by ensuring there is an oversight and policies that verifies the methods and systems used. The following table summarizes the main concept (characteristic and stages) of trust in alignment with the 3 in 1 perspective. As an outcome, it can then be summarized as a "shared trust model", creating the synthesis of the 3 in 1 approach (Table 2 & Figure 5).

Trust model	Description	Characteristic	3 in 1
Inherited trust	"begin to have responsibility for an information or context that previously existed or belonged to another party"	Process, information, data	Human oversight
Relational trust	"the way two or more parties are connected, or the way they interact towards each other"	Configuration, agreement, understanding, people	Governance
Artefact trust	"something that is known to exist, especially something for which proof exists, or about which there is a peer review"	Method, model, standard,	DT + AI
Shared trust	"is the combination of all trust models"	unified approach	Synthesis

Table 2 - trust model - digitalised data flow characteristics in e.g ML or AI use-case

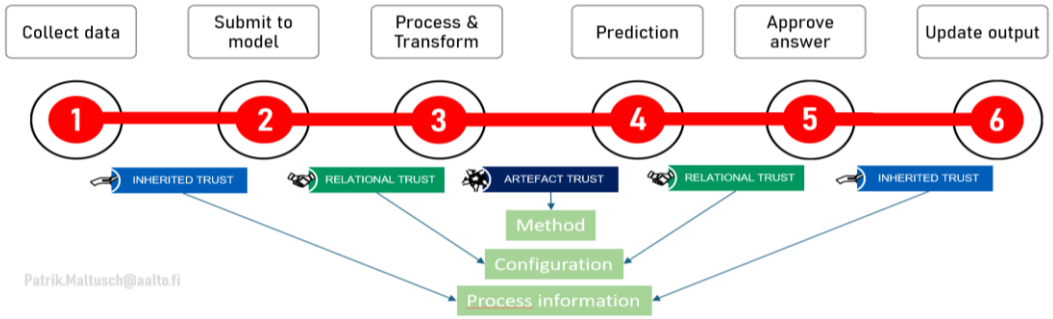

Figure 5 - Trust model - digitalised data flow stages in e.g ML or AI use-case

Where there is trust there are risks to be taken into account. While the risk posed by AI raises massive concern among different stakeholders, including academics, auditors, policymakers, AI companies, and the public, MIT has developed the AI Risk Repository, a comprehensive database cataloging 777 distinct risks associated with artificial intelligence, extracted from 43 existing frameworks (Slattery et al., 2024). Why? Because the non-commonly established understanding of the risks of AI hampers the effective means to talk about, learn, or act against the AI.

Trust Model	Description	AI Risk Domain	Key AI Risks	Mitigation Strategies
Inherited Trust	Responsibility for inherited information, process, or data.	Data & Bias Risks	Biased AI, Data Poisoning, Opaque Decision-Making	Ensure human oversight, improve dataset quality, apply fairness checks.
Relational Trust	Trust built through governance, agreements, and stakeholder interactions.	Governance Risks	Regulatory Non-Compliance, Accountability Issues	Strengthen AI governance, enforce accountability frameworks, improve transparency.
Artefact Trust	Trust based on validated methods, models, and standards.	Model & Algorithm Risks	Black-Box Models, AI Hallucinations, Unverified Outputs	Develop explainable AI, validate models, create standardized AI evaluation criteria.
Shared Trust	A unified approach synthesizing all trust models.	Systemic AI Risks	AI Misinformation, Cyber Threats, Unintended Consequences	Adopt a comprehensive AI governance strategy, implement interdisciplinary risk assessments.

Table 3 - Trust model - Mapping the risk and trust into one view

So, using this repository in their study (Slattery et al., 2024), aims to provide a unified framework for understanding and addressing AI-related risks, benefiting policymakers, researchers, industry professionals, and AI safety experts. The strategic governance in our 3 in 1 approach can benefit from tapping into this risk repository. Current standing of this evolving data set highlights the following interesting insights:

- Source of Risks: A majority (51%) of the risks are attributed to AI systems themselves, while 34% are linked to human actions.
- Timing of Risks: Most risks (65%) emerge post-deployment of AI models, with only 10% identified during the pre-deployment phase.
- Intentionality: Risks are nearly evenly split between intentional (35%) and unintentional (37%) origins.

To better understand the idea behind this, the previous table (Table 3) presents the trust model – mapping the risk and trust into one view.

