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Artificial intelligence and machine learning: usage and impacts on future higher education

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Abstract

Artificial Intelligence (AI) and Machine Learning (ML) technologies have the potential to revolutionize public sector operations, enhancing efficiency, citizen engagement, and service delivery. Despite benefits like improved healthcare and public safety, challenges remain, including workforce readiness and regulatory concerns. Similarly, higher education (HE) faces pressure to integrate AI&ML effectively to meet evolving societal needs and maintain competitiveness amidst global uncertainties. AI&ML technologies are rapidly transforming HE, offering opportunities to improve teaching, learning, research, and administrative processes. These technologies are increasingly used in admissions, personalized learning, predictive analytics, and administrative tasks. Diversity, Equity and Inclusion (DEI) are vital in HE institutions (HEIs), promoting fairness, access, and inclusion for all. Overcoming challenges like bias detection, personalized learning, language accessibility, diverse faculty recruitment, and inclusive curriculum development requires leveraging AI&ML driven tools. Our research, i.e., a thorough review of the results of previous studies and contemporary literature on the effects and consequences of AI&ML, does not intend to provide a clear answer to the question of whether it will replace or enhance and enrich the role of the teacher in the teaching process. This is due to the fact that we are only at the beginning of the serious use of AI&ML in HE in all its areas. The conclusions highlight the lack of critical reflection on AI&ML in HE challenges and risks, the weak connection to theoretical pedagogical perspectives, and the need for further exploration of ethical and educational approaches in AI&ML applications in HE.

Keywords: artificial intelligence, machine learning, public sector, higher education, diversity, equity and inclusion

Introduction

Our research, i.e., a thorough review of the available results of previous studies and contemporary literature on the effects and consequences of AI & ML explores the intersection of AI&ML within the realm of HE, beginning with an examination of its broader implications within the public sector. The central focus of the paper delves into the utilization and consequences of AI&ML specifically within HE contexts. Finally, the paper underscores the significance of AI&ML in fostering DEI within HEIs.

AI& ML technologies are poised to transform public sector operations, offering avenues for increased efficiency, enhanced citizen engagement, and improved service delivery. Despite their potential benefits, challenges persist, such as the need for workforce readiness and regulatory oversight (Berryhill *et al.*, 2019).

For instance, while AI-driven predictive analysis can bolster crime prevention and emergency medical responses, concerns regarding data privacy and integrity linger (Habeheh and Gohel, 2021). Moreover, the public sector's adoption of AI&ML remains hindered by factors like recruitment hurdles and the absence of effective oversight mechanisms, impacting public trust (Berryhill *et al.*, 2019).

In HE, where AI&ML are pivotal for innovation and research, there's a growing imperative to integrate these technologies effectively into institutional practices (Mikhaylov *et al.*, 2018; Berglind *et al.*, 2022). The COVID-19 pandemic and geopolitical tensions underscore the significance of quality education and research in advancing AI&ML applications for societal well-being and economic resilience (Mikhaylov *et al.*, 2018). However, challenges persist in aligning HE objectives with workforce needs, ensuring data privacy, and fostering research integrity (Berglind *et al.*, 2022). Addressing these issues is crucial for fostering a skilled workforce capable of leveraging AI&ML to navigate complex challenges, such as supply chain disruptions and shifting consumer behaviors, while maintaining national competitiveness (Kolkman, 2020). Thus, ongoing discussions and strategic planning are essential to effectively integrate AI&ML into HE and research institutions, ensuring they remain agile and responsive to evolving societal demands.

AI&ML technologies have experienced a rapid surge in adoption within HE, offering vast potential to revolutionize various aspects of teaching, learning, research, and administrative processes. The incorporation of AI in HE has garnered substantial attention in recent years, evident in the proliferation of AI tools and applications (Siemens, 2013; Greller and Drachler, 2012; Salem *et al.*, 2021; Barramuño *et al.*, 2021). These technologies are increasingly utilized in admissions and enrollment processes, personalized learning experiences, predictive analytics for student support, and administrative efficiency (Barramuño *et al.*, 2021; Zawacki-Richter *et al.*, 2019). Additionally, AI&ML have been instrumental in expanding access to education through online learning platforms and fostering collaborative learning environments (Baker, 2016; Eubanks, 2018).

However, the implementation of AI&ML in HE also presents challenges, including algorithmic biases, data privacy concerns, and resistance to change (Selwyn, 2019; Watters, 2015). A comprehensive understanding of both the advantages and disadvantages of AI&ML in HE is crucial for informed decision-making and effective integration into educational frameworks (Chen *et al.*, 2020; Crompton *et al.*, 2020, 2021). By addressing these challenges proactively and ethically, HE institutions can harness the transformative potential of AI&ML to enhance educational experiences for students, educators, and stakeholders alike (Selwyn, 2019; Watters, 2015).

DEI initiatives play a crucial role in HEIs, ensuring fairness, access, and inclusion for all members of the academic community. They not only enrich the learning experience by exposing students to diverse perspectives but also prepare them for success in a globalized society (National Center for Education Statistics, 2024). Overcoming challenges such as bias detection, personalized learning, language accessibility, diverse faculty recruitment, and inclusive curriculum development requires leveraging AI-driven tools (Bird *et al.*, 2020). For instance, the University of California, Berkeley has developed an AI-powered tool to detect and mitigate biases in the admissions process, aiming to create a more inclusive admissions process (Pearson, 2024).

