High Intelligent Tutoring Systems in Higher Education: Ethical, Regulatory and Pedagogical Foundations for Academic Success

HITS Consortium

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Summary

This handbook explores how High Intelligent Tutoring Systems (HITS) can support academic success and innovation in higher education by leveraging the latest advances in artificial intelligence. It offers a comprehensive overview of Intelligent Tutoring Systems, from their definition, history, and pedagogical foundations to their current and potential applications in personalized learning, dropout prevention, academic and career guidance, and student performance analysis.

The document situates HITS within the evolving international regulatory and ethical landscape, presenting key guidelines and principles from UNESCO, OECD and the European Union, including the EU AI Act and FATE (Fairness, Accountability, Transparency, Ethics) approaches. Particular attention is paid to issues such as bias, transparency, data protection, implementation costs, and user acceptance among students and educators, which are critical for responsible and sustainable deployment.

Building on empirical evidence from focus groups and questionnaires with students, professors, and tutors, as well as on real-world case studies (e.g. MATHia, Panther Retention Grant, Brightspace Insights, Course Signals, IBM Watson), the handbook identifies concrete needs and priorities for higher education institutions considering the adoption of ITS. It concludes with practical recommendations and lessons learned to guide the design and implementation of user-centred, inclusive, and ethically grounded HITS, with a clear focus on improving teaching, learning, and assessment processes across diverse educational contexts.

Chapter 1 Introduction to Intelligent Tutoring System (ITS)

The search for innovative and effective methods to enhance learning is an ongoing process. Intelligent Tutoring Systems (ITS) are emerging as a powerful tool with the potential to transform the way we learn and teach.

Unlike traditional methods, ITSs harness the power of technology to deliver personalized, adaptive and immersive learning experiences. These systems can assess each student's progress, identify their strengths and weaknesses, and adapt content and activities accordingly.

In this chapter, we will thoroughly explore the features, applications and benefits of ITS. We will analyze how these systems are revolutionizing education at various levels, from individualized tutoring to non-formal and informal education. Besides, we address the challenges and opportunities presented by implementing ITSs and discuss their potential to transform the future of learning.

#INTELLIGENTTUTORINGSYSTEM #HIGHEREDUCATION #LIFELONGLEARNING

1.1 Definition and characteristics of Intelligent Tutoring Systems

1.1.1 What are Intelligent Tutoring Systems?

In the current educational landscape, Intelligent Tutoring Systems (ITS from now on) are presented as innovative tools with the necessary potential to transform the way we learn, teach support and evaluate students in Higher Education. To better understand their impact, it is crucial to accurately define what ITS are, distinguishing them from other traditional educational tools. Now, we find ourselves at a crucial point regarding technological advancements, and higher education must be at the forefront, progressing simultaneously to keep up with them.

1.1.1.1 Dataset availability and explainability of AI techniques

We will begin with the definition of an Intelligent Tutoring System. Martínez-Durán & Calvo (2021) define it as “computational systems designed to deliver instruction and support teaching-learning processes intelligently through interaction with the student". The revolutionary aspect of IT is **its understanding of the interactions with learners**, providing a more complex perspective on their questions instead of replying repetitively.

ITS offer an innovative and powerful alternative to traditional tutoring systems, with great potential to improve the quality and equity of education. However, it is important to consider that ITS are still in development and that their effective implementation requires careful planning, adequate resources and specialized training for teachers and tutors.

The choice between ITS and traditional tutoring will depend on the specific needs of the educational context, the characteristics of the students and the available resources. In some cases, a combination of both approaches may be the most appropriate solution.

As technology advances and costs decrease, ITS are likely to play an increasingly relevant role in the future of education, complementing and, in some cases, replacing traditional tutoring systems

1.1.1.2 Dataset availability and explainability of AI techniques

ITS have very outstanding characteristics that make them great allies for the revolution, which brings their entry into the higher education system. We will follow the pedagogical trend that places the student at the center of the teaching-learning process, and, in their environment, learning patterns will be built. This movement is not revolutionary, since great pedagogues such as John Dewey or Lev Vygotsky began to develop it in the 20th century. However, it is more viable to develop in the classroom thanks to the use of ITS that offer the opportunity to adapt a set of principles to the different learning profiles that current students present.

Identification of the individual characteristics of the student body.

The student will be at the center of the process, which means that it is important to have a set of data to be able to analyze the learner and generate the most convenient itineraries pathways. In the interaction with the students, the individual needs and learning styles of each student must be identified, considering their academic history, their performance and their projects. Another important aspect will be the learning style, which will determine the way in which information is best acquired, whether visual, auditory, analytical, creative or Kinesthetic. A determining parameter will be the most common errors during learning, the strategies used

for enhancing their understanding, and the time needed by the student to carry out the learning process.

Finally, we must not disregard the personal interests and motivations of the student, their personal and professional goals, as well as the motivation they have to continue. All these inputs provided to the system will locate and analyze the complex patterns of student behavior that generate personalized learning paths that can predict future performance and adapt activities accordingly.

Custom content.

When focusing on the student, we must keep in mind that, although the content is always the same, the way in which this knowledge is presented does not have to be the same for all students. ITS, with the prior information provided by the student about their learning patterns, will be able to personalize how the content is presented, selecting what is truly relevant to their learning, their interests, their needs and the level of understanding, adjusting the complexity and depth, but guaranteeing that the content is acquired. To ensure this learning process, we will work with activities, but again, they can be personalized based on the learning style or challenges that the student faces. This personalization will help adapt and adjust the difficulty of the activities based on a logical, progressive and rhythmic sequencing appropriate to the student's profile.

This entire process responds to the concept of “Scaffolding of learning” also known as scaffolding, it is a metaphor used in the educational field to describe the process of temporary support that is provided to students so that they can reach new levels of knowledge and skills. This approach is based on the idea that learning is a constructive and collaborative process, in which students need the guidance and support of others to advance their cognitive development, and ITSs have the perfect place in that role. Thus, complex tasks could be divided into less complex tasks, offer examples, clues or problem-solving models, and provide immediate feedback on the student's performance along with suggestions for improvement.

Adaptation in real time.

ITS have the ability to adapt the educational experience in real time, based on progress and individual response, adjusting it to the profiles of the student. This feature allows them to offer personalized and effective learning, optimizing the process of acquiring knowledge and skills.

On the one hand, immediacy makes learning routes personalized but dynamic, and can change as the student's vital needs, personal or professional objectives and motivations do.

On the other hand, timely and detailed feedback is essential for effective learning. This feedback helps the student identify their strengths and areas for improvement. For feedback to work and improve student learning, it must be specific and provide detailed information about what the student did well and what can be improved. It should be descriptive, explaining

the reasons for the success or failure of the activities and, above all, it should provide the student with concrete suggestions on how to improve their performance.

Continuous assessment.

As we have seen previously, the use of ITS adapts to the teaching-learning process, and that includes evaluation. Continuous evaluation is a cornerstone in ITS, enabling measurement of student progress as well as gathering valuable information to adjust learning experiences in real time.

This evaluation is holistic and multidimensional, which directly affects various aspects of learning beyond memorization or the evaluation of knowledge itself. Thus, outstanding aspects such as problem solving, critical thinking, creativity and communication will be considered. In addition, all possible perspectives are regarded (self-assessment, peer and external) providing a comprehensive overview of the progress, possible difficulties and potential of the student body.

Finally, the way information is gathered is critical. This intelligent system will base its analysis on applying concepts, solving problems and performing tasks in real or simulated contexts. This analysis can be carried out in different formats such as

- Portfolios that include works, projects, presentations and reflections, identifying patterns of learning and development.
- Self-assessments that encourage student reflection on their own learning, allowing them to identify their strengths, weaknesses and areas for improvement.
- Adaptive tests that adjust the level of difficulty based on the student's performance, providing an accurate and personalized evaluation.
- Educational games that integrate evaluation in playful and motivating environments, enabling the student to learn and evaluate their progress in an entertaining way.

In this way, ITS offer a valuable tool to optimize learning, encourage active student participation, and develop metacognitive skills that are key for academic and personal success.

Adaptation to context.

These intelligent systems create personalized experiences that not only personalize educational content and activities but can also tailor the learning environment to meet the individual needs and preferences of each student. This feature allows you to create more inclusive, accessible and effective learning experiences for everyone. In this way, it becomes a support tool that can integrate accessibility arrangements such as screen readers, voice recognition software and subtitles, enabling students with visual, auditory or motor disabilities

to access and fully participate in learning. It can offer content translation options into different languages, for students who aren't fluent in the system's first language. In addition, as expected, it offers assistance through live chats, discussion forums and virtual tutors. So that students can get help and support when they demand it.

Lastly, although not as critical, it offers the option of having a personalized interface, enabling students to choose the appearance of the system, including colors, fonts, font size and contrast, to optimize visual comfort and accessibility. On the other hand, it can offer different navigation options, such as drop-down menus, keyboard shortcuts, and voice commands, to suit the student's preferences and abilities. Finally,it can present the information in an organized and structured way, using visual resources such as icons, images and diagrams, to facilitate understanding and access to the content.

1.2 Brief history of Intelligent Tutoring Systems

Intelligent Tutoring Systems are not new but have evolved over the decades due to the work of visionary researchers and educators.

Since the early 1950s intelligent tutoring was well established as an endeavor area and it was already well recognized that different interaction policies and cues of student confusion led to different learning outcomes. However, it was not until the early 1980s that instructional psychology began to shift its focus toward topics and tasks that had real-world relevance, addressing the issue by connecting its findings to broader social needs. (Romero-Salón 2020). This took place essentially because of the appearance of intelligent and adaptive computer systems capable of automating the process of providing effective research-based instruction of the sort that has been proven effective in their laboratories over the previous 30 years. This new research approach in instructional psychology went beyond the traditional applications of 'drill and practice' and 'practice and feedback' to a broader range of educational goals based on the delivery of instruction that can be tailored to the needs of the individual.

The first applications in this area, dating back to 1956, supported the research already undertaken at that time in cognitive psychology and focused on mathematics teaching and logical reasoning tasks. While much of the initial momentum for smart tutoring applications was driven by an interest in the practical applications of that research and a desire to improve education. Our main concern here is smart tutoring in general and research on tutoring systems, particularly at higher education levels. In this area, much of the currently relevant research dates back to the 1970s and it is based on instructional philosophy that has informed much of the past psychological research on instruction in complex domains. (AlDhaen 2022).

Over the past 40 years of developing smart tutors, a lot has been learned about how to strengthen the power of AI-based tutoring systems. Part of this growth can be attributed to advances in computers and digital technologies. There has been continuous improvement in the graphical user interface and other computer technologies that make interactions with smart

tutors smoother and more efficient. These technological improvements continue. Currently, they include a resurgence of interest in project-based learning, learning from big data, and large-scale automated assessment.

Great advancements have been made in understanding the principles of learning and the characteristics of intelligent tutors. They are adaptive and interactive activities. They present course material in a cascade of small, well-sequenced steps and adjust to the cognitive and affective needs of students. We can group these activities into four categories. They encompass different forms of student support, effective combinations of learning resources and well-designed learning activities. In the realm of problem solving, researchers continue to identify and understand the conditions under which feedback is effective. Feedback is also useful for students of humanities and laboratory sciences. There is strong evidence to support the use of solid and elaborate feedback in mathematics. In some cases, we understand that it is not beneficial, such as in cases where a solution is right or wrong and does not require any explanation.

1.2.1 Adaptation to Higher Education.

In recent years, the presentation of Explainable Artificial Intelligence (XAI) has been celebrated, which places emphasis on the transparency and explainability of the AI algorithms used in ITSs, enabling educators and students to better understand the decisions made by the system and build confidence in its use.

ITS become more sensitive to the context in which they are used, suiting teaching to the characteristics of the educational environment, culture and the specific needs of students. Greater interoperability and compatibility are sought between ITSs and existing educational systems, facilitating their implementation and adoption on a large scale.

Overall, the last decade has been an innovation era and accelerated progress in the field of Intelligent Tutoring Systems. Technological advances have brought new possibilities to personalize learning, have made it more accessible and attractive, and have enhanced collaboration between students. As these technologies continue to develop, we can expect to see an even greater impact of ITSs on education, transforming the way we learn and preparing new generations for success in an ever-changing world.

Intelligent Tutoring Systems are at a crucial point in their evolution, with enormous potential to transform the educational landscape. By addressing current challenges and taking advantage of the opportunities offered by new technologies, we can build a future in which SITs are essential tools to provide all students with a personalized, engaging and effective education.