6 The Future of Higher Education Globally

The future of HE undoubtedly faces several significant obstacles and risks as institutions strive to effectively integrate AI and DT. (Benavides et al., 2020; OECD, 2021; Crompton & Burke, 2023). Admittedly, one of the primary challenges is the governance gap that stems from the lack of clear and consistent policies and procedures for the ethical and responsible use of AI in education (Neumann et al., 2023) This gap is arguably large and can lead to unintended biases, privacy violations, and a lack of accountability for decisions made based on AI. Researchers from around the world are making this great imperative clear in their studies (Mökander & Floridi, 2021; EDUCAUSE, 2024).To address these risks, there are solutions, which is why these studies, like ours, are being conducted. The question is how? The following top five pillars are giving an overview.

- **Pillar 1** - It is crucial for institutions to develop comprehensive AI governance frameworks, establish oversight committees, and actively engage stakeholders in governance models. These are the first steps to take.

- **Pillar 2** - In addition, ethical dilemmas pose a significant risk, particularly with regard to fairness, transparency, and the impact of AI on human relationships and action. The potential erosion of academic integrity and overreliance on AI underscore the need to prioritize ethical considerations in AI design, conduct ethical impact assessments, and promote open dialogues on the ethics of AI within academia.

- **Pillar 3** - Equally important is the issue of the digital divide, which stems from unequal access to technology and deficiency in digital literacy, as the gap of achievement between students who possess these resources and those who do not has the potential to grow. This problem can be solved by investing in digital infrastructure, providing digital literacy education, and designing AI tools that are easy to use. Moreover, the gap between offered skills and what the job market needs is a major reason institutions need to modernize their curricula.
- **Pillar 4** - Cost-effectiveness is a concern, especially since both digital transformation and AI implementation come at a cost that many institutions cannot afford over time. In addressing this gap, universities need to adopt strong governance measures that empower them to annually assess and change plans for DT as well as alter investment policies and ensure that expenses are not wasted.
- **Pillar 5** - Equally important during the incorporation of AI and DT into HE is increasing the AI literacy as well as the professional development of the educators and students involved. The constantly changing world of AI technologies calls for institutions' relevant continuous learning and development efforts so that all faculty members are ready to use AI tools in their HEIs, and students are ready for the AI economy. This pillar also highlights the broad AI literacy gap.

In our attempt on this paper to shed light on the existing barriers and risks, we present the following table (Table 1)Table 4 - Key Barriers / Risks, Potential Impacts, and Strategies to Address AI, DT and GOV in in order to give users a succinct direction of the AI integration within HE and the strategies needed to overcome the challenges noted.

Category	Barrier/Risk	Description	Potential Impact	Strategies to Address / Direction
Governance and Ethics	**Governance Gaps**	Lack of clear policies for ethical and responsible AI use.	- Unintended biases and privacy violations. - Lack of accountability for AI decisions.	- Develop AI governance frameworks. - Establish oversight committees. - Engage stakeholders in governance models.
	Ethical Dilemmas	Concerns related to fairness, transparency, and AI's impact on human relationships.	- Perpetuation of biases. - Erosion of academic integrity. - Over-reliance on AI.	- Prioritize ethical AI design. - Conduct ethical impact assessments. - Foster dialogue about AI ethics.
	Regulatory Compliance and Risk Management	Aligning AI policies with regulations to mitigate legal and operational risks.	- Prevents legal challenges. - Enhances institutional credibility.	- Implement GDPR-compliant policies. - Conduct regular risk assessments. - Establish AI ethics committees.
Equity and Access	**Digital Inequality**	Unequal access to technology and digital literacy skills, worsened by AI adoption.	- Widens the achievement gap. - Excludes certain populations from AI benefits.	- Invest in digital infrastructure. - Provide digital literacy training. - Ensure AI solutions are accessible.
	AI Literacy and Professional Development	Training faculty, staff, and students to use AI tools effectively.	- Increases AI adoption. - Reduces resistance to change.	- Offer AI literacy workshops. - Develop certification programs. - Incentivize continuous learning.
Financial and Sustainability	**Financial Sustainability - Constant Recalibration**	High costs of digital transformation and AI tools challenge long-term sustainability.	- Budget strain on institutions. - Risk of stalled projects.	- Prioritize governance for financial planning. - Phase investments in AI. - Monitor sustainability metrics.
Skills and Workforce	**Skills Mismatch**	Gap between university curricula and rapidly changing market demands.	- Unprepared workforce. - Decreases employability of graduates.	- Update course catalogs. - Focus on competencies-based programs. - Expand micro-credentialing.
Collaboration and Innovation	**Interdisciplinary Collaboration and Research**	Encouraging cross-disciplinary partnerships to maximize AI's potential.	- Accelerates innovation. - Broadens research applications.	- Establish AI research hubs. - Promote collaborative funding opportunities. - Facilitate data-sharing protocols.
	Global Collaboration and Policy Alignment	Establishing international partnerships for shared AI and digital transformation standards.	- Promotes interoperability. - Facilitates knowledge exchange.	- Join international AI consortia. - Develop global AI standards. - Promote policy alignment initiatives.