Similarly, Georgia State University implemented an AI-driven advising system to provide personalized support and interventions for students from underrepresented backgrounds, leading to significant improvements in retention and graduation rates (Georgia State News Hub, 2022). These initiatives, supported by AI technologies, create inclusive academic environments that prioritize fairness, accessibility, and representation for all stakeholders.

AI&ML usage in the Public sector

In this section, the focus is primarily on the integration and adaptation of AI&ML into New Public Management- applying different management techniques used in the private sector in public administration (Morisson and Doussineau, 2019). During the past decade, AI&ML have been an essential part of the reforms in the public sector which include efficiency, participation and engagement, transparency, service delivery, and innovation. AI represents a technology-based application that can impact on public policies and deliveries of public services- from basic, social, and economic services (Maalla, 2021). The public sector, if AI as well as ML are properly considered and deployed, can improve operational efficiency (e.g., minimizing redundancy) and citizen engagement (through better public communication- 2-way engagement with citizens).

Connectivity has enhanced the use of AI&ML among public agencies and between a public agency and citizens. In the past, improving performance and quality of the delivery of public services have focused on process automation with eliminating manual and repetitive activities (Berryhill *et al.*, 2019). To better utilize, the reform trends in the public sector require further engagement and communication with citizens (and business operators alike) due to resource and budget constraints as well as changing expectation. Keep in mind that citizens and business operators can directly compare their experience from public agencies with private firms in the digitalized transactional services. Anticipating the future needs of citizens is recognized as part of a public agency's responsibility- shifting from reactive to proactive operations.

Thereby, AI&ML become an integral part of the public sector's operations- from planning, service delivery, and assessment and evaluation for performance improvement. AI&ML have significantly contributed to improved service delivery by the public sector (e.g., facilitating faster passenger movements at an airport, identification of high-risk population group for vaccination during the COVID-19 pandemic, planning for COVID-19 vaccine distribution). It has positively strengthened public communication and participation as part of regaining public confidence and trust.

Customizing public services to specific population groups is also possible (Berglind *et al.*, 2022). Personalized healthcare for elder citizens such as medicine and nutrition based on health records, behavior, and requests is one of many examples of improved public services derived from AI&ML (Habeheh and Gohel, 2021). Transparency and anti-corruption, especially in the areas of public procurement and fraud prevention, can also be strengthened by AI&ML applications such as blockchain technology.

Additional illustrations to highlight the positive impacts from AI&ML can be summarized as follows. For policy initiative, it is commonly expected that the public sector needs to practice evidence-based policymaking (Kolkman, 2020) as a way to regain public confidence and trusts which have been eroded for many decades. This practice requires the use of quality information to make policy decisions. Quality data indicates a systematic analysis of data, instead of a large amount of data.

For instance, a policy decision on regulatory requirements relating to environment and ecology is often based on the use of AI&ML for forecasting the future. The decisions relating to an expansion of economic infrastructure such as airport expansion, runway extension, railway connection, and maintenance of roadways and bridges are also expected to be evidence-based, especially during public hearings.

For basic government services such as identity and permits, AI&ML have been extensively applied in many operations to underline the ability to innovate for public services (Serra *et al.*, 2024). For instance, filing an income tax has become friendlier and more convenient which reduces or eliminates the need for copies. AI&ML have also helped increase user security through a series of user verifications. Regarding public

safety and security, facial recognition through AI&ML has become accepted, especially when crossing borders, and applying for a public card or document. Crime prevention through predictive analysis has adapted AI&ML, especially when a large public gathering is organized. Emergency Medical Responses, commonly referred to as EMS, has embraced AI&ML to help prepare facilities and resources. Before an ambulance reaches a hospital, use of AI&ML can improve diagnosis of a patient such as medical records, etc.

Despite the benefits of AI&ML, the public sector is still behind in utilizing this technology (Berryhil *et al.*, 2019). Public employment (from ability to recruit, to enhance digital skills continuously, and to innovate public services through open and connected government) is viewed as a major hurdle in embracing and utilizing AI&ML in the public sector. Moreover, regulatory restrictions need to be recognized as public confidence and trust have eroded due to a lack of effective oversights when applying AI&ML. This includes an inability to prevent manipulation of public data for unlawful (i.e., personal and business) gains. Concerns over privacy and personal protection of data has often been raised to signify the readiness of public agencies to fully utilize AI&ML to their potentials.

One of the areas where the use of AI&ML for public service is becoming under more scrutiny and discussion is HE. The reason is that HE and research represent a foundation for social and economic development (Mikhaylov *et al.*, 2018; and Berglind *et al.*, 2022). In other words, despite advanced technology relating to AI&ML are developed by HE and/or research institutions, how this technology itself can be applied within institutional domains and operations remains unclear. Recent uncertainties such as a pandemic and a geo-political conflict remind the importance of the quality of HE and research to further innovate AI&ML due to their impacts on the well-being of citizens and the survival of businesses.