1.3 Importance of Intelligent Tutoring Systems in higher education

Intelligent Tutoring Systems have proven to be versatile and effective educational tools, with a wide range of applications in various educational scenarios. Responding to individual needs of each student, offering personalized learning experiences, and using cutting-edge technology make them a valuable resource for improving the quality of education and promoting effective learning. Some of these applications can be:

Content recommendation

Intelligent Tutoring Systems can recommend relevant and personalized educational resources for each student, based on their interests, needs and learning style. This is achieved through techniques such as:

- Student profile analysis including academic interests, learning style, and learning pace.
- Learning history analysis including the content the student has seen, the activities the student has carried out and their performance on evaluations.
- Recommendation technologies, through collaborative filtering and machine learning, to suggest relevant and personalized educational resources.

The benefits in this area are broad and diverse, since students have access to a wide range of quality educational resources that fit their interests and needs. Students can learn in a more personalized and effective way by focusing on content relevant to them. In addition, the guidance and recommendation of relevant content can increase students' motivation to learn, optimizing time by not having to search for educational resources randomly.

Virtual reality and augmented reality

Intelligent Tutoring Systems can create simulated, interactive learning environments enabling students to experiment and apply concepts in realistic contexts. This is achieved through techniques such as:

- Immersive simulations that transport students to different places, times or hypothetical scenarios. Enabling students to experience historical events, explore scientific environments, or practice medical procedures in a safe, controlled environment.
- Augmented learning environments, overlaying digital information on the real world, creating interactive and contextualized learning experiences.

It becomes clear that by using it, students would learn through real experience, applying concepts and solving problems in simulated contexts that resemble the real world. Undoubtedly, educational simulations and games are more attractive and motivating for

students, increasing their participation and commitment to learning, through the development of practical skills, such as problem solving, critical thinking and decision-making in a safe and controlled environment. Lastly, experiential learning and interaction with simulated environments promote better long-term knowledge retention.

Plagiarism Detection

Intelligent Tutoring Systems can identify and prevent plagiarism in academic works, promoting originality and intellectual integrity:

- hrough the comparison of texts with a large database of academic works, articles and websites to identify possible cases of plagiarism.
- hrough the analysis of writing style, identifying inconsistencies or unusual similarities with other texts
- throughthe detection of plagiarism patterns such as copying and pasting text without citing sources or paraphrasing without adequate attribution.

The advances are more than evident, but we highlight that it promotes originality and intellectual integrity, reduces the risk of academic sanctions through the promotion of values such as academic honesty and ethics, improving the quality of academic works

Inclusive and personalized education

Intelligent Tutoring Systems can be adapted to the individual needs of students with visual, hearing, motor or cognitive disabilities, providing them with specific tools and resources to facilitate their access to learning.

The offers for the student body include multiple advantages, from personalized tutoring aimed at helping them overcome difficulties and improve their situation at risk of social exclusion, to the use of alternative and augmentative communication systems where Artificial Intelligence acts as an ally, providing immediate feedback and accurate in situations of danger or personal risk.

Continuous training and professional development

Lifelong learning is another area of higher education where ITS have a determining role, since they can be used to train professionals in technical and transversal skills, such as the use of specific software, communicating ideas or managing people.

ITS can help professionals prepare for training and certifications by providing personalized study materials, mock exams, and detailed feedback on their performance.

Informal education and lifelong learning

Intelligent Tutoring Systems have proven to be invaluable tools in formal education, but their potential extends far beyond the traditional classroom. In the field of non-formal and informal education, ITS have the power to transform the way people learn and acquire knowledge outside of structured educational environments.

In non-formal education, ITS can offer customized training programs for individuals to acquire the skills needed to enter the labor market or improve their career prospects. Another area of action is a healthy lifestyle, worked on through the prevention of diseases and improving the general well-being of people. Besides, social and citizen participation is worked on through fostering education about rights and civic duties, promoting values such as tolerance, interculturally and respect for the environment.

In informal education, ITS has a critical role; they can be used to learn hobbies and leisure activities, such as playing a musical instrument, practicing a sport or cooking. This can contribute to personal enrichment, entertainment and socialization. Searching for people's motivations and passions are key for keeping people motivated to continue and seek their complete personal development. Furthermore, perhaps this awakes in them new avenues of professional development.

Research and development in education

One of the largest areas of action of ITS is the field of educational research and development. Due to their multiple options and immediate response, they can gather valuable data on student behavior and learning, enabling researchers to identify patterns, develop theoretical models and assess the effectiveness of different teaching strategies.

Like technological advancement, teaching methodologies must advance and keep up with the new technologies offered by the market. So, they can be used to experiment with new teaching methodologies, such as adaptive learning, project-based learning or collaborative learning.

Finally, the greatest feature of ITS is the personalization power they have; they can serve as a basis for the development of personalized educational tools, adapted to the specific needs of each student and learning context.

1.4 The Future of Education: Intelligent Tutoring Systems

Intelligent Tutoring Systems have come a long way since their inception in the 1960s, evolving from simple programmed learning systems to sophisticated tools powered by artificial intelligence and machine learning. Throughout their history, ITS have demonstrated enormous potential to transform education, offering personalized, adaptive and effective learning experiences for students of all levels and backgrounds.

Today, ITS are at a tipping point, with the ability to revolutionize the way we learn and teach. Technological advances in artificial intelligence, big data and other emerging areas are opening up new possibilities for creating more sophisticated, personalized and accessible ITSs.

However, for ITS to reach their full potential, a few key challenges need to be addressed such as ensuring equitable opportunities for access to ITS for all students, regardless of socioeconomic background, geographic location, or technological skills. Another challenge refers to their integration with teaching practice by providing them with the necessary training and support to make the most of these tools.

Despite these challenges, the future of Intelligent Tutoring Systems is promising. The combination of innovative technologies and sound pedagogical approaches can transform education into a more personalized, engaging and effective process for all students. ITS has the potential to democratize access to high-quality knowledge, close educational gaps and prepare new generations for the challenges of the 21st century.

In short, Intelligent Tutoring Systems are not just an educational tool of the future, but a reality that is already transforming the educational landscape. As we continue to develop and implement these systems responsibly and effectively, we can build a future in which all students have the opportunity to reach their full potential.

Chapter 2 Successful implementation of ITS in higher education. How can AI be used in higher education today?

2.1 Introduction

The rapid expansion of research in digital education is evident across various fields, including teaching and learning practices, career guidance, tutoring, skills and knowledge assessment, and academic management. This growth is driven by the increasing adoption and innovation of digital technologies within educational settings (Car et al., 2019). In fact, digital technology has become central to higher education, significantly influencing student engagement and the overall student experience (Bond et al., 2020). The COVID-19 pandemic has further accelerated digital transformation, prompting leaders to adapt to this new reality and explore its implications (Laufer et al., 2021).

With this growth, there is a heightened demand for education and training in areas such as gamification, artificial intelligence, and big data analytics (Soma & Nuckchady, 2021). Integrating digital skills development has also become a challenge in vocational schools and cooperative higher education institutions due to the increased use of internet and communication technologies among students and teachers (Wild & Heuling, 2020). Studies highlight the multidimensional nature of digital education, emphasizing aspects such as openness, quality, and the development of alternative credentials (Veletsianos et al., 2021). Therefore, the impact of digitalization on learning outcomes and various sectors beyond education is a key area of interest (Qureshi et al., 2021).

The transformation of the educational environment due to digitalization leads to a shift in cultural values and an emphasis on developing cognitive, interpersonal, and intrapersonal skills among learners. Research shows that the readiness and accessibility of technology positively influence student learning outcomes. Today, many higher education institutions face the challenge of addressing diverse technological readiness levels among students, with deficiencies in information and digital literacy posing obstacles to success (Buzzetto-Hollywood et al., 2018).

The integration of technology into teaching practices is essential for successful teaching and impacts student outcomes (Mollaei & Riasati, 2013). Consequently, technology in education has evolved from being a cost to be a critical factor in student success.

Moreover, faculty members' technical proficiency is crucial, especially in institutions offering technology-driven programs, as it significantly impacts student success. In fact, educators'

acceptance and utilization of technology, including assistive technologies, play a vital role in enhancing student success. Technology-driven assessment strategies and activities are critical for improving student success rates (Khumalo, 2018).

In terms of student retention, technology enhances engagement. Tinto (Tinto, 2023) found that student engagement is critical for retention, and technology can facilitate this through online forums, interactive materials, and personalized feedback systems. Providing various tools and resources helps create a supportive learning environment that encourages persistence and success. A meta-analysis by Tamim (Tamim et al, 2011) demonstrated that technology-enhanced learning environments positively affect student achievement. Incorporating multimedia resources, adaptive learning platforms, and data analytics allows educators to tailor instruction to individual needs, improving learning outcomes.

Technology is essential for student enrolment, retention, and educational outcomes in higher education. Introducing new technologies can attract and retain students, enhance engagement, and improve overall outcomes. Thus, universities must explore innovative ways to integrate technology into their practices to ensure student success in the digital age.

The future of programming education is of great interest in the fields of education and technology. As information technology evolves, its role in education becomes increasingly significant. Integrating technology in educational settings enhances learning experiences, improves student engagement, and provides new opportunities for collaboration and peer learning. Collaboration and peer learning are key components of effective programming education, as working together allows students to learn from each other, share ideas, and solve complex problems. Peer learning also fosters teamwork and communication skills, essential in technology fields. Digital education offers advantages such as scalability, flexibility, and adaptability, making it a promising approach for new peer learning practices. In this new perspective, Artificial Intelligence (AI) has the potential to revolutionize higher education by enhancing teaching and learning processes.

2.2 Artificial Intelligence in HEIs: potentialities and threats for improving academic processes and practices

utoring methods supported by Artificial Intelligence (AI) are an exciting development in programming education. AI technologies have been increasingly applied in higher education, with a focus on automating teaching and learning tasks to enhance student learning experience, provide student support, and improve enrolment management (Hannan & Liu, 2021). Moreover, AI-powered tutoring systems can provide personalized learning experiences, adapt to individual student needs, and offer real-time feedback and support. The aim is to provide a service tailored to the specific needs and learning style of individual students. By analyzing student performance data, AI tutors can identify areas where students are struggling and provide targeted interventions to help them improve their programming

skills. Several studies have highlighted the various applications of AI in higher education, such as profiling, prediction, assessment, evaluation, adaptive systems, personalization, and intelligent tutoring systems (Zawacki-Richter et al., 2019; Bozkurt et al., 2021). By leveraging AI technologies, higher education institutions can analyze vast amounts of data to gain insights into student performance and tailor instruction to individual needs. This can lead to improved learning outcomes and increased student satisfaction. AI-powered adaptive learning platforms can analyze student data in real-time to provide personalized recommendations and feedback, helping students improve their understanding and retention of course material. Additionally, AI can assist in the grading process by automating the evaluation of assignments and exams, allowing educators to focus more on providing valuable feedback and support to students. AI assistance in data analysis can identify trends and patterns in student performance, helping educators in making informed decisions about instructional strategies and interventions. Promoting self-directed learning is a frontier that AI can face developing virtual tutors and intelligent learning systems. The potential lies in the improvement of instructional delivery, personalizing learning experiences, automating administrative tasks, and providing valuable insights into student performance and outcomes. Gamified learning platforms, virtual reality simulations, and chatbots can motivate students' engagement in learning, making it more enjoyable and leading to higher levels of commitment. Automating administrative tasks, such as grading assignments and managing schedules, frees up educators' time to focus on more meaningful interactions with students. From personalizing learning experiences and adapting curricula to analyzing data for informed decisions, AI tools are reshaping education's landscape in unprecedented ways. By harnessing the power of AI, educators can create dynamic and engaging learning environments that equip students with the skills and knowledge they need to excel in the modern world.