Table 4 - Key Barriers / Risks, Potential Impacts, and Strategies to Address AI, DT and GOV in HE

7 Areas for Further Research

Digital Twins (DTs) one of the main emerging technologies impacting on the digital transformations of multiple industries. By their very nature, DTs technology is highly beneficial for HEIs. The key advantage of DTs in HEIs is their ability to facilitate experiential learning by simulating various training scenarios and environments, especially STEM. Specifically, DTs can simulate industrial plants or engineering systems, where students may engage in realistic, hands-on learning experiences that mirror real-world cases (Autiosalo et al., 2021). This approach, which has specific similarities with MR and XR applications, deepens understanding and better prepares students and researchers for the complexities of modern engineering and technology fields (Zacher, 2020).

For example, The JENII project (Jumeaux d'Enseignement Numériques, Immersifs et Interactifs) represents a significant step forward in the digital transformation of HE, integrating immersive digital twins to enhance technical and engineering training. Led by Arts et Métiers Institute of Technology in collaboration with Le Cnam, CESI, and CEA, JENII exemplifies how XR technologies can revolutionise pedagogy through high-fidelity, interactive simulations. By embedding digital twins into chemistry and industrial engineering, the project facilitates active learning, procedural mastery, and cognitive engagement. Research has shown that VR-based training significantly improves knowledge retention and safety awareness, particularly in high-risk environments such as forge and foundry workshops. These realistic, risk-free simulations allow students to develop technical expertise before transitioning to physical, hands-on applications (Facon & Fernagu, 2023). Studies presented at EDUCAUSE conducted on the VR-based chemistry labs at Le Cnam demonstrate that students develop stronger procedural knowledge with accessibility improvement when compared to traditional teaching methods (Koscielniak et al., 2022; Cousquer et al., 2022; Cousquer & Sylla, 2024). With €9.5 million in funding from the French government's PIA4 DemoES programme, JENII has gained national and international recognition as a model for immersive education. Its presentations at EDUCAUSE highlighted its potential for scaling XR solutions globally, positioning Arts et Métiers and its partners as leaders in digital pedagogy and industry-aligned training.

Beyond education, digital twins can also improve the operational efficiency of HEIs, similarly to any other industry. By modelling campus facilities and operations, institutions can optimize resource allocation, maintenance schedules, and optimize energy consumption. This application can lead to cost savings and improved sustainability practices for the HEIs. DTs of course is another interesting area for further research.

8 Conclusion

This research revealed the impact AI, DT, and GOV will have on HE in the future. The rapid growth of AI enables unprecedented opportunities for self-paced learning, effortless administration, and intelligent decision making. At the same time, digital transformation is transforming education in systems and methods that are cost-effective, modern, and revolutionized. There are, however, great complexities that arise from these advances, especially in governance, where complexities arise from regulatory issues and the rapid pace of technological advancement. Data privacy, ethical utilization of AI, algorithmic discrimination, and digital divides bring to light the need for proper governance approaches. The study made it clear that AI and digital tools need to be used responsibly and effective governance is a key factor. Institutions must be able to develop strong measures including ethical practices, data safety, and open policy AI risk governance to control the risks posed by AI. This issue also requires global intervention as it concerns all nations. A **"Global Compact on AI in Education"** can significantly aid in setting standards, ethical provisions, and equal opportunity regarding the use of

technology across the globe. Last but not least, this research highlighted the necessity for politicians to pick up the pace and revise existing AI regulations with additional ethical and security components.

While institutional leaders must work towards improving the system's digital governance capacity, educationalists, on the other hand, have to change their pedagogy to make proper use of AI. Considering the relationship between AI, digital transformation, and governance, the higher education sector can certainly address those issues and maintain continuous and equitable advancement. All in all, we know it's a global issue.

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president and founder of France Immersive Learning, the French association for XR learning stakeholders. He is member of Apereo Board and Karuta Open Source Portfolio Governing Board. During his career Thierry has always been deeply involved in the use and promotion of open source EdTech: Moodle, Sakai, uPortal, Karuta, Mahara, H5P and others. He believes and is committed in strong international networking and was a presenter at several conferences: EUNIS, JASIG, MoodleMoot, EDUCAUSE, Online Educa Berlin, Integrated System Europe. He was the first European member of the EDUCAUSE 2019 annual conference Program Committee. As expert in EdTech in higher education, he performs an active watch and research on digital learning and presently the pedagogical uses of virtual reality and augmented reality. He is member of the Immersive Learning Squad of the European Digital Education Hub. Thierry completed his PhD in computational chemistry and molecular design at Sorbonne University in Paris.