Quarantine, lockdown, travel restriction, uncertainty in supply chain, fluctuation of price (of many important raw materials), rapidly- changing consumer lifestyle require a large number of qualified graduates who can immediately apply AI&ML for business operations. Furthermore, many changes and expectations from HE and research include personalized or individualized learning (to support quality of formal and life-long learning), preparing future workforce, upskilling and reskilling current workforce, and developing new ideas and practices. These changes and expectations are essential for the long-term competitiveness of a country. At the same time, the ability for HE to operate more efficiently, to ensure data privacy and protection, and to maintain the integrity of research has become ever more important today. Therefore, ongoing internal and external issues facing HE require the next discussion to focus on planning and implementation of AI&ML.

AI&ML usage and implementation in the HE

AI has significantly integrated into the daily experiences of individuals in the twenty-first century, and it is widely recognized for its potential to enrich and progress various aspects of society (Górriz *et al.*, 2020). Its deployment has garnered substantial attention in HE, a field deeply shaped by advancements in information and communication technologies (Alajmi *et al.*, 2020). In recent years, particularly over the past half-decade, the incorporation of AI within the realm of HE has experienced a rapid surge (Chu *et al.*, 2022), accompanied by an expansion in the variety of AI tools on offer. Siemens (2013) provides insights into the use of learning analytics, including predictive modeling, in HE.

Greller and Drachler (2012) proposed a framework for learning analytics in HE, which includes the use of AI&ML techniques. Salem *et al.* (2021) discuss the use of machine learning algorithms for predicting student performance in HE. Barramuño *et al.* (2021) examine the use of predictive analytics to address student attrition in HE and claim that the predictive method and machine learning identify attrition students

in the university program and could be used to improve student retention in higher grades. Zawacki-Richter *et. al.* (2019) analyzed AI in HE from 2007 to 2018 to reveal four primary uses of AI in education: profiling and prediction, assessment and evaluation, adaptive systems and personalization, and intelligent tutoring systems. On a broader view of AI in HE, Ouyang *et. al.* (2022) conducted a systematic review of AI in online HE and investigated the literature regarding the use of AI from 2011 to 2020. The findings show that performance prediction, resource recommendation, automatic assessment, and improvement of learning experiences are the four main functions of AI applications in online HE. Such research contributions are pivotal in enlightening educational practitioners regarding the potential applications of AI&ML in the educational landscape, specifically within HE education contexts.

AI&ML is increasingly utilized in HE to enhance various aspects of teaching, learning, research, and administrative processes. Here are several ways in which AI&ML are being implemented in HE: Zawacki-Richter *et al.*, 2019; Akinwalere & Ivanov 2022; AIDhaen, 2022; Hutson *et al.*, 2022; Saxena *et al.*, 2024; Khan, 2024)

- **Admissions and Enrollment:** AI is used in the admissions process to analyze applicant data, predict student success, and optimize enrollment decisions. ML algorithms can assess applicant qualifications, predict the likelihood of acceptance, and identify factors contributing to student retention and success.
- **Student admission process:** Beyond admissions software, universities are leveraging chatbots as auxiliary AI tools, designed to respond immediately to inquiries, thereby enhancing students' efficiency and effectiveness in navigating academic processes.
- **Personalized Learning:** AI and ML algorithms can analyze student data to provide personalized learning experiences tailored to individual needs and learning styles. This includes adaptive learning platforms that dynamically adjust content and pacing based on student performance and preferences.
- **Predictive Analytics:** Institutions use predictive analytics powered by AI and ML to identify at-risk students who may need additional support or intervention. By analyzing factors such as academic performance, attendance, and engagement, predictive models can forecast student outcomes and enable early intervention strategies.
- **Virtual Teaching Assistants:** with AI-powered chatbots and virtual assistants provide students instant support and assistance. These virtual teaching assistants can answer common questions, provide guidance on coursework, and offer support services, enhancing the student learning experience.
- **Virtual Labs and Simulations:** AI-powered virtual labs and simulations provide students with hands-on learning experiences in healthcare science, engineering, and healthcare fields. These virtual environments allow students to conduct experiments, practice skills, and explore concepts safely and interactively.
- **Automated Grading and Feedback:** AI&ML technologies enable automated grading and feedback for assignments, quizzes, and exams. Natural Language Processing (NLP) algorithms can assess written assignments and provide detailed feedback to students, saving instructors time and providing more timely feedback to students.
- **Research and Data Analysis:** AI&ML are used in research settings to analyze large datasets, identify patterns, and generate insights. These technologies facilitate data-driven research in various fields, including scientific discovery, social sciences, and humanities.
- **Administrative Efficiency:** AI&ML tools streamline administrative processes in HEIs. This includes applications such as student enrollment management, course scheduling, resource allocation, and financial management.

Overall, AI&ML are significantly transforming the HE sector. They improve learning outcomes by personalizing educational experiences and offering tailored feedback to students. Additionally, these

technologies enhance research capabilities by analyzing vast datasets and uncovering new insights. AI and ML also optimize administrative processes, making them more efficient and reducing the workload on staff. Furthermore, they provide innovative solutions that address the evolving needs of students, faculty, and institutions, ensuring that the educational landscape can adapt to future challenges and opportunities.

Advantages and disadvantages in AI&ML usage and implementation in HE

Implementing AI&ML in the HE sector offers numerous advantages, but it also comes with certain challenges. Delving into both the advantages, strengths, and opportunities as well as the disadvantages and risks of AI&ML in HE is crucial for developing a comprehensive perspective. By thoroughly examining the positive aspects, we can leverage AI&ML to innovate and enhance the educational landscape, potentially transforming traditional teaching methods, personalizing learning experiences, and improving administrative efficiency. On the flip side, considering the potential drawbacks is equally important. It prompts us to address ethical dilemmas, safeguard data privacy, and mitigate the risk of exacerbating educational inequalities through a digital divide. A balanced approach ensures that we can make informed, ethical decisions while effectively integrating these transformative technologies into educational frameworks, ultimately fostering an environment that supports equitable and effective learning.