Based on the above considerations, it is clear that Artificial Intelligence promises to transform higher education by enhancing learning, research, and leadership in schools and universities. However, the integration of AI in higher education comes with significant challenges, requiring a deeper engagement with its societal implications to ensure successful implementation (Bearman & Ajjawi, 2023). Despite over 30 years of AI use in education, there remains a limited understanding of its effects on teaching and learning in higher education (Durso & Arruda, 2022). The potential of AI to enhance teaching and learning in higher education is acknowledged (Slimi, 2022), but there is a need for more investigation on the adoption of AI in this context (Crompton & Song, 2021). Researchers agree that there is a lack of critical reflection on the pedagogical and ethical implications of AI in higher education (Bozkurt et al., 2021). The integration of AI is a significant development that requires careful consideration of ethical and educational approaches (Zawacki-Richter et al., 2019). It is crucial to balance AI-driven enhancements with the essential human touch that educators provide, ensuring technology augments rather than replaces the human connection at the heart of education. Addressing potential obstacles to AI-supported teaching and learning is essential for successful implementation (Watanabe, 2023). To fully realize the benefits of Artificial Intelligence in higher education, social, cultural, and ethical issues related to bias, fairness, privacy, transparency, fairness, and security must be considered. Without careful

consideration of these issues and proactive oversight, AI could exacerbate inequality, undermine trust in institutions, and perpetuate bias against marginalized groups. Additionally, the resource requirements for responsible AI implementation—such as technical staff, data infrastructure, management systems, and ongoing funding—pose challenges for some institutions. Faculty, staff, and students may resist AI due to concerns about job threats, dehumanization of education, and a lack of transparency in algorithm-based recommendations. These challenges suggest that AI initiatives should be implemented after careful research and testing, and in a way that is consistent with educational priorities, ethical principles, and societal values. Addressing these challenges and finding solutions highlights the need to strengthen university management to promote AI integration in higher education. University strategic leadership plays a critical role in guiding appropriate AI adoption and innovation to balance benefits and risks. Examples of strategic actions that educators can pursue include articulating an AI vision within the context of broader institutional goals, fostering a campus climate that embraces experimentation and thoughtful adoption of AI tools, ensuring transparency and oversight of AI initiatives, and allocating resources to support ethics. Educators need a deep understanding of AI opportunities, trends, challenges, and applications specific to higher education to distinguish hype from reality, critically evaluate vendor offerings, and formulate AI investment strategies that maximize benefits while minimizing potential harm.

In conclusion, with the rise of Artificial Intelligence, education faces two challenges: reaping the benefits of AI to improve education processes, both in the classroom and at the system level, and tooling up students with new skills for increasingly automated economies and societies. While AI applications are still in their infancy, numerous promising examples suggest how AI could revolutionize education. As mentioned before, with reference to the classroom, AI can accelerate personalized learning (Panigrahi & Joshi, 2020) and support for students, while at the system level, it delivers predictive analysis to reduce dropout, and assess new skill sets. A new demand for complex skills that are less easy to automate (e.g. higher cognitive skills like creativity and critical thinking) is also the consequence of AI and digitalisation. Reaching the full potential of AI requires that stakeholders trust not only the technology, but also its use by humans. This raises new policy challenges on “trustworthy AI”, encompassing the privacy and security of data, but also possible wrongful uses of data leading to biases against individuals or groups (Vincent-Lancrin & van der Vlies, 2020). The successful implementation of ITS based on AI tools in higher education has the potential to transform learning, research, and leadership in colleges and universities (Tarisayi, 2023). AI can be used to personalize teaching, provide formative feedback, identify at-risk students, accelerate research discovery, and streamline administrative processes (Tarisayi, 2023). It must be clear that AI based ITS are not a competitor to human teaching, but rather an auxiliary tool that can enhance various operations and improve the educational process. The adoption of AI in higher education can be facilitated by understanding the implications for teachers and students, and by using adoption theories and models (Chatterjee & Bhattacharjee, 2020).

2.3 Limitations and Challenges in implementing Intelligent Tutoring System in Higher Education

Implementing Intelligent Tutoring Systems in higher education presents a range of limitations and challenges that must be carefully considered. These include technological barriers, integration issues, and the need for substantial investment in both time and resources to ensure effective deployment and utilization.

2.3.1 Dataset availability and explainability of AI techniques

Intelligent Tutoring Systems aim to provide individualized instruction by modeling learners' psychological states (Ma et al., 2014). They have been developed and evaluated over the last few decades, with a focus on applying Artificial Intelligence and cognitive science in education. Intelligent learning diagnosis is crucial for ITS, as it estimates learners' current knowledge mastery status and predicts their future learning performance (Wang et al., 2022). However, integrating ITS into education has proven difficult (Modén et al., 2021). Transitioning to more accessible and flexible education models, ITS can help move away from traditional teaching methods. The development of ITS has been a focus of applying Artificial Intelligence and cognitive science in education. Despite the challenges, ITS have shown statistically significant improvements in student learning outcomes compared to traditional teaching methods.

A significant challenge is the availability and quality of datasets for training and testing ITS. Without sufficient and relevant data, the performance and effectiveness of the system may be compromised. Researchers need to ensure that the datasets are comprehensive, diverse, and representative of the target student population to enhance the accuracy and reliability of the ITS. Another challenge lies in explaining the AI techniques employed in ITS to educators, students, and other stakeholders. Understanding how AI algorithms work and how they contribute to the learning process is crucial for gaining acceptance and trust in the system. Communicating complex AI concepts in a clear and accessible manner will facilitate the adoption of ITS. Advancements in AI, such as machine learning, natural language processing, and deep learning, can significantly improve the adaptability and personalization of ITS. However, further research and development are needed to leverage these techniques effectively in educational contexts and address specific challenges such as individualized learning paths, real-time feedback, and adaptive assessments. Additionally, more research is needed on software engineering practices specifically tailored to the design, development, and maintenance of ITS. Creating ITS requires interdisciplinary expertise in AI, education, psychology, and computer science, making it crucial to establish best practices and guidelines for ITS development. Research in software engineering for ITS can streamline the design process, enhance system scalability and reliability, and support the integration of new technologies and pedagogical methods. Addressing the limitations and challenges in implementing ITS in higher education requires a concerted effort from researchers, educators, and developers.

2.3.2 Data Privacy and Ethics

According to the concerns of faculties to use ITS (Wang et al., 2020), data privacy and ethics still represent another relevant challenge for implementing ITS in higher education. The elaboration of extensive student data raises issues regarding privacy and ethical use. The effectiveness of ITS has been evaluated, indicating that the results are influenced by the nature of control treatments and the adequacy of program implementations (Kulik & Fletcher, 2015). Despite offering strong learning gains, ITS are traditionally designed for most-developed countries, posing a challenge when scaling them up to mainstream educational contexts (Nye, 2014).

The topic will be discussed in detail in Chapter 4, but here it seems useful to anticipate and underline some points of discussions. The literature comparison highlights the urgent need to address student data privacy protection in AI-driven education, with increasing attention to ethical risks from various stakeholders. It underscores the necessity of establishing a robust data protection framework encompassing information privacy, anonymity, surveillance, autonomy, non-discrimination, and information ownership (Huang, 2023).

Willis (Willis III, et al., 2016) discusses the growth of learning analytics techniques, the need for ethical reflection on student data collection, and presents an analysis of ethical review processes at three research institutions. However, the study shows some limitations, suggesting the need for further research, deeper development of more extensive approval guidelines, and presents the awareness of ethical issues related to learning analytics. It acknowledges limitations in providing a comprehensive understanding of the phenomenon and points out that the main actor in the process is the lecturer, excluding other stakeholders.

2.3.3 Bias

Researchers in education have recently begun drawing attention to existing cases of algorithmic bias in educational technologies. In fact, the possible increase, due to the adoption of AI and machine learning tools, may result in harmful impacts. AI algorithms may perpetuate existing biases in education, leading to inequitable outcomes. As a starting place in understanding the origins of algorithmic bias, Mitchell (Mitchell et al. 2021) makes a helpful distinction between statistical and societal forms of bias, where the first ones encompass sampling bias and measurement error, while societal bias refers to “concerns about objectionable social structures that are represented in the data”. AI algorithms used in ITS have the capability to perpetuate existing biases in education, which can ultimately result in inequitable outcomes for students.

Addressing bias in algorithms within ITS means dealing with bias present in the data used to train these systems. If historical data used to train the AI algorithms contain biases, such as gender or racial biases in grading or student performance, the ITS may inadvertently learn and perpetuate these biases. This can lead to discriminatory outcomes for students from

marginalized groups, further exacerbating existing inequalities in education. Algorithmic bias has been documented in situations ranging from at-risk prediction for high school or college dropout, at-risk prediction for failing a course (Hu & Rangwala, 2020; Kizilcec & Lee, 2020), automated essay scoring (Bridgeman et al., 2012), assessment of spoken language proficiency (Wang et al., 2018), and even the detection of student emotion (Ocumpaugh et al., 2015).

Moreover, the complexity of AI algorithms used in ITS can make it challenging to identify and effectively mitigate biases. These algorithms often operate as “black boxes”, meaning that the decision-making process is not transparent or easily interpretable. As a result, it can be difficult for educators and administrators to understand how biases are being perpetuated within the system and to intervene to address them.

Another limitation in implementing ITS in higher education is the lack of diversity and inclusivity in the development teams creating these systems. This limitation is further compounded by interoperability issues, which make it difficult to deploy these systems in educational platforms. To address these challenges, Santos (Santos et al., 2013) proposes a new approach to implement open-source and interoperable ITS. Woolf (Woolf, 1988) suggests incorporating community expertise to enhance the competence of current tutors, while Bonner (Bonner et al., 2016) highlights the complexities of building ITS for teams and provides a recommended process for authoring team based ITS. If the teams responsible for designing and developing ITS lack diversity, they may inadvertently embed their own biases into the algorithms, further perpetuating inequities in education. Then, it is essential for higher education institutions to prioritize diversity and inclusivity in the development and implementation of ITS. This includes ensuring that data used to train AI algorithms are regularly audited for biases and that mechanisms are in place to address and mitigate any identified biases. Additionally, transparency in the decision-making process of AI algorithms is crucial to enable educators to understand how these systems operate and to intervene when biases are detected.

2.3.4 Implementation Costs

Implementing ITS in higher education faces significant challenges also in terms of implementation costs and the technical expertise required (Kulik & Fletcher, 2015). In fact, deploying AI technologies in higher education requires significant financial investment and technical expertise. The financial investment needed to deploy AI technologies in higher education is substantial, and the expertise necessary to effectively integrate these systems is crucial (Kulik & Fletcher, 2015). Despite the potential learning gains offered by ITS, the costs and technical demands associated with these systems pose barriers to widespread adoption, especially in developing countries (Nye, 2014).

The scalability of ITS to mainstream educational settings has been a notable challenge for the research community (Nye, et al., 2018). While developers aim to enhance the use of Information and Communication Technology (ICT) in ITS, limitations in data provision and ICT

infrastructure in developing countries hinder implementation efforts. Additionally, the willingness of faculty to embrace ITS in the era of AI is a critical factor in the successful integration of these systems (Wang et al., 2020).

The sophistication of software capable of replicating the social-emotional and cognitive roles of educators is essential for the widespread use of ITS (Hughes, 2022). Furthermore, challenges such as technical infrastructure requirements, teacher training, data privacy, security, and ethical considerations need to be addressed when implementing AI in education, including physics education (Mahligawati, 2023).

2.3.5 User Acceptance

Resistance from some students and educators towards AI-driven tools can hinder the successful integration of ITS in educational settings, since they may be resistant to adopting AI-driven tools, preferring traditional teaching methods. Individuals may be hesitant to embrace AI technologies due to concerns about job displacement, lack of trust in machine-based systems, or simply a preference for traditional teaching methods. One of the key reasons for user resistance is the fear of job displacement among educators. Some teachers may perceive ITS as a threat to their roles, fearing that AI technologies could replace them in the classroom. This apprehension can lead to reluctance in adopting ITS and may result in a lack of support for its implementation.

Moreover, the lack of trust in machine-based systems is another significant factor contributing to user resistance. Students and educators may question the accuracy and reliability of AI-driven tools, especially in complex educational tasks that require human intervention and understanding. This skepticism towards ITS may slow its acceptance. Some educators may have strong beliefs in the effectiveness of conventional teaching approaches and may be reluctant to incorporate technology-based solutions into their teaching practices. The preference for traditional teaching methods over AI-driven tools limits the potential benefits in enhancing ITS learning outcomes (Chocarro et al., 2021). Addressing the concerns related to job displacement, building trust in machine-based systems, and promoting the benefits of AI-driven tools are essential steps to overcome resistance and facilitate the successful integration of ITS in educational settings.

2.4 Implementing Intelligent Tutoring System in Higher Education

Implementing an ITS in higher education necessitates a comprehensive understanding of research directions to effectively guide its development and deployment. Research directions denote the paths and patterns of research endeavors, offering insights into the evolution and outcomes of various studies. By outlining these trajectories, it becomes possible to track the progression of research topics over time, aiding in the identification of emerging trends and areas of focus within a particular field. Analyzing trajectories in educational research enables educators to tailor ITS content and delivery to cater to diverse learner needs. They inform the

development of algorithms predicting student learning paths, enabling timely and targeted interventions to support student progress. Furthermore, research trajectories in the field of computer science can offer valuable insights into trajectory planning for intelligent systems, such as robots used in educational settings. Trajectory planning algorithms can, also, enhance the effectiveness of ITS by optimizing the delivery of educational content based on individual student trajectories and learning preferences (Li et al., 2023). Leveraging research directions from diverse fields like education, computer science, and psychology significantly enhances ITS design and implementation.