Raimund Vogl holds a Ph.D. in elementary particle physics from the University of Innsbruck (Austria). After completing his Ph.D. studies in 1995, he joined Innsbruck University Hospital as IT manager for medical image data solutions and moved on to be deputy head of IT. He served as a lecturer in medical informatics at UMIT (Hall, Austria) and as managing director for a medical image data management software company (icoserve, Innsbruck) and for a center of excellence in medical informatics (HITT, Innsbruck). Since 2007 he has been director of the it department of the University of Munster (WWU IT, Germany). His research interests focus on management of complex information systems and information infrastructures.

Wolfgang Nejdl has been a full professor of computer science at Leibniz Universität Hannover since 1995. He studied Computer Science at the Vienna University of Technology (Dipl.Ing. 1984, Dr.techn. 1988), was Assistant Professor in Vienna and Associate Professor at RWTH Aachen. He worked as a visiting researcher / professor at Xerox PARC, Stanford University, University of Illinois at Urbana-Champaign, EPFL Lausanne, PUC Rio, Uni Trento and Politecnico di Milano. Prof. Nejdl heads the L3S research center, www.L3S.de, and conducts research in the fields of information retrieval, web science, artificial intelligence, social and semantic web, digital libraries and technology enhanced learning. From 2014 to 2019, he was Principal Investigator of the ERC Advanced Grant ALEXANDRIA, where he worked on foundations for temporal search, exploration and analytics in web archives. Current projects include NoBIAS, SoBigData++, the International Leibniz Future Lab on Artificial Intelligence, with a particular focus on personalized medicine, and DAISEC, a European Digital Innovation Hub for innovation through AI and cybersecurity. He is also involved in the Leibniz AI Academy, which introduces AI into various degree programs at Leibniz University, including mechanical engineering, geoscience and education, and is a member of the interdisciplinary Leibniz Research Initiative on Digital Education. Wolfgang Nejdl has published more than 440 scientific articles listed at DBLP, with an h-index (based on GScholar) of 79.

Christos Nikolaos Anagnostopoulos is the Head of Cultural Technology and Communication Department, University of the Aegean and Director of the Intelligent Systems lab in the same Department. He received his Mechanical Engineering Diploma from the National Technical University of Athens (NTUA) in 1998, and the Ph.D. degree from the Electrical and Computer Engineering Dpt., NTUA in 2002. His research interests include image processing, computer graphics, cultural informatics and artificial intelligence. He has published more than 180 papers in scientific journals and conferences, in the above subjects as well as other related fields in informatics.

Martín López Nores is currently an Associate Professor and teaches Telematics engineering at the University of Vigo, Spain. He is the Coordinator of rurALLURE H2020 project. He has published extensively and has been involved in projects including ConectaPEME, INNTERCONECTA, Xunta de Galicia, the 7th Framework Program of the European Union and the H2020 program. His research focuses on communications services in mobile device networks, the semantic web, new technologies applied to the diagnosis and treatment of cognitive and communication disorders and teaching and learning in the metaverse

Gill Ferrell supports two inter-related edtech communities in Europe, fostering knowledge exchange and developing communities of practice. EUNIS (European University Information Systems organisation) is a professional association for all stakeholders delivering the digital infrastructure for higher education. The 1EdTech community develops and maintains open standards (such as learning tools interoperability) to deliver a flexible learning ecosystem. She previously directed a support service providing advice, guidance and training to further and higher education providers across the UK. Dr Ferrell has led research and edtech projects in areas such as assessment and feedback, curriculum design, course management, learner records, learning spaces and learning analytics.

John O'Brien serves as the president and CEO of EDUCAUSE, a nonprofit organization seeking to inspire the transformation of higher education in service to a greater good. EDUCAUSE serves over 2,000 member colleges, universities, and organizations from 41 countries who themselves collectively serve over 14 million students. He speaks and writes on a variety of topics related to higher education, technology, and the crucial intersection where the two meet. Throughout his career in higher education, John has served as an academic, technology, and institutional leader. He was a faculty leader in instructional technology, a statewide IT project leader, and associate vice chancellor/deputy CIO at the system level. He has been a college provost and president in the Minnesota State Colleges and Universities system, the fourth largest higher education system in the United States. Immediately prior to his appointment at EDUCAUSE, he served as the system's senior vice chancellor of academic and student affairs. John holds a bachelor's degree in English from Augustana University, a master's degree in Anglo-Irish Literature from Trinity College Dublin, and a doctorate in English from the University of Minnesota