Research conducted by various academics (e.g., Chen *et al.*, 2020; Crompton *et al.*, 2020, 2021) highlights the numerous advantages AI&ML presents for both educators and learners in the HE sector. Zawacki-Richter *et al.* (2019) in their study provide an overview of AI applications in HE and discuss their potential advantages. These advantages encompass how AI can be used to create more engaging and interactive learning environment (Dietz-Uhler and Hurn, 2013), the tailoring of teaching methods to accommodate diverse learner profiles (Luckin *et al.*, 2016; Verdú *et al.*, 2017), the democratization education by providing personalized learning pathways (Bulger, 2016), delivery of personalized and timely feedback (Bulgar, 2016; Dever *et al.*, 2020), the creation of evaluative measures (Baykasoğlu *et al.*, 2018), and the forecasting of student achievement (Çağataylı & Çelebi, 2022). Baker's work (2016) focuses on the use of AI for educational data mining and learning analytics to improve learning outcomes.

As we can see from these references, AI and ML are fundamentally reshaping HE, enhancing learning outcomes through personalized experiences and tailored feedback. These technologies also revolutionize research by analyzing extensive datasets to uncover new insights and accelerate discoveries. Administrative processes are streamlined, reducing staff workload and improving efficiency in tasks like scheduling and record management. Innovations such as AI-powered chatbots enhance student support and facilitate flexible learning options, ensuring institutions can adapt to diverse educational needs. Embracing AI&ML enables HE to remain competitive and responsive, fostering a culture of innovation and continuous improvement across campuses.

Research has illuminated various challenges and potential risks associated with the use of AI&ML in HE, impacting educators, students, and institutions. These concerns range from ethical dilemmas and data privacy issues to the potential for exacerbating educational inequalities. The dynamic nature of AI&ML also poses questions about the adaptability of curricula and the professional development needs of faculty, alongside considerations about the long-term implications for student learning and institutional policies. Eubanks (2018) highlights the risks of relying on automated systems for critical decisions in public services, including education, which can perpetuate inequality and bias.

Broussard (2018) emphasizes the limitations and failures of AI in complex social systems like education, advocating for a more human-centered approach. Selwyn (2019). discusses the potential drawbacks of educational technologies, including AI, emphasizing the need for critical engagement with these tools.

Selwyn highlights the need for nuanced discussions around the capacity of AI to replicate the social, emotional, and cognitive qualities of human teachers. O'Neil (2016) examines the negative consequences of algorithm-driven decision-making in various sectors, including education, highlighting issues of fairness and transparency. Noble's work (2018) focuses on algorithmic biases in digital platforms, including educational technologies, and their impact on marginalized communities. Watters (2015) critiques the unexamined adoption of AI&ML in education, pointing out issues related to surveillance, data privacy, and the commercialization of learning.

These authors contribute to the discourse on the potential downsides of integrating AI&ML into HE, covering a range of issues from ethical concerns and data privacy to inequality and the dehumanization of education. Their works serve as a cautionary reminder of the need to critically assess the role of technology in educational contexts. Overall, while AI&ML offers promising opportunities to transform HE, institutions need to address the associated challenges proactively and ethically to maximize the benefits for students, educators, and society as a whole. Addressing these risks requires careful planning, ethical considerations, and ongoing monitoring and evaluation of AI and ML implementations in HE. Institutions must prioritize transparency, fairness, and equity to ensure that these technologies benefit all students and stakeholders.

Based on an in-depth review of scientific literature concerning the use and implementation of AI&ML technologies, coupled with insights drawn from our personal experiences in the field, we can outline a comprehensive list of both the advantages and disadvantages associated with the integration of AI&ML in the realm of HE. These points of analysis are meticulously detailed and contrasted in Table 1, offering a clear and structured visualization of the potential impacts these technologies may have on academic institutions, educators, and students alike.

Table 1: Advantages and disadvantages of AI&ML usage and implementation in HE

Advantages		Disadvantages	
type	description	type	description
Improved Decision-Making	AI-powered decision support systems can assist administrators and policymakers in making more informed decisions by analyzing complex data and providing actionable insights.	Bias and Fairness	AI algorithms may exhibit bias if they are trained on biased datasets, leading to unfair outcomes or discrimination. Ensuring fairness and transparency in AI systems requires careful attention to data selection, algorithm design, and model evaluation.
Innovative Teaching Methods	AI&ML tools enable educators to experiment with innovative teaching methods such as adaptive learning, virtual reality simulations, and gamification. These technologies can enhance student engagement and promote active learning experiences.	Dependency on Technology	Overreliance on AI&ML technologies may lead to a loss of human expertise and judgment. Educators and administrators must strike a balance between leveraging technology to enhance efficiency and preserving the human touch in education.
Predictive Analytics	Institutions can use predictive analytics powered by AI&ML to identify at-risk students who may need additional support or intervention. Early identification of struggling students allows for timely intervention strategies to improve retention rates and academic success.	Algorithmic Transparency	AI&ML algorithms can be complex and opaque, making it difficult to understand how decisions are made. Lack of transparency in algorithmic processes may undermine trust and accountability, particularly in critical decision-making contexts.