This section is devoted to the exploration of four crucial domains: Personalized Learning Experiences, Student Dropout Prevention, Tutoring and Academic Career Guidance, Students Performance Analysis. After presenting the main aspects of the topic, a few case studies are presented.

2.4.1 Personalized Learning Experiences

AI-assisted systems have been developed for personalized learning, adaptive testing, intelligent tutoring systems, learning analytics, and content creation. A number of studies have explored the potential of AI-powered systems to provide personalized learning experiences tailored to individual student needs. Rizvi (Rizivi, 2023) emphasizes the ability of these systems to adapt to students' strengths, weaknesses, and learning styles, specifically highlighting the use of machine learning, natural language processing, and data mining. Chaplot (Chaplot et al., 2016) and Fernandez (Fernandez et al., 2023) further delve into the technical aspects, with Chaplot proposing a new adaptive learning system architecture using neural networks, and Fernandes leveraging supervised machine learning techniques to schedule assignments and educational activities based on students' needs and preferences. However, ethical, and societal implications, as well as the need for further research, are also highlighted by Tiwari. Recently, Fernandes (Fernandez et al., 2023) leveraged effective Supervised Machine Learning (ML) techniques to adaptively schedule assignments and educational activities based on the students' needs, preferences, and background. The proposed intelligent system is trained based upon different academic factors from student learners' characteristics such as proficiency level, interest level, remote/in-person preference, and assignment type preference and prescribes a proper learning plan to maximize the students' overall grade and satisfaction rate at the end of course. In addition, they conduct analysis of demographic parameters such as gender and race and their effects on students' success and academic satisfaction. A comprehensive analysis of five different machine learning models for ITS including Logistic Regression (LR), K-Nearest Neighbours (KNN), Support Vector Machine (SVM), Decision Tree (DT), and Random Forest (RF) are examined in (Fernandez et al., 2023).

Case study 1: Carnegie Learning's MATHia

The platform offers tailor-made activity courses for children aged 5 to 11, and it offers several key features: One-on-One Coaching, Student Reports, Educator Reports and LiveLab that is a sort of MATHia that mirrors a human math coach by delivering real-time feedback and support to students. Carnegie Learning's MATHia platform has been the subject of several studies. Fancsali (Fancsali et al., 2014) found that the platform's personalization, including the use of learner-specified interests and friends' names, was associated with better learning outcomes. Miranda (Miranda et al., 2015) highlighted the importance of personalized learning objectives in mathematics, a feature that MATHia provides. Ritter (Ritter et al., 2016) discussed the practical implementation of MATHia in real-world classrooms, while Kalloo (Kalloo et al., 2010) emphasized the role of personalization in a game-based mobile learning application for mathematics. These studies collectively underscore the effectiveness of MATHia's personalized approach in improving students' math skills. Other interesting studies based on MATHia are:

1. EMERALDS Study (2021) used anonymized student data from MATHia to evaluate predictors of success in Algebra I. Completion of more workspaces in MATHia led to better performance in Algebra I, especially for students who had low test scores in middle school. MATHia helps close the gap for students who need it most. (https://www.businesswire.com/news/home/20210721005130/en/Carnegie-Learning-Announces-New-3rd-Party-Study-Indicating-That-MATHia-Leads-to-Better-Performance-in-Algebra).

2. A randomized field trial within MATHia explored whether rewriting content in “word problems” improved student mathematics performance, particularly among emerging English language readers. The study demonstrated positive effects of the rewrite intervention (https://link.springer.com/content/pdf/10.1007/978-3-031-36336-8_30).

3. Scalable and Equitable Math Problem Solving Strategy Prediction in Big Educational Data (https://arxiv.org/pdf/2308.03892.pdf). This study introduces an AI-driven method to identify students' problem-solving strategies in mathematics. By employing mastery-based embeddings (MVec) and non-parametric clustering, the approach ensures fair and accurate predictions across diverse skill levels. Utilizing real-world datasets from MATHia, the model demonstrates scalability and effectiveness in enhancing personalized learning.

4. Rewriting Math Word Problems to Improve Learning Outcomes for Emerging Readers: A Randomized Field Trial in Carnegie Learning’s MATHia (https://link.springer.com/chapter/10.1007/978-3-031-36336-8_30). The study investigates whether modifying the language of math word problems can enhance performance among emerging English readers. Conducted with over 12,000 students, the trial utilized AI-driven methods to identify learners likely to benefit from simplified problem statements.

2.4.2 Student Dropout Prevention

ITS have demonstrated effectiveness in various domains, including student dropout prevention. By harnessing AI capabilities, these systems can analyze data to identify students at risk of dropping out and provide timely interventions. For example, Georgia State University's Panther Retention Grant program uses predictive analytics to pinpoint such students and offer financial assistance to help them remain in school. Similarly, the University of Arizona has implemented an early alert system driven by AI to detect students in jeopardy of dropping out and offer targeted support services.

Nye (2014) suggests that while ITS have historically been developed for more affluent nations, their potential to enhance learning outcomes is widely acknowledged. These systems, as described by Laaziri et al. (2019), replicate the behavior and guidance of human tutors to deliver personalized support and enhance the learning process. Additionally, Aleven (Aleven et al. 2016) showcases how ITSs can expand educational reach by customizing instruction based on students' knowledge, making them valuable tools in tackling issues like student dropout rates. By integrating AI and metacognitive feedback (as discussed by Roll et al., 2011), ITSs can improve students' help-seeking skills, thereby contributing to student success and retention. By tailoring instruction to individual needs, ITS provide adaptive training experiences that cater to specific learner requirements, potentially reducing dropout rates. The utilization of ITS in student dropout prevention represents a promising field that merges AI capabilities with personalized support to identify at-risk students and deliver interventions that can enhance retention rates.

Case study 2: Georgia State University's Panther Retention Grant program

Georgia State University's Panther Retention Grant program is a notable initiative aimed at preventing student dropouts through the utilization of predictive analytics. This program is designed to identify students who are at risk of dropping out and provide them with financial assistance to support their academic journey. By leveraging predictive analytics, the university can proactively identify students who may be facing challenges that could lead to dropping out and intervene to provide the necessary support. One key reference that provides insights into the Panther Retention Grant program at Georgia State University is a study by Goldrick-Rab (Goldrick-Rab et al., 2016). This study highlights the importance of financial assistance in promoting college completion and underscores the significance of programs like the Panther Retention Grant in supporting at-risk students. Another relevant reference is a research article by Bettinger and Baker (Bettinger & Baker, 2011). This study examines the impact of student coaching and mentoring programs on student outcomes, including retention and graduation rates. Such mentoring programs, similar to the support provided through the Panther Retention Grant program, have been shown to positively influence student success and persistence in higher education. Furthermore, a report by the National Association for College Admission Counseling (NACAC) on "Predictive Analytics in Higher Education: Five Guiding Practices for Ethical Use" offers insights into the ethical considerations associated with the

use of predictive analytics in higher education. This report emphasizes the importance of ensuring that predictive analytics are used responsibly and ethically to support student success and retention, as exemplified by the Panther Retention Grant program at Georgia State University. Panther Retention Grant program at Georgia State University represents a proactive approach to student dropout prevention through the strategic use of predictive analytics and financial assistance. By referencing studies such as those by Goldrick-Rab (Goldrick-Rab et al., 2016) and Bettinger and Baker (Bettinger & Baker, 2011), as well as reports like the one by NACAC, we can gain a comprehensive understanding of the significance and impact of such initiatives in promoting student success and retention in higher education.

Case study 3: AI powered early alert system powered at University of Arizona

The University of Arizona's implementation of an early alert system powered by Artificial Intelligence (AI) to identify students at risk of dropping out and offer tailored support services is a significant advancement in the field of education. This innovative approach leverages AI technology to analyze various data points and patterns to predict student outcomes accurately. By utilizing this system, the university aims to intervene proactively and provide timely assistance to students who may be facing challenges that could lead to dropping out. One key reference that provides insights into the University of Arizona's early alert system is the research article by Arnold and Pistilli (Arnold & Pistilli, 2012). This study discusses the implementation of a similar early alert system at Purdue University, which utilized predictive analytics to identify students at risk of academic failure. The findings highlight the effectiveness of such systems in improving student retention rates and academic performance. Another relevant reference is the work by Dawson and McWilliam (Dawson & Mcwilliam, 2008) on "Investigating the application of IT-generated data as an indicator of student progress." This study explores the use of IT-generated data, including learning management system interactions and assessment results, to predict student success and retention. The research demonstrates the potential of leveraging technology to support student success initiatives and enhance educational outcomes.

2.4.3 Tutoring and Academic Career Guidance

AI-based systems can provide tuition for specific topics or subjects in very interactive and interesting ways, which also do not require humans to explain concepts and answer questions. Later, it can also be extended to automate school or college education, integrating difficult-to-maintain knowledge from a particular human teacher. ITS systems work on a knowledge base to provide personalized reactions to student input and intelligent behavior. They also aim to ease tutoring for teachers with multiple students or cumbersome students. Now, ITS can be used to mimic the behavior of a human teacher for a particular subject, and the aim is to integrate in-depth knowledge from various sources and expert-level decision-making to cover the AI-complete task. AI can also be used for guidance counselling and distance education in a favored manner.

Case study 4: IBM Watson's AI-powered virtual advisor

IBM Watson's AI-powered virtual advisor is made to understand and provide effective responses to inquiries asked in regular natural language for a conversational interface and can be taken to any implementation corresponding to a robot, a PC, or a mobile device. The system uses XML technology to input a predefined set of data on the knowledge base for a specific field so that the virtual advisor can effectively answer and provide information to the user. The conversation is analyzed and broken down, and with the use of a finite state transducer, the most appropriate response is matched by picking the most appropriate path with the most matched keywords to select the most appropriate response. A hit score is generated by comparing the input conversation to a database of indexed keywords and most frequent responses to closely match the input with the best response.

A range of studies has explored the potential of IBM Watson's AI-powered virtual advisor in the education sector. Asakiewicz (Asakiewicz et al. 2017) and Gaglio (Gaglio et al., 2019) both developed virtual advisors using Watson technology to support students and staff in a university setting. These advisors were designed to answer questions, provide information, and help in various areas, including course selection and career planning. Vijjapu (Vijjapu, 2019) further enhanced the capabilities of the virtual advisor by incorporating machine learning techniques to aid in educational planning and academic advising.

IBM Watson's AI-powered virtual advisor ban potentially assists students in course selection, career planning, and accessing support services. By creating an academic information system that can be accessed by the student everywhere and every time, the students can find the information that they need without contacting the lecturers or the administrators. Nevertheless, providing these various types of student support requires huge efforts, especially in the case of academic monitoring and providing detailed information for all the students. For academic monitoring, it can be done by extracting the academic data and processing them. This method is very efficient instead of monitoring each student one by one. IBM Watson's AI-powered virtual advisor used to make academic monitoring even more efficient by creating a system that can be used to simulate the student's academic condition. This virtual system behaves like the real student, and it can stop whenever there is a problem with the student. This system appears to be helpful to ease administrators in determining what should be done to provide support to the student.

2.4.4 Student Performance Analysis

AI can analyze academic performance data to identify patterns and trends, enabling educators to provide targeted support.

Several educational databases have been proposed, which enabled the application of data mining to extract useful information on student’s performance data that can be used to identify patterns and trends, enabling educators to provide targeted support. This led to the

emergence of Education Data Mining (EDM) (Calvet Liñán & Juan Pérez, 2015; Dutt, et al., 2017) as an independent research field. Nowadays, EDM plays a significant role in discovering patterns of knowledge about educational phenomena and the learning process (Anoopkumar & Zubair Rahman, 2016), including understanding performance. Especially, data mining has been used for predicting various crucial educational outcomes, like performance, retention, success, satisfaction, achievement, and dropout rate.

AI has the potential to analyze academic performance data with the aim to identify patterns and trends, enabling targeted support for struggling students. This can be achieved using algorithms that predict student success and performance (Ricon-Flores, et al., 2020). However, the challenge lies in translating this data into actionable insights for educators (Pardo, et al., 2016a). Learning Analytics (LA) can provide a general picture of the group's performance, leading to overall improvement. Despite individual forecasts not being accurate, instructors can adapt teaching techniques for better results. Students believe that knowing predictive results at the start of the course can help them perform better. Nevertheless, providing learning analytics alone may not lead to changes in teaching practices. Pardo (Pardo, et al., 2016b) proposes a model to help instructors identify subpopulations of students for targeted support actions based on predicted exam scores derived from the learning design. The resulting model classifies students according to their predicted exam scores.