Advantages		Disadvantages	
type	description	type	description
Personalized Learning	AI&ML algorithms can analyze student data to provide personalized learning experiences tailored to individual needs and learning styles. This can lead to improved student engagement, satisfaction, and learning outcomes.	Quality of Education	AI&ML technologies may not always guarantee improvements in the quality of education. Poorly designed or implemented systems could lead to unintended consequences, such as decreased student engagement or academic integrity issues.
Enhanced Research Capabilities	AI&ML tools facilitate data-driven research by analyzing large datasets, identifying patterns, and generating insights. This can accelerate the pace of scientific discovery and innovation across various academic disciplines.	Resistance to Change	Implementation of AI&ML initiatives may face resistance from stakeholders, including faculty, staff, and students, who may be skeptical of new technologies or concerned about job displacement.
Efficiency and Automation	AI&ML technologies enable the automation of administrative tasks such as grading, scheduling, and resource allocation, freeing up time for educators and administrators to focus on more strategic initiatives.	Cost and Resource Constraints	Implementing AI&ML solutions in HE requires significant investments in technology infrastructure, training, and support. Smaller institutions or those with limited resources may face challenges in adopting and maintaining these technologies effectively.
Collaborative Learning Environments	AI&ML technologies can facilitate collaborative learning environments by connecting students, educators, and researchers across geographical boundaries. This fosters knowledge sharing, collaboration, and interdisciplinary learning experiences.	Data Privacy and Security Concerns	The use of AI&ML in HE requires access to large amounts of sensitive student data, raising concerns about privacy and security. Institutions must implement robust data protection measures to safeguard student information from unauthorized access or misuse.
Lifelong Learning	AI&ML-powered platforms can support lifelong learning initiatives by providing personalized learning pathways and opportunities for continuous skill development and upskilling.	Ethical and Legal Issues	The use of AI&ML in HE raises ethical and legal questions regarding consent, transparency, accountability, and intellectual property rights. Institutions must navigate these complex issues to ensure the responsible and ethical use of AI technologies.

Sources: AIDhaen, 2022; Akinwalere & Ivanov, 2022; Baker, 2016; Baykasoğlu *et al.*, 2018; Broussard, 2018; Bulger, 2016; Çağataylı & Çelebi, 2022; Chen *et al.*, 2020; Crompton *et al.*, 2020, 2021; Dever *et al.*, 2020; Dietz-Uhler & Hurn, 2016; Eubanks, 2018; Hutson *et al.*, 2022; Khan, 2024; Luckin *et al.*, 2016; Noble, 2018; O'Neil, 2016; Saxena *et al.*, 2024; Selwyn, 2019; Verdú *et al.*, 2017; Watters, 2015; Zawacki-Richter *et al.*, 2019.

Table 1 presents a comprehensive overview of the advantages and disadvantages of incorporating AI&ML in HE. On the positive side, AI&ML enhances decision-making through data analysis, introduces innovative teaching methods, utilizes predictive analytics to support at-risk students, expands educational access, personalizes learning experiences, boosts research capabilities, improves efficiency via automation, encourages collaborative environments, and promotes lifelong learning. However, these advancements come with challenges, including potential biases in AI algorithms, increased dependency on technology, opaque decision-making processes, concerns about educational equity, questions regarding the quality of education, resistance from stakeholders, financial and resource constraints, data privacy and security issues, and various ethical and legal considerations. This balanced examination highlights the need for careful

implementation and management of AI&ML technologies in the HE to maximize their benefits while mitigating associated risks.

Diversity, Equity and Inclusion and Higher Education Institutions Value and Future

In order to contextualize the role of Diversity, Equity and Inclusion (DEI) initiatives in HEIs, it is necessary to briefly define and discuss the broader context of DEI. Each key term can be described as follows.

Diversity refers to the variety of identities, backgrounds, perspectives, and experiences present within a community or institution. These identities may include race, ethnicity, gender, sexual orientation, socioeconomic status, religion, nationality, disability status, and more. (Lin, 2019) Diversity in HE enriches the learning environment by exposing students to a wide range of viewpoints, cultures, and lived experiences. It fosters critical thinking, creativity, and innovation by encouraging dialogue and collaboration among individuals with diverse perspectives. (Leroy *et al*, 2021) Additionally, diversity prepares students for success in a globalized world and promotes social cohesion and understanding across differences. (Miller, 2023)

Equity involves ensuring fair treatment, access, opportunity, and advancement for all individuals, regardless of their backgrounds or identities. (McKinsey and Company, 2022) It acknowledges that different groups may face systemic barriers and inequalities and seeks to address these disparities through proactive measures and policies. Equity in HE aims to level the playing field and remove obstacles that may hinder certain groups' access to educational opportunities and resources. (Pendell, 2022) By promoting equity, institutions strive to create a more inclusive and supportive environment where all students, faculty, and staff can thrive and reach their full potential.

Inclusion involves creating a welcoming and supportive environment where all individuals feel valued, respected, and empowered to participate fully. It goes beyond mere representation and seeks to foster a sense of belonging and community among diverse individuals. (McKinsey and Company, 2022) Inclusion is essential for ensuring that all members of the university community feel welcomed and supported in their academic and professional pursuits. (Rumage, 2024) It encourages collaboration, empathy, and mutual respect among individuals from different backgrounds and identities. Inclusive environments promote student retention, faculty satisfaction, and overall institutional success by cultivating a culture of belonging and equity. (Cultural Partners, 2024)

In HE, diversity, equity, and inclusion are interconnected principles that are essential for creating a vibrant and equitable learning environment. By embracing diversity, promoting equity, and fostering inclusion, institutions can enhance student learning outcomes, advance social justice and equity, and contribute to the development of a more diverse and inclusive society. (Minkin, 2023) Opportunity to learn is often one of the main positive outcomes from the recognition of diversity in learning environment (Serra *et al.*, 2024).

Diversity in a community or institution is the range of identities, backgrounds, viewpoints, and experiences that exist there. Race, ethnicity, gender, sexual orientation, country, socioeconomic class, religion, and handicap status are a few examples of these identities. (Office of Diversity, Equity, Inclusion & Belonging, 2024) Diversity in HE exposes students to a wide range of perspectives, cultures, and life experiences, which enriches the learning environment. By promoting communication and cooperation between people with different viewpoints, it develops critical thinking, creativity, and invention. Furthermore, variety fosters social cohesiveness and cross-cultural understanding while preparing pupils for success in a globalized society. (Roberio, 2021) Ensuring equitable treatment, access, opportunity, and growth for all people, irrespective of their identities or histories, is the essence of equity. It recognizes that differences in

systemic barriers and inequalities may exist between groups and works to address them. (Ferris State University, 2024)

While a desirable goal, designing and implementing an impactful DEI initiative in the context of HEI, meets with many challenges. To understand the current DEI environment, some data and metrics have been compiled and analyzed, particularly in the United States. Concerning enrollment diversity, according to the National Center for Education Statistics (NCES), enrollment in HEIs in the United States is becoming increasingly diverse. In 2019, about 22% of undergraduates and 14% of graduate students identified as Hispanic, 15% of undergraduates and 12% of graduate students identified as Black or African American, and 8% of undergraduates and 10% of graduate students identified as Asian/Pacific Islander. The enrollment of minority students, particularly Hispanic and Black students, has been steadily increasing over the past few decades. However, there are still significant disparities in enrollment rates among different racial and ethnic groups. (National Center for Education Statistics, 2024)

As for faculty diversity, despite efforts to improve diversity among faculty, there remains a significant underrepresentation of minority faculty members in HEIs. According to the National Center for Education Statistics (NCES), as of 2018, only about 6% of full-time faculty in degree-granting postsecondary institutions were Black, and about 5% were Hispanic. The lack of diversity among faculty not only limits the perspectives available to students but also affects recruitment and retention efforts for minority students. (National Center for Education Statistics, 2024)

Graduation and retention rates vary significantly among different demographic groups. According to data from the U.S. Department of Education, there are persistent gaps in graduation rates between White students and students from underrepresented minority groups. (National Center for Education Statistics, 2022) Closing these gaps requires targeted support and resources to address the unique challenges faced by minority students.

Access to HE remains a challenge for many minority students, particularly those from low-income backgrounds. Economic disparities, lack of access to quality K-12 education, and systemic barriers contribute to disparities in college access and enrollment rates. (ACLU, 2023) Efforts to improve access to HE includes outreach programs, financial aid initiatives, and partnerships with community organizations to support underrepresented students in pursuing HE. (ACLU, 2023) Campus climate surveys provide insights into the experiences of students from diverse backgrounds on college campuses. These surveys often highlight issues such as discrimination, microaggressions, and feelings of exclusion among minority students. (Soundrocket, 2023)

As has been argued, creating an inclusive campus climate requires proactive efforts to address bias, promote cultural competency, and foster a sense of belonging for all students. These statistics underscore the importance of diversity, equity, and inclusion initiatives in HE institutions to ensure that all students have equitable access to educational opportunities and support systems needed to succeed.

Concerning International statistics and data on diversity in HEIs, there is significant variation across countries and regions, but several trends and patterns can be observed globally. Many HEIs around the world actively recruit international students to enhance diversity on campus and foster global perspectives. According to data from organizations like UNESCO and the OECD, international student enrollment has been steadily increasing in recent years.

Countries such as the United States, the United Kingdom, Australia, Canada, and Germany are popular destinations for international students due to their reputation for academic excellence and diverse cultural

environments. International students come from diverse backgrounds, representing a wide range of nationalities, ethnicities, cultures, and languages. This diversity enriches the educational experience for all students and contributes to a more inclusive learning environment. HEIs often celebrate cultural diversity through events, festivals, and student organizations that promote cross-cultural exchange and understanding. (UNESCO, 2022)

Like student populations, faculty and staff in HEIs are becoming increasingly diverse, with many institutions actively recruiting scholars and professionals from around the world. Efforts to enhance faculty and staff diversity often focus on recruiting individuals with diverse cultural backgrounds, expertise, and perspectives to enrich teaching, research, and institutional leadership. International students and faculty may face various challenges and barriers, including language barriers, cultural adjustment issues, visa and immigration regulations, and discrimination or prejudice. (Eden, *et al.*, 2024) HEIs may implement support services and programs to assist international students and faculty in overcoming these challenges and integrating into the academic community.