Case study 5: Brightspace Insights by D2L for student data analysis and recommendations

Brightspace Insights by D2L creates visual representations of a course data, allowing one to make informed decisions. Insights also supports the ability to "drill down" on widgets like the course access and student's last accessed activity to obtain details. Insight's dashboard is very customizable and allows you to rearrange the layout and add or remove the widgets displayed. Instructors can create their own dashboards for specific tasks. This can be done by creating the new dashboard on the right side of the screen and adding particular widgets to it, which can be chosen by clicking the dropdown on the widgets displayed on the screen. An effective and successful analyst is one who understands the technologies that he is working with and intends to use so that the most can be drawn out of the data. This insight is an invaluable tool for those who are looking to enhance and improve their learning environment and the student experience. For example, student login and comment rates could be used to help design an intervention to identify at-risk students in a learning activity. Particularly powerful predictive models are used to determine what types of learning path intervention are needed to maximize student performance in a course or at a certain learning outcome. These models simulate various scenarios and provide the best help decisions to improve learner performance.

This aggregated data can be organized using multidimensional frameworks, such as defined rubrics, across all courses in the applied discipline from one or many institutions. Aggregate results against these frameworks are presented to provide insight into the teaching and

learning process. For example, are the first-year students meeting the expected outcomes for a particular course? Subgroup analysis on performance against criteria or, in the case of learning paths, sequence of performance across criteria can provide a more profound understanding of the learning process. Available and accomplished course and student performance is made more transparent. Steering reports show aggregate student performance in a course. These reports compare to a previous state or specific outcome, indicating if the performance change was positive or negative.

At the time of writing, Brightspace Insights is available with the Learning Environment, Connect for Learning mixed model delivery, and predict. In both cases, data about the learning environment from the course activity, student interactions, and resulting performance can be automatically aggregated into a data mart.

Case study 6: Course Signals system at Purdue University

Purdue University's Course Signals system, which uses predictive analytics to identify at-risk students, has been shown to be effective in improving student performance. Course Signals is a predictive analytic system built on Bayesian Theorem and predictive modelling designed to enhance course-level student success. At Purdue University, Course Signals was implemented in fall 2007 in courses with high D, F and Withdrawal (DFW) rates. The primary goals of Course Signals are to provide students with feedback on their performance in a course, to predict students' final course grade, and to provide advisors and faculty with information to help students succeed in their courses. The core educational issue addressed by Course Signals is student disengagement. Throughout the course of a semester, a large number of students fall behind in their coursework, and as a result, they become discouraged about their chances of success and reduce their effort in the course. If students can identify early and accurately when their chances of success in a course are in jeopardy, then with watching for undesirable states and a set of proposed intervention techniques, these students can be steered back onto the path of successful course completion. A more engaged student is a more successful student at Purdue. Further, an early feedback intervention system is an effective and unobtrusive way to initiate dialogue with disheartened students about what led to their state and the best strategies for moving forward in their coursework.

Course Signals provides students with immediate feedback on their performance in undergraduate courses. The goal is to use this feedback on student behavior and performance data to create predictive models for student success and use these models to build an intervention system to improve retention and on-time degree completion. The original problem was to develop an intervention system for students, particularly freshmen, but the underlying goal is to improve undergraduate education at Purdue. It emerged from a project named Boilerfailure Early Intervention System, which was started in 2002. This program used data mining techniques to identify students at risk for poor performance in FYE courses and to notify their advisors. In 2007, Purdue University (West Lafayette campus) formed a task force to study the problems of high DFW rates and "student disengagement" in large enrollment

courses. The task force recommended possible solutions, including developing an online system that students could use to check their performance in a given course. The Course Signals project was handed off to the Technical Assistance Program (TAP) and development began in fall 2007. The first pilot of the system was in Spring 2009 in 22 different courses across campus.

Corrigan (Corrigan et al., 2015) further demonstrated the potential of predictive analytics in improving test performance and providing early alerts to struggling students, respectively. These studies collectively highlight the value of using data-driven approaches to support student success.

2.5 Open Learner Model

Open Learner Modelling (OLM) is another crucial aspect of ITS research, focusing on the interpretability of AI representations (Conati et al., 2018). ITS contains intelligence and has four key components: the domain model, student model, teaching model, and learning environment (Freedman et al., 2000). The student model, which contains information about the student's background and learning preferences, is a fundamental component of an ITS (Panagiotopoulos, 2012).

Chang (2020) proposes an ontology-driven approach to represent pedagogical rules in an ITS, using data mining to automatically extract rules from tutoring sessions. These studies collectively highlight the importance of OLM in making AI representations interpretable and explainable in ITS research. In other words, OLM focuses on interpretability of AI representations in ITS research. OLMs aim to open up AI models of learners' cognition and emotions to support human learning and teaching. The research in ITS and OLM can serve as a foundation for an interpretable AI framework applicable beyond education contexts.

The main challenge here is to decide the most appropriate sequence of activities that can improve the average learning rate over all the skills. The methodology involves analysing various knowledge tracing methods and empirical methods for predicting a student's mastery of a skill. The methodology involves Artificial Intelligence concepts, dynamic student modelling, human cognition, intelligent user interfaces, intelligent help systems, and the use of strategies. In this frame, domain independence is a key theme in ITS research, focusing on the reuse of knowledge across different domains. Nevertheless, task independence, which refers to the system's ability to support various student tasks, remains largely unaddressed in most systems. (Freedman et al., 2000).

Below, different techniques are reported for representing learners' background knowledge and preferences:

- **Cognitive Tutor** is the ITS platform developed by Carnegie Learning, whose functionality has been detailed above, that utilizes OLM to provide personalized

instruction in mathematics. It adapts to individual student learning styles and preferences by continuously assessing their knowledge and skills, providing feedback, and offering tailored exercises and practice problems.

- **ALEKS (Assessment and Learning in Knowledge Spaces)** is an adaptive learning platform that incorporates OLM to assess students' knowledge gaps and deliver customized learning paths in subjects like mathematics, chemistry, accounting, and more. It uses sophisticated algorithms to dynamically adjust the difficulty of questions based on students' responses and learning progress.

- **SMART Learning Suite** is an integrated set of digital tools for interactive and collaborative learning. It includes SMART Notebook for lesson creation, SMART Response for formative assessment, and SMART amp for collaborative workspaces. While not strictly an ITS, SMART Learning Suite integrates OLM features to provide personalized learning experiences and track student progress over time.

- **DreamBox Learning** is an adaptive math program for students in kindergarten through eighth grade. It utilizes OLM techniques to tailor instruction to each student's level of understanding, learning pace, and preferences. DreamBox Learning also provides real-time feedback to both students and teachers, helping them monitor progress and identify areas for improvement.

2.6 Conclusion

Successful implementation of ITS in higher education involves leveraging AI techniques to provide personalized support, enhance collaborative learning, and strategically integrate digitization and virtual reality (VR) technologies into the learning environment. ITS can engage students in the learning process and provide personalized feedback, identify students' intentions, and support adaptive navigation. Additionally, AI can support collaborative learning by distinguishing learners working in collaboration and adapting the learning support system to individual and group needs. AI techniques can be used to diagnose errors in student solutions, recognize individual learners, and enable a conversation with students. They can be used to enhance the learning experience through virtual reality (VR) technologies. The adoption of VR in education offers universities a wide range of options to improve the achievement of pedagogical goals. By strategically integrating digitization and AI into learning and teaching, universities can develop infrastructure and sustainability strategies that align with higher-level goals. AI can be successfully implemented in higher education using ITS. These systems leverage AI techniques to engage students in the learning process and provide personalized support. AI has the potential to transform higher education through personalized teaching, feedback provision, at-risk student identification, research acceleration, and administrative process streamlining. Empowering university leadership is crucial for successful AI adoption, and governance, strategic investment, and a human-centric approach are essential for maximizing the benefits in higher education. AI is considered an auxiliary,

valuable tool in higher education, not a competitor to teaching staff. Its effective use can assist in selecting optimal learning strategies for students and meeting labor market needs. AI is an emerging technology with the potential to transform social interaction. As well, education can lead to personalized learning experiences and improved learning outcomes. Case studies of AI use in education are also provided. Integrating AI into higher education requires significant changes in both content and delivery, with a division of labour between AI and human educators being the optimal approach. Critical considerations for successful integration of AI tools in education include ensuring data privacy, addressing bias in algorithms, maintaining a balance between technology and human interaction, and preparing educators effectively.

In conclusion, main findings in this comparative review can be listed as follows:

- AI is effective in addressing students' needs and discovering their capabilities.
- Challenges in applying AI in higher education include high cost, lack of expert personnel, and weak soft skills.
- Machines are not ready to replace humans but can enhance human capabilities.
- Cognitive tutors improve learning outcomes in education.
- Balancing instructional assistance and self-directed learning is a challenge with AI-driven tools.
- AI tools in higher education provide numerous advantages at the institutional, social, and instructional levels.

Chapter 3 Current regulation on AI in Higher Education

3.1 UNESCO

3.1.1 Universal Declaration of Ethics for Artificial Intelligence

Artificial intelligence (AI) has the potential to revolutionize many industries, but it has the most impact on education. It is now essential for universities to incorporate AI into their educational operations to improve student results, customize training, and expedite administrative procedures as they adopt new technologies (UNESCO, 2020).

AI integration in higher education involves many applications, from improving teaching and learning outcomes to handling administrative duties. AI-powered solutions can automate repetitive administrative activities like scheduling, grading, and admissions, giving teachers more time to concentrate on important work. Additionally, AI-driven analytics help universities make sense of massive amounts of data, which makes resource allocation and decision-making easier (UNESCO, 2020).

Artificial Intelligence (AI) presents new techniques for individualized education in the teaching and learning area. Smart tutoring programs may adjust to meet the needs of each student, offering customized guidance and feedback. AI-powered systems can also evaluate student performance data to pinpoint areas in need of development and suggest tailored learning programs. Artificial intelligence (AI) powered by virtual reality (VR) and augmented reality (AR) technologies improve experimental learning by enabling students to participate in learning environments (Siemens & Baker, 2012).

However, there are drawbacks to the adoption of AI in higher education as well, such as privacy issues, ethical issues, and the requirement for instructors to receive additional training in order to use AI tools efficiently. Overcoming these obstacles is essential to realizing AI's full educational potential.

In a world ruled by the rapid evolution of technology, the major contribution of AI in any field is undoubtedly evident. Equally obvious is the danger of using AI technologies without ethical barriers. Without a code of ethics, fundamental human rights can be significantly affected. In these contexts, the interest and major concerns of many states are obvious in developing a unique standard for ethics in AI. “Recommendation on the Ethics of Artificial Intelligence” was the first standard adopted by UNESCO in November 2021, to which 193 Member States joined. The central objective of this approach is to establish a universal framework of values to guide states in the development of legislation related to artificial intelligence.

The Fundamental Principles for Ethics in Artificial Intelligence (AI) aim to ensure the responsible use of AI for the benefit of humanity. The key recommendations are as follows:

- Respect for fundamental human rights: AI should protect human dignity and promote social inclusion, free from discrimination and bias.
- Transparency: AI systems must be transparent and easily understandable to users.
- Responsibility and accountability: Those involved in the development and deployment of AI are responsible for the impact and decisions made by these technologies and must be accountable for any harm or negative outcomes.
- Privacy and data protection: AI must manage data ethically and in compliance with privacy regulations.
- Equity: AI should ensure that its benefits are accessible to all social groups.
- Security and safety: The development and use of AI must protect against cybersecurity risks and prevent misuse of the technology.

3.1.2 Guidelines for Artificial Intelligence in Education

The use of AI in teaching and learning could be one of the most common uses in higher education. Adaptive learning systems driven by artificial intelligence examine huge amounts of student data in order to customize lessons to each student's unique learning preferences and speed. By offering real-time feedback, individualized study suggestions, and dynamic material delivery adjustments, these systems can increase student engagement and enhance learning results.

Additionally, chatbots and AI-powered virtual tutors function as virtual assistants, providing students with immediate support and helping them do tasks outside of the classroom. These intelligent technologies can supplement conventional teaching techniques and encourage individual learning by responding to inquiries, offering clarifications, and offering help with assignments (Siemens & Baker, 2012).

Administrative responsibilities at universities are numerous and include everything from managing enrolment and admissions to planning and marking courses. AI expedites these procedures by automating tedious jobs, giving administrators and teachers back critical time and resources. AI-driven chatbots, for example, can answer questions from potential students, helping them through the admissions process and giving them pertinent details about requirements and programs [20].

Universities can also increase operational efficiency and optimize resource allocation with the use of AI-driven predictive analytics. Universities can estimate trends in student enrolment,

anticipate staffing needs, and improve course scheduling to promote academic success and student happiness by examining historical data (Knight, et al., 2014).

AI systems can scan through enormous databases of scientific papers, find pertinent research articles, and extract insightful data that helps guide future discoveries and educational activities. In addition, AI-powered modelling and simulation tools make it easier to conduct experiments and test hypotheses in a variety of fields, including economics, social sciences, chemistry, and physics. Using these simulations, scientists can investigate intricate phenomena, replicate actual situations, and accelerate the rate of innovation and discovery.

Although integrating AI into higher education has enormous potential, there are obstacles and ethical questions that need to be answered. It is imperative to provide serious consideration to issues about data privacy, algorithmic bias, and transparency to guarantee the responsible and ethical implementation of AI systems. To effectively use AI tools and navigate the changing world of technology in education, educators and administrators need to upskill (Government of Germany, 2018).

UNESCO has formulated comprehensive guidelines on the use of artificial intelligence (AI) in education. The main recommendations are generally focused on the ethical, fair and efficient integration of AI technologies in education. The formulated principles include the approaches on inclusion and equity. In UNESCO's view, AI should improve access to education, especially for marginalised and disadvantaged groups. Furthermore, AI technologies must support diverse linguistic, cultural and regional needs.: AI in education must respect human rights without violating privacy.

AI applications must protect the personal data of students and teachers, ensuring data transparency in how decisions are made.

AI technologies must be educationally supported in teaching and learning processes, especially personalized learning. Educational content can be tailored to the specific needs and learning styles of students, with AI improving students` engagement and outcomes.

Teachers, especially those from the university environment, are increasingly interested in using AI tools in their teaching activities. AI can be used effectively and ethically in both education and research. Ethics in research requires that any innovation based on artificial intelligence must still be analysed to ensure that the research results are beneficial to society.

3.2 OECD

3.2.1 Guiding Principles for the Development and Use of Artificial Intelligence

Artificial Intelligence is a technology that is rapidly evolving, that has a great impact on different aspects of daily life, including education. Artificial Intelligence presents a lot of opportunities

now for teaching and learning, but it also poses potential challenges related to its behaviour in human interaction and child development. Therefore, regulating Artificial Intelligence is mandatory (Council of Europe Standing Conference of Ministers of Education, 2020).

It was proved that Artificial Intelligence can help in different educational settings. Technologies that use AI proved themselves useful when were used to support diverse learners, including children and lifelong learners, as well as those with special needs. The data that was collected from these processes might help offer insights into the learning process, while tools like voice assistants and adaptive tutoring might help improve more inclusive learning (Maria Gkountouma, European Commission, 2023).

However, it is important to also acknowledge the negative impacts that the use of Artificial Intelligence in education might have. Poor pedagogic practices might be automated, therefore perpetuating existing biases and discriminatory approaches. It could also help spread disinformation and misinformation. This could also affect human rights, specifically the right to education of every human being (Council of Europe Standing Conference of Ministers of Education, 2020).. Another negative aspect of using Artificial Intelligence is how the data that the models learn are processed and used in further applications. Individualised learning, privacy, and equity in the field of education, are questioned, and users need to develop a better understanding of the impact it is having on their surroundings (Maria Gkountouma, European Commission, 2023).

The Digital Education Action Plan 2021-2027 presents the European Commission's strategic view on the long-term digital transformation of education and training systems. This plan offers a long-term strategic view for high-quality and inclusive European digital education. It addresses the challenges that appeared during the COVID-19 pandemic, which led to different changes in the educational field. It seeks stronger cooperation at the EU level on digital education and it presents opportunities, including improved quality and quantity of teaching concerning digital technologies. This plan proposes two strategic priorities: to foster a high-performing digital education ecosystem and to enhance digital skills and competencies for the digital age.

The usage of Artificial Intelligence systems can potentially enhance teaching, learning, and assessment, providing better learning outcomes and helping schools to operate more efficiently. However, it should be questioned if the same AI applications are designed properly because otherwise, it could lead to harmful consequences. Teachers and educators need to be aware and question the reliability of the AI systems that they are using, and if the educational data that is provided is managed and secure. In 2021, the European Commission proposed a comprehensive legal framework for AI (AI Act) explaining mandatory requirements for "high-risk" AI systems used in several areas, including the educational field (European Union, 2020).

These guidelines identify four cases in which Artificial Intelligence can be used in classrooms across Europe (European Union, 2020):

- Student teaching – using AI to teach students (student-facing);
- Student supporting – using AI to support student learning (student-facing);
- Teacher supporting – using AI to support the teacher (teacher-facing);
- System supporting – using AI to support diagnostic or system-wide planning.

To develop these guidelines, four key factors were identified and taken into consideration [16]:

- Human agency – this factor relates to an individual's capacity to become a competent member of society. A person with the agency can take life actions and also be fully responsible for those choices. Concepts such as autonomy, self-determination, and responsibility are often associated with agency.
- Fairness – this factor refers to how an individual is treated inside its social organisation. All the processes need to be clear for all the users to receive equal access to opportunity. Equity, inclusion, non-discrimination, and fair distribution of rights and responsibilities are concepts that are associated with fairness.
- Humanity – this factor refers to the identity, integrity, and dignity of the people. Factors that are necessary for human connection, such as well-being, safety, social cohesion, meaningful contact, and respect, need to be taken into consideration. This connection implies that people should be approached with respect for their intrinsic values and not as a data objects. This is the basic definition of a human-centric approach to AI.
- Justified Choice – this factor relates to the use of knowledge, facts, and data to justify necessary collective choices by multiple individuals in the educational field. It must be transparent and is based on participatory and collaborative models of decision-making models.

These ethical considerations are valuable in education. They should guide educators, teachers, and school leaders in their decisions regarding the usage of AI software. The AI Act proposes some requirements for every AI system that is deployed and used in education. The requirements are (European Union, 2020).:

- Human agency and oversight – this includes fundamental rights, children's rights, human agency and human oversight;
- Transparency – this includes traceability, explainability, and communication.

- Diversity, non-discrimination, and fairness – this includes accessibility, universal design, the avoidance of unfair bias, and stakeholder participation.

- Societal and environmental well-being – this includes sustainability, environmental friendliness, social impact, society and democracy.

- Privacy and data governance – this includes privacy, quality, and integrity of data, and access to data.

In conclusion, the AI field is constantly growing and becoming more accessible to every user. Its capabilities can make a great tool or resource for educators and students but misusing them can lead to harmful consequences. Every AI software needs to abide by certain principles so that it can be ethical and human-centred. According to the European Commission AI Act, AI software can be used in various modes in schools. Still, it needs to respect certain guidelines, such as human rights, data security, and inclusion, for it to be considered a reliable source of learning.

In 2019, the OECD adopted five principles of artificial intelligence (AI). These principles include recommendations for developing artificial intelligence systems that benefit society. 42 countries have adhered to these principles approved by OECD members.

According to these principles, the main beneficiary of the technologies

AI is society. According to the principles formulated by the OECD, AI must contribute positively to the economic growth of a society and increase social inclusion, while reducing the negative impact on society. In addition, AI technologies must be designed so that they do not harm vulnerable people, and any person can understand the results and benefits of AI.

Applications based on artificial intelligence must be designed to work in good conditions without producing harmful results and to be secure and resistant to external attacks.

3.2.2 Recommendations on Artificial Intelligence in Education

Recommendations for Leveraging AI in Education

- Invest in AI infrastructure and training: To improve instructors' skills in using AI tools, universities should make significant investments in training programs and a strong AI infrastructure. These consist of online courses, workshops, and conferences on the use of AI in education.

- Encourage multidisciplinary collaboration among educators, AI academics, and industry professionals to investigate new AI solutions customized to meet educational needs. Launch research projects to find out how AI affects teaching methods, student engagement, and learning outcomes.

- Encourage ethical AI practices: Create policies and procedures that address issues like algorithmic programs, data privacy, and transparency when using AI in education. To guarantee justice and equity, promote accountability and openness in AI-powered decision-making processes.

- Facilitate learning that is focused on the student: Utilize AI-driven adaptive learning platforms to provide customized training according to the needs and preferences of every student. Support students in taking control of their education by offering independent learning modules and interactive resources.

- Use AI for student support services: Set up chatbots and virtual assistants with AI capabilities to offer students round-the-clock assistance with questions about course registration, academic advising, and campus resources. By using AI-driven interventions universities could identify students with problems early and offer focused support interventions, increasing student engagement and decreasing college dropout (UNESCO, 2020).

- The use of AI in education has the potential to entirely reshape university teaching and learning methods. Universities can improve student learning results, customize courses, and expedite administrative procedures by effectively using AI tools. To fully reap the educational benefits of AI, however, coordinated efforts addressing pedagogical, technical, and ethical issues are needed. Universities may harness the revolutionary power of artificial intelligence (AI) to define the future of education by adopting a collaborative and student-cantered approach.

3.3 European Union

3.3.1 General Data Protection Regulation (GDPR) in Artificial Intelligence (AI)

The General Data Protection Regulation (GDPR), implemented by the European Union (EU) in May 2018, has had a profound influence on the management and security of personal data. As AI technologies continue to progress and get integrated into a wider range of businesses, the convergence of GDPR and AI has emerged as a critical issue for ensuring data security and privacy. This essay examines how GDPR affects AI systems and highlights the challenges and potential solutions for protecting personal data while utilizing AI for applications. The GDPR, which lays a significant focus on values like accountability, transparency, and individual rights over personal data, establishes a comprehensive framework for data protection.

AI and big data

Artificial Intelligence has developed rapidly during the past ten years. It has a strong scientific foundation and several effective applications. It offers chances for knowledge dissemination,

energy sustainability, improved health care, and social, cultural, and economic advancement. Serious concerns including unemployment, inequality, discrimination, social exclusion, monitoring, and manipulation come along with these opportunities.

Data minimization and purpose limitation

Data minimization, which mandates that personal data be collected be appropriate, relevant, and restricted to what is necessary for the indicated purpose, is one of the fundamental tenets of the General Data Protection Regulation (GDPR). Large datasets are, however, usually needed for AI systems to increase their performance and accuracy. This calls for striking a careful balance between following the data reduction principle and gathering enough data to create reliable AI models.

Moreover, GDPR requires that personal data be gathered for stated, defined, and lawful purposes and not be handled in a way that is inconsistent with those goals. Artificial intelligence (AI) systems, particularly machine learning-based ones, frequently entail continuous learning and data reuse, which can be in opposition to the purpose limitation principle. To solve this, organizations need to make sure that data subjects are informed of the precise goals of data processing and that any further uses of the data are consistent with the original aim.

Data Subject Rights and AI

GDPR grants several rights to data subjects, including the right to access, rectify, and erase their data, as well as the right to data portability and to object to automated decision-making. These rights present unique challenges for AI systems, particularly those involving automated decision-making processes.

For instance, the right to explanation, derived from the GDPR's provisions on automated decision-making, requires that individuals are provided with meaningful information about the logic, significance, and consequences of automated decisions. Given the complexity and opacity of many AI algorithms, providing such explanations can be difficult. Organizations must strive to enhance the transparency of their AI systems, potentially through the development of explainable AI techniques that can offer clearer insights into how decisions are made.

Protecting Data in AI Systems

To ensure compliance with GDPR while leveraging the benefits of AI, organizations must implement robust data protection measures. Several strategies can be employed to safeguard personal data in AI applications.

Data anonymization and pseudonymization

An effective approach to protect personal data in AI systems is through anonymization or pseudonymization. Anonymization involves removing all personally identifiable information (PII) from the dataset, rendering it impossible to identify individuals. Pseudonymization, on the other hand, replaces PII with artificial identifiers or pseudonyms, reducing the risk of data re-identification while allowing some level of data utility.

Both techniques can help organizations mitigate privacy risks and comply with GDPR requirements. However, it is crucial to ensure that anonymization and pseudonymization methods are robust and resistant to re-identification attacks, which can compromise data privacy.

Privacy by design and default

The GDPR places a strong emphasis on the idea of "privacy by design and default," which calls for the early integration of data protection safeguards into the creation and functioning of systems. This means that for AI systems, privacy concerns must be considered at all phases of the AI lifecycle, from gathering and processing data to training and deploying models.

Organizations should adopt practices such as data encryption, access controls, and regular security assessments to protect personal data. Additionally, conducting data protection impact assessments (DPIAs) can help identify and mitigate potential privacy risks associated with AI systems, ensuring compliance with GDPR.