Internationalization of HE involves collaboration and exchange agreements between institutions across borders. These partnerships facilitate student and faculty mobility, joint research projects, and cross-cultural learning experiences. As it appears, initiatives such as study abroad programs, international research collaborations, and dual degree programs can be argued that they promote diversity, equity, and inclusion in HE by fostering global perspectives and intercultural competence.

Some countries and international organizations conduct surveys and assessments to measure diversity and inclusion in HEIs. These efforts help identify areas for improvement and monitor progress in promoting diversity, equity, and inclusion. Metrics may include enrollment data, faculty and staff demographics, student satisfaction surveys, and indicators of intercultural competence and global engagement. One prominent survey-based study by the International Association of Universities (IAU) –the 6th Annual Global Survey Report focuses on the Internationalization of Higher Education: Current Trends and Future Scenarios. (Marinoni *et al.*, 2024). With a focus on diversity and inclusion as manifested through internationalization, the study expresses factors driving the increase in interest in internationalization via a global regional comparison as is exhibited in the following Table 2.

Table 2: Most responsible factors for the increase of internationalization by region

Factors / Regions	Asia & Pacific	Europe	Latin America & the Caribbean	Sub-Saharan Africa	North Africa & the Middle East	North America	World
Increased need to strategically connect with other HEIs globally	76%	73%	73%	67%	53%	48%	70%
Increased demand and/or support by government or governmental organizations (national, regional, etc.) to focus on internationalization	48%	36%	19%	28%	34%	21%	31%
Increased interest/demand by academic staff at our institution	24%	34%	50%	39%	43%	28%	39%
Increased interest/demand by administrative staff at our institution	4%	11%	11%	3%	5%	24%	10%

Factors / Regions	Asia & Pacific	Europe	Latin America & the Caribbean	Sub-Saharan Africa	North Africa & the Middle East	North America	World
Increased interest/demand by students at our institution	46%	40%	55%	25%	38%	31%	44%
Increased need for income generation through internationalization	15%	20%	8%	33%	17%	45%	18%
Requirement for international accreditation	24%	14%	20%	11%	36%	7%	19%
Requirement from international rankings	24%	15%	10%	36%	48%	21%	19%
Shift of priorities at institutional level	13%	16%	23%	9%	13%	21%	18%
Other	6%	6%	8%	3%	3%	3%	6%

Source: Marinoni et al. 2024 -- IAU 6th Annual Global Survey

While the interest for internationalization is multi-dimensional, the regional differences are varied. Overall, promoting diversity, equity, and inclusion in HEIs requires ongoing efforts to create welcoming and inclusive environments for students, faculty, and staff from diverse backgrounds, both domestically and internationally. To best design and implement a DEI initiative with the aid of AI, the following factors need to be taken into consideration. Foremost, AI algorithms may inadvertently perpetuate or amplify existing biases and inequalities, leading to unfair treatment or discrimination against certain individuals or groups. Ethical considerations involve ensuring that AI systems promote fairness, equity, and justice for all stakeholders. (Kahn, 2022)

Furthermore, an ethical AI inclusion requires transparency in how algorithms make decisions and accountability for their outcomes. Institutions must provide clear explanations of AI processes and decisions to stakeholders and establish mechanisms for addressing algorithmic errors or biases. (Balasubramian et al, 2023). AI systems often rely on vast amounts of data, raising concerns about privacy, consent, and data security. Institutions must adhere to data protection regulations and ethical guidelines to safeguard sensitive information and ensure individuals' privacy rights are respected. (Bird et al., 2020)

Ethical AI involves striking a balance between automation and human oversight. While AI can streamline processes and improve efficiency, it should not replace human judgment and decision-making entirely. Institutions must maintain human control and oversight over AI systems to prevent unintended consequences and ensure accountability. (Intel.gov, 2020)

Addressing bias in AI begins with ensuring that training data is diverse, representative, and free from biases and stereotypes. Institutions should carefully curate datasets to include diverse perspectives and mitigate the risk of algorithmic biases. Institutions can employ techniques such as fairness-aware machine learning to identify and mitigate biases in AI algorithms. These techniques involve assessing algorithmic outputs for disparities across different demographic groups and adjusting models to promote fairness and equity. (Gonzalez-Dendino et al., 2024) Additionally, Ethical AI requires ongoing monitoring, auditing, and evaluation of AI systems to detect and address biases or errors. Institutions should implement regular audits and evaluations of AI algorithms to ensure they operate ethically and comply with established standards and guidelines. (Encord, 2023)

With respect to successful DEI initiatives in HE, there are a number that have recently come to light. With respect to automated bias detection and mitigation, the University of California, Berkeley developed an AI-powered tool to detect and mitigate biases in the admissions process. The tool analyzes admissions data to identify patterns of bias and provides recommendations for improving fairness and equity in admissions decisions. By leveraging AI, the university aims to create a more inclusive admissions process that considers the diverse backgrounds and experiences of applicants. (Pearson, 2024)

For personalized learning for diverse student populations, Georgia State University implemented an AI-driven advising system to provide personalized support and interventions for students from underrepresented backgrounds. The system analyzes students' academic performance, engagement, and other data to identify at-risk students and recommend targeted interventions, such as tutoring, mentoring, or additional resources. As a result, the university has seen significant improvements in retention and graduation rates for minority and low-income students (Georgia State News Hub, 2022)