Fairness, accountability, and transparency

For AI systems to comply with GDPR, fairness, accountability, and transparency are essential. To prevent discriminatory outcomes from AI models, organizations need to put processes in place to identify and reduce biases in these models. This entails conducting routine fairness audits of AI systems and implementing remedial measures upon the discovery of biases.

Organizations must keep thorough records of all data processing operations, including the goals, types of data handled, and any data transfers, to be held accountable. To react to data subject requests and demonstrate compliance with GDPR, this documentation is necessary. Transparency is telling data subjects in an understandable and accessible way how their data is being used by AI systems. People must be informed about the different kinds of data that are gathered, the reasons behind the processing, and their rights as per the GDPR. Improving openness can guarantee informed consent and foster trust with data subjects.

Organizations face possibilities as well as obstacles when integrating AI technologies with GDPR. Even though AI systems have a lot to offer in a lot of different fields, maintaining GDPR compliance is crucial to safeguarding personal information and respecting people's rights. Organizations can use AI responsibly and ethically by putting strong data protection measures in place, such as data anonymization, privacy by design, and encouraging fairness and

openness. To maintain privacy and build trust in the digital era, continuous attempts to harmonize AI practices with GDPR will be essential as AI continues to advance.

3.3.2 European Strategy for Artificial Intelligence

The use of artificial intelligence (AI) in education is a growing trend with the potential to transform teaching and learning processes. As the digital revolution continues, AI technologies are increasingly recognised for their ability to improve educational outcomes through personalised learning, efficient administration, and new teaching approaches. Europe, known for its excellent education systems and pioneering technological breakthroughs, is at the forefront of this trend. Drawing on their long history of academic success and technological innovation, European countries are actively developing and implementing comprehensive strategies to integrate AI into their educational institutions. This chapter looks at the main ways in which AI is being incorporated into education systems in Europe. It looks at projects involving both the European Union and individual Member States. AI integration brings significant benefits to the educational sector. These benefits include the ability to provide personalized learning experiences tailored to individual student needs, the automation of routine administrative tasks, the support and augmentation of teaching capabilities, and the increased accessibility of education for students with diverse needs. However, alongside these promising benefits, there are notable limitations and challenges associated with AI integration in education. These challenges encompass ethical and privacy concerns, the high costs of AI implementation, the persistence of the digital divide, and potential resistance to technological changes within educational institutions.

Integration of AI in education is a crucial focus for the European Commission, which has developed a comprehensive strategy to promote AI adoption across various sectors, including education. This strategy emphasizes the importance of ethical guidelines, significant investment in AI research, and the creation of a robust digital education action plan. A key component of this strategy is the Digital Education Action Plan (2021-2027) – DEAP (2021-2027), which aims to foster the effective use of digital technologies and develop digital skills across Europe. This plan seeks to ensure that educational institutions are equipped to integrate AI in ways that enhance learning and teaching experiences (European Commission, 2020). It is important to note that the plan emphasizes the importance of digital literacy and competency among both educators and students. By prioritizing digital skills, the plan ensures that all stakeholders in the education system can effectively utilize AI tools and resources. This includes providing training programs and professional development opportunities for teachers, enabling them to harness AI technologies to improve their instructional methods and engage students more effectively. DEAP (2021-2027) focuses on the development and dissemination of high-quality digital learning materials and platforms. These resources are designed to leverage AI to create personalized learning experiences that cater to the individual needs of students. By utilizing AI algorithms, these platforms can analyse student performance data and provide customized recommendations and feedback, thereby enhancing the learning process and outcomes . This personalized approach not only supports students in their

academic journey but also helps educators identify and address learning gaps more efficiently. It also advocates for significant investment in AI research and innovation. This includes funding for projects that explore new AI applications in education, such as intelligent tutoring systems, adaptive learning environments, and AI-driven assessment tools. By fostering a culture of innovation, the plan aims to keep Europe at the forefront of AI advancements in education, ensuring that the latest technologies are integrated into the classroom. This investment also extends to the development of infrastructure, such as high-speed internet and modern digital devices, which are essential for the effective deployment of AI tools in schools and universities. Ethical considerations are a cornerstone of the European Commission's strategy for AI integration in education. The plan underscores the need for AI systems to be transparent, fair, and accountable. This involves implementing robust data protection measures to safeguard student privacy and prevent misuse of personal information. Additionally, the plan calls for the establishment of ethical guidelines that govern the use of AI in education, ensuring that AI applications do not perpetuate biases or inequalities. By addressing these ethical concerns, the European Commission aims to build trust among educators, students, and parents, thereby facilitating the widespread adoption of AI technologies. The DEAP (2021-2027) also highlights the importance of collaboration and partnership. It encourages cooperation between educational institutions, technology providers, and policymakers to create a cohesive ecosystem that supports AI integration. This collaborative approach ensures that the diverse needs and perspectives of different stakeholders are considered, leading to more effective and inclusive AI solutions (European Commission, 2020).

Another important initiative is the AI4EU project, a European Union-funded platform that provides collaborative resources and expertise in AI (AI4EU, 2021). In the context of education, the AI4EU initiative supports the development of AI-driven tools and applications that can significantly enhance personalized learning. These tools can automate administrative tasks, thereby allowing educators to focus more on instruction and student engagement. Additionally, AI4EU supports teachers by providing AI applications that can help deliver more effective instruction tailored to individual student needs. By implementing advanced AI algorithms, these tools can analyse vast amounts of data on student performance, preferences, and learning behaviors. This data-driven approach allows for the creation of customized learning paths that adapt to the individual needs and pace of each student, thus making learning more efficient and effective. Personalized learning facilitated by AI ensures that students receive the right support and resources at the right time, promoting better engagement and understanding of the material (AI4EU, 2021). The AI tools also facilitate differentiated instruction, where teachers can cater to diverse learning styles and abilities within the same classroom. The collaborative nature of AI4EU is another key aspect that enhances its effectiveness in integrating AI in education. By bringing together experts from academia, industry, and educational institutions, AI4EU fosters a multidisciplinary approach to AI development and deployment. This collaboration ensures that the AI tools and applications are grounded in cutting-edge research and best practices, and are designed to address the real-world challenges faced by educators and students. The platform provides a

space for knowledge exchange and innovation, where stakeholders can share insights, develop new solutions, and continuously improve AI applications for education (AI4EU, 2021). AI4EU's commitment to ethical AI practices aligns with the broader European strategy for AI integration. This involves implementing safeguards to protect student data and privacy, ensuring that AI algorithms do not reinforce biases, and promoting the ethical use of AI in educational settings. By adhering to these principles, AI4EU aims to build trust among educators, students, and parents, facilitating the widespread adoption of AI technologies in education (AI4EU, 2021).

The European Commission's AI Watch initiative is a comprehensive monitoring framework aimed at assessing and analysing the development, adoption, and impact of artificial intelligence (AI) across Europe (AI Watch, European Commission, 2024). Launched to support the European Union's AI strategy, AI Watch provides valuable insights into AI advancements, policy implementations, and the socio-economic effects of AI technologies. By gathering and disseminating data on AI trends, the initiative helps policymakers, researchers, and stakeholders make informed decisions to foster the ethical and effective integration of AI in various sectors, including education, healthcare, and industry. Within the AI Watch framework several European countries have developed their national AI strategies, emphasizing the integration of AI in education (AI Watch, European Commission, 2024).. For example, France's national strategy includes the 'AI for Humanity' program, which specifically supports the development of AI applications in the educational sector. This program aims to harness AI to create innovative learning solutions and improve educational outcomes [4]. Similarly, Germany's AI strategy highlights the use of AI to enhance educational results and foster the development of digital competencies among students (Government of France, 2018). These national strategies illustrate the commitment of European countries to leverage AI technologies to advance their educational systems.

These efforts by the European Commission and individual European nations highlight a coordinated approach to integrating AI into education. The strategies focus on ensuring that AI adoption is ethical, research-driven, and beneficial to the educational community. By fostering collaborations, investing in AI research, and developing national policies, Europe aims to lead the way in creating an AI-enhanced educational landscape that is both innovative and inclusive.

The integration of AI in education offers numerous benefits that can significantly enhance the educational experience for both students and educators. One of the most profound advantages is the ability of AI technologies to provide personalized learning (Holmes et. al, 2019). By analyzing vast amounts of data on student performance, AI can tailor educational experiences to meet the individual needs, preferences, and learning speeds of each student. This customization enables the provision of targeted recommendations and resources, which can greatly enhance the overall learning process. Another significant benefit of AI in education is the enhancement of administrative efficiency, where a variety of routine administrative tasks, such as grading, scheduling, and reporting can be automated with AI tools. This automation

not only reduces the workload on educators but also allows them to allocate more time to teaching and engaging with students. As a result, the overall efficiency of educational institutions is improved, enabling them to operate more effectively (Luckin, 2016).

AI-driven tools also provide substantial support for teachers. These tools can offer valuable insights into student progress, helping teachers to identify learning gaps and suggest appropriate intervention strategies. By leveraging these insights, teachers can deliver more targeted and effective instruction, which can lead to improved educational outcomes (Sonkar, S. 2023). This support system empowers teachers to enhance their instructional methods and better cater to the diverse needs of their students. Accessibility in education can be significantly improved with AI, particularly for students with disabilities (Seale, 2013). The development of assistive technologies powered by AI, such as speech recognition and text-to-speech applications, can provide critical support for students with visual or hearing impairments. These technologies enable such students to participate more fully in educational activities, thereby fostering a more inclusive learning environment.

While the integration of AI in education presents numerous advantages, it also introduces several significant unique limitations that must be carefully considered. One of the primary concerns is related to ethical and privacy issues (Binns, 2018). The implementation of AI in educational settings necessitates the collection and analysis of vast amounts of student data. This raises critical concerns about data security and student privacy. Additionally, there is a potential for bias in AI algorithms, which can lead to unfair or discriminatory outcomes (Binns, 2018). Ensuring that AI systems are transparent, fair, and accountable is essential to address these ethical and privacy concerns effectively. Another substantial limitation is the high cost associated with the development and deployment of AI technologies in education. Implementing AI requires significant financial investment, which includes the costs of developing AI-driven tools, purchasing necessary hardware and software, and training staff to use these new technologies effectively. Many educational institutions, particularly those with limited budgets, may find it challenging to secure the necessary funding and resources to adopt AI, thereby hindering its widespread implementation (Zawacki-Richter, 2019). The digital divide also poses a significant barrier to the adoption of AI in education. This divide refers to the gap between those who have access to modern information and communication technologies and those who do not (Van Dijk, 2020). Students and schools with limited access to technology and reliable internet connectivity may be unable to benefit equally from AI-driven educational tools. This disparity can exacerbate existing inequalities in education, as students from underserved communities may lag behind their peers in accessing and utilizing AI-enhanced learning resources. Moreover, there is often resistance to change among educators and institutions when it comes to adopting new AI technologies. This resistance can stem from various factors, including a lack of understanding of AI, fears of job displacement due to automation, and skepticism about the effectiveness of AI in improving educational outcomes (Selwyn, 2019). Overcoming this resistance requires comprehensive professional development programs to educate and train educators on the benefits and applications of AI in education, as well as addressing their concerns and misconceptions. Thus, while AI holds

great potential to revolutionize education, addressing ethical and privacy concerns, high implementation costs, the digital divide, and resistance to change is crucial for its successful integration. By proactively tackling these limitations, educators and policymakers can better harness the power of AI to enhance educational outcomes and ensure equitable access to its benefits.

Overall, the European strategy for integrating AI in education highlights a forward-thinking approach to leveraging technology for educational advancement. While the potential benefits of AI in education are substantial, addressing the associated challenges is essential for successful implementation. Ensuring ethical use, equitable access, and adequate support for educators and students will be critical in realizing the full potential of AI in transforming education in Europe.

3.3.3 EU AI Act

The European Union's initiative to regulate AI, known as the AI Act, is a comprehensive attempt to encompass all possible applications of AI, assessing them based on risks they might present. Within the realm of education, this regulatory framework aims to safeguard students and educational institutions by enforcing strict compliance codes for AI developers and distributors, especially focusing on high-risk applications. This act is pivotal in ensuring that educational tools empowered by AI are safe, transparent, and fair. It also sets out to penetrate the more technical aspects, emphasizing not just operability and efficiency but mindful and ethical usage that aligns with broader societal values.

The EU AI Act introduces a pioneering legal framework structured to safeguard EU citizens from the high-risk applications of AI, categorizing AI systems according to their implied risks to rights and safety: unacceptable risk, high risk, limited risk, and minimal risk. This classification influences how rigidly different AI systems should be regulated.

1. **Unacceptable Risk**: AI applications that manipulate human behavior to circumvent users' free will, or really any use of AI that can create social scoring, are forbidden.

2. **High Risk:** AI systems used in critical sectors, like education, where the stakes of mismanagement are significantly high, fall under stringent regulatory measures. These include mandatory risk assessment plans, high levels of data security, and rigorous standards for accuracy and reliability.

3. **Limited Risk:** AI interacts more mildly with personal stakes here but may shape user experiences or expectations, such as chatbots. Transparency obligations are prescribed to ensure users know they are interacting with an AI.

4. **Minimal Risk:** Most AI applications are relegated to presenting only minimal risk and hence enjoy more relaxed regulation within the Act.

The Act is not purely restrictive but is also directed at fostering innovation while ensuring new and existing technologies meet these strict guidelines before a wider deployment. Such a proactive and graded approach ensures that all relevant stakeholders can benefit from technology while decreasing potential ethical and safety risks typical within higher-risk sectors, like education. This dual focus protects and empowers, creating a balanced regulatory frame tailored to the broad development and application scope of AI tools in education. This detailed regulatory attention enables stakeholders to fully embrace ethical standards tailored to localized and broad-based educational contexts within the AI framework provided by the Act.

Embedding ethical decision-making structures within the technological design and operational stages can significantly redefine the landscape of educational technology development. By adhering closely to the principles of FATE, bolstered by legal standards like those set out in the EU AI Act, stakeholders in the educational sector have a robust blueprint for realising the vast potential of AI in education. This ensures technology serves as a bedrock for enhancing learning processes while safeguarding the interests of all participants within the system – a steppingstone towards a more ethical future in educational technology.

Chapter 4 Ethical concerns

As technological innovations permeate the landscape of higher education, implementing Artificial Intelligence (AI) systems offers extraordinary opportunities and significant ethical considerations. Ethical AI in education refers to the thoughtful and principled creation and application of AI technologies that respect all participants' values, needs, and rights within the educational sphere. The focus is not only on making AI effective, but also on ensuring it is used in a morally sound and socially responsible way.

The importance of ethics in AI for education cannot be overstated. It shapes how AI systems are designed, who they are designed by, and how they impact students and teachers. Ethically aligned AI helps build trust among users, enhances the educational experience, and ensures that advancements in AI contribute positively to educational outcomes without causing harm or perpetuating inequities.

Ethical AI is vital for education because it stands at the intersection of technology's limitless possibilities and the intrinsic value of educational integrity and equity. Education systems shape knowledge and skills and influence societal norms and individual behaviors. Unethical AI in these settings can perpetuate biases, reduce transparency, and challenge the fairness of educational opportunities, thereby reinforcing existing societal disparities. For instance, an AI system that is not meticulously designed might inaccurately predict student success based on biased data, potentially discriminating against underrepresented student groups. Alternatively, AI systems might prioritize certain learning styles over others, disadvantaging students who do not fit a predetermined mold. Similarly, without stringent ethical controls, AI could compromise student data privacy, exposing vulnerable populations to exploitation or manipulation. Thus, advocating for and establishing ethical AI practices in education is not just a necessary regulation—it is imperative to ensure these technologies serve as tools of empowerment rather than tools of exclusion.

4.1 FATE (Fairness, Accountability, Transparency, Ethics) Principles

To effectively contextualize and implement ethical AI in education, it is imperative to delve into the FATE principles that guide the establishment of principled AI frameworks. These principles act as pillars ensuring that AI systems in educational settings do not merely function efficiently but do so in a manner that aligns with safeguarding human interests and upholding democratic values. Each component of FATE addresses critical ethical considerations, grounding these systems in practices that promote inclusivity, responsibly trace decision-making, create transparency, and prioritize ethical standards.

Fairness: AI systems in education must be free from biases that can disadvantage any group of users. Fair treatment for all users is crucial to ensure the technology is just and equitable.

Accountability: There should be mechanisms to hold designers and operators of AI systems responsible for how these systems operate. Recognizing that the development of AI technologies is not neutral supports proactive measures to address potential issues and rectify them transparently.

Transparency: Openness in AI processes and decisions crucially aids understandability and trustworthiness. Stakeholders should know how and why AI systems are making decisions in educational settings.

Ethics: AI's alignment with ethical values ensures that these technologies act consistently with the common good, respecting the privacy, dignity, and rights of individuals and demonstrating sensitivity to the complexities of educational environments.

4.2 Ethical Challenges in AI

4.2.1 Bias and Fairness

Bias in AI arises when an AI system behaves prejudicially due to flawed assumptions in its algorithm or data inputs. In educational contexts, if the data used to train an AI system encompasses historical biases or unequal representation of various groups, the AI might amplify these biases instead of overcoming them. For example, an AI tutoring system might be more effective for students from certain backgrounds if the training data predominantly represents those populations, potentially deepening educational disparities rather than closing gaps. Overcoming this challenge necessitates stringent auditing processes, diverse data sets, and continuous adjustments to ensure AI assesses and interacts with all students equitably.

Fairness in AI within an educational setting encompasses a lack of prejudice and equal treatment across diverse student demographics. However, achieving fairness can be immensely challenging as biases from various sources can infiltrate AI systems. For instance, if a dataset used for training an AI for college admissions primarily includes information from historically affluent schools, it may unintentionally favor applicants from similar backgrounds. Similarly, language processing tools might perform inadequately for non-native English speakers if primarily trained on datasets dominated by native speech, potentially resulting in lower evaluations of their written assignments. These scenarios stem from what is often societal bias--preconceptions that are ingrained in societal structures being unwittingly encoded into AI systems. Such unfairness can significantly impact students' educational opportunities and experiences, wherein certain groups might be systematically and disproportionately disadvantaged. Identifying and continually correcting these embedded biases is crucial to fortifying the fairness of AI in education.

Historical and societal biases deeply embedded in our culture can inadvertently seep into AI systems, resulting in unfairly biased machine learning (ML) models. When an AI system leverages historical data to make predictions or decisions, it essentially draws on a dataset

that may already reflect past inequalities or stereotypes. For instance, if historical academic performance data show disparities among different demographics (based on socio-economic status, ethnicity, etc.), using such data directly to train ML models can lead to these systems perpetuating or accentuating the disparities they embody. The outcomes or predictions made by these biased systems then have real-life implications—they can influence university admissions, scholarship allocations, or even career advice—affecting the opportunities and treatment of individuals based on flawed or predisposed assessments. Hence, these decisions reinforce the existing societal norms by continually favoring those already advantaged while potentially disenfranchising others, thereby feeding back into the societal data cycle with new data tainted by the same old biases. This looping effect—a self-fulfilling prophecy of bias sustenance—only deepens divides unless active, continuous interventions interrupt this chain, spot skewness early, and reconfigure processes to more equitable grounds, ensuring AI systems serve to bridge rather than widen gaps born from historical and societal biases.

4.2.2 Transparency and Explainability

When AI systems operate in education, the decisions they make can significantly influence students' academic journeys and professionals' teaching strategies. However, AI algorithms' inner workings, often called 'black boxes,' can be opaque. The lack of transparency makes it difficult for users, including students, educators, and administrators, to understand how or why a decision was made. This can erode trust in AI applications and potentially hinder their effectiveness and acceptance.

Explainability ties directly to the ethical call for transparency, referring to the ability of AI systems to justify the decisions or recommendations they make in understandable terms. In educational settings, where decisions can affect career trajectories and personal growth, stakeholders should be aware of AI decisions and understand the rationale behind them. The priority should be promoting insights into AI processes, which helps nurture confidence among users, facilitate acceptance, and enable stakeholders to correct or refine AI systems over time realistically and collaboratively.

Explainable AI (XAI) refers to techniques and practices designed to help humans understand and trust the outputs provided by AI systems. This is crucial in education, where decisions influenced by AI can impact educational trajectories significantly. Recent approaches in XAI incorporate layer-wise relevance propagation, which visually indicates how neural networks make decisions, and local interpretable model-agnostic explanations (LIME), which help to clarify predictions by approximating the underlying model locally with an interpretable one. Another important technique is SHAP (SHapley Additive exPlanations), which assigns each feature an importance value for a particular prediction. By integrating XAI techniques like these into the development and deployment of AI systems in higher education, institutions can ensure that decisions affecting students' academic trajectories are transparent, interpretable, and trustworthy. This level of explainability allows educators and administrators to not only

critique AI-driven outcomes but also make informed adjustments that benefit the entire educational process, promoting fairness and fostering trust in AI systems.

4.2.3 Accountability and Responsibility

Determining accountability in AI-driven decisions poses profound ethical challenges. Unlike traditional systems, AI's decision-making process involves complex algorithms and extensive datasets, making it challenging to pinpoint responsibilities when something goes wrong—such as issuing an unfair grade or denying educational opportunities based on skewed data processing. Addressing this issue requires clear regulatory frameworks, responsibilities assigned to both developers and users of AI tools, and thorough documentation of decision-making processes.

Accountability also involves responsive recourse where affected persons can contest unjust decisions. It necessitates a governance framework that embeds accountability within every phase of AI design and deployment, emphasizing ethical considerations from the outset. It also requires more than just ethical intention; it asks for mechanisms encouraging ethical practices, including educating AI developers on the ethical considerations within artificial intelligence and ensuring educational institutions understand their obligations when implementing AI.

Accountability for AI in education involves delineating clear responsibility for the AI system's deployment and ensuring exceptions or malfunctions are appropriately addressed. For instance, when an AI fails to predict students' learning challenges accurately and subsequently recommends insufficient or incorrect resources, it should be clear which body - the technology provider, the institution, or a specific educational department - is responsible for correcting the error. Furthermore, this accountability should extend into anticipatory planning, considering potential failures and designing AI systems that can either accommodate manual oversight or alert humans when unexpected patterns or results occur. On the governance side, educational institutions could establish an ombudsman or similar role specializing in AI-related issues to handle disputes, maintain fairness, and navigate situations where responsibility might be ambiguous. Schools and higher education entities may also draft a set of standards outlining their commitments and describing how they maintain accountability in their deployment of educational AI technologies. This structured and preemptive approach to accountability creates an environment where AI tools can be questionably more beneficial and integrated into educational frameworks with minimal disruption and optimal efficiency.

4.2.4 Data Privacy and Protection

With AI systems continuously collecting and analyzing vast amounts of data, the potential to misuse sensitive personal information is a significant concern. If safeguards are insufficient, there could be leaks or unauthorized exploitation of private data, thus compromising the privacy and security of students and educators. Compliance with strong data protection laws

like the EU GDPR is vital, ensuring data collected for educational advancements respects individual privacy rights without compromise.

Moreover, ethical considerations necessitate broader discussions beyond mere adherence to regulatory requirements. They advocate for secure design perspectives prioritizing user consent steps, minimal data retention periods, and strict limitations on data usage. They reiterate the necessity for educational AI applications to be built on principles of respect for user autonomy and privacy, fostering safer digital learning environments.

4.3 Hypothetical Case Studies

Hypothetical case studies can vividly illustrate how ethical dilemmas play out in implementing AI in education—highlighting potential risks and possible resolution strategies.

4.3.1 Example 1: An AI-Powered Tutoring System

Imagine a university rolling out an AI-powered tutoring system intended to assist students in understanding complex mathematical concepts. The data used to configure the system has been sourced from several high-performing schools with limited demographic diversity. As a result, the customized learning modules are inadvertently better suited for those demographics, inadvertently bypassing nuances that could aid different backgrounds. Over time, monitoring students' academic performance reveals that while average scores have increased from the primary demographic, there's a declining trend or stagnation in scores among students from other ethnic groups.

Upon more in-depth investigation, it is shown that the example problems built into the AI system involve contexts not familiar to everyone universally—such as scenarios highlighting golf or skiing, sports statistically favored by upper socio-economic groups—a subtlety creating a biased learning experience. Under these mounting ethical concerns, the university must now redesign the AI's algorithms, incorporating a broader dataset that reflects a diversity of experiences and social contexts. In response, educators collaborate with AI developers to create a more inclusive model involving user input changes and expanded scenarios broadly recognizable across all student groups, which helps personalize and, therefore, improve the learning outcomes across the previously underperforming demographics.

4.3.2 Example 2: Classroom Management AI Monitoring Student Engagement

Consider a secondary school that uses a classroom management AI to monitor student engagement and participation. This system utilizes real-time data from students' interactions with digital devices, course platforms, and even physiological signs via wearable technology to gauge attention and engagement, adapting instruction methods accordingly. However,

concerns about surveillance and data privacy arise. Students and parents are growing uncomfortable with the pervasive data collection—everything from the links the students click on to how long they gaze at