As for language translation and accessibility the University of Washington developed an AI-powered language translation tool to improve accessibility for students with limited English proficiency. The tool automatically translates course materials, lectures, and other educational content into multiple languages, allowing non-native English speakers to fully participate in classroom activities and access learning resources. By removing language barriers, the university promotes inclusivity and ensures equitable access to education for all students. (Milne, 2023)

Stanford University uses AI-driven recruitment platforms to identify and attract diverse candidates for faculty positions. These platforms analyze job postings, candidate profiles, and demographic data to identify potential biases in the hiring process and recommend strategies for reaching a more diverse applicant pool. By leveraging AI, the university aims to increase representation of women, minorities, and other underrepresented groups among faculty members. (Stanford, 2024)

Arizona State University implemented an AI-driven platform to support inclusive curriculum development and course design. The platform analyzes course materials, syllabi, and learning objectives to identify potential biases, stereotypes, or gaps in representation. Faculty members receive recommendations for enhancing diversity and inclusion in their courses, such as incorporating diverse perspectives, authors, and case studies. By integrating AI into curriculum development processes, the university promotes equitable learning experiences for all students. (Pirehpour, 2023)

The University of Michigan uses AI-powered chatbots and virtual assistants to enhance community engagement and outreach efforts. These chatbots provide information, resources, and support to prospective students, current students, faculty, staff, and alumni. By leveraging AI, the university ensures that its services and support systems are accessible and responsive to the diverse needs of its community members, including those from underrepresented backgrounds. (O'Connell, 2024)

These examples demonstrate how AI can be harnessed as a powerful tool for promoting diversity, equity, and inclusion in HEIs, spanning areas such as admissions, student support, faculty recruitment, curriculum development, and community engagement. By leveraging AI-driven initiatives, universities can create more inclusive academic environments that prioritize fairness, accessibility, and representation for all stakeholders. While there are significant challenges and concerns to DEI in HE, such as systemic barriers and historical inequalities, lack of institutional support and resistance to change, implicit bias and discrimination, and financial and resource allocation restraints, there are opportunities for optimistic outcomes.

Conclusion

AI and ML technologies hold promise for revolutionizing public sector operations, offering opportunities for increased efficiency, enhanced citizen engagement, and improved service delivery (Maalla, 2021). However, challenges persist, including the need for workforce readiness and regulatory oversight (Berryhill *et al.*, 2019). Concerns regarding data privacy and integrity also remain prominent (Habeheh and Gohel, 2021). In HE, integrating AI&ML effectively into institutional practices is essential for innovation and research (Mikhaylov *et al.*, 2018; Berglind *et al.*, 2022). However, this integration faces obstacles such as aligning educational objectives with workforce needs, ensuring data privacy, and fostering research integrity (Berglind *et al.*, 2022). Strategic planning and ongoing discussions are crucial to effectively harness the potential of AI&ML in both the public sector and HE (Kolkman, 2020).

AI and ML technologies have rapidly gained prominence in HE, offering opportunities to enhance various aspects of teaching, learning, research, and administrative processes. Research contributions highlight the diverse applications of AI&ML in HE, including predictive modeling for student performance (Salem *et al.*, 2021), adaptive learning platforms (Zawacki-Richter *et al.*, 2019), and virtual teaching assistants (Chu *et al.*, 2022). These technologies are increasingly utilized in admissions and enrollment processes, personalized learning experiences, predictive analytics for student support, and administrative efficiency (Barramuño *et al.*, 2021).

While AI&ML offer advantages such as improved decision-making, innovative teaching methods, and enhanced research capabilities, their implementation also poses challenges such as algorithmic biases, data privacy concerns, and resistance to change (Eubanks, 2018; Selwyn, 2019; Watters, 2015). A balanced approach, considering both the benefits and risks, is essential to effectively integrate AI&ML into HE and maximize their potential to transform educational experiences (Chen *et al.*, 2020; Crompton *et al.*, 2020, 2021).

Key findings in DEI initiatives within HEIs underscore the importance of fostering fairness, access, and inclusion for all members of the academic community. These initiatives aim to enrich the learning experience by exposing students to diverse perspectives, preparing them for success in a globalized society. Leveraging AI-driven tools can help address challenges such as bias detection, personalized learning, language accessibility, diverse faculty recruitment, and inclusive curriculum development. For instance, institutions like the University of California, Berkeley and Georgia State University have successfully implemented AI-powered solutions to enhance diversity and inclusion efforts, leading to improvements in student retention and graduation rates. These findings highlight the transformative potential of AI-driven initiatives in creating more inclusive academic environments.

And finally (H)E faces at least two potential outcomes. First, AI&ML has the potential to revolutionize existing teaching and learning, assessment, and learner engagement. Second AI&ML also can create an entirely new education system in which the role of professors could be less important and present. There are questions about how the impact of an over-reliance on AI&ML might result in a decline in many of the traits that make us human. Our research, which includes a comprehensive review of contemporary literature and the results of previous studies on the effects and consequences of AI&ML, does not offer a definitive answer to the question of whether these technologies will replace or enhance and enrich the role of professors in the educational process. This ambiguity is likely because we are only at the early stages of the serious application of AI & ML across all areas of HE. As such, the long-term impact and potential of these technologies in education are still largely uncertain and remain to be fully understood.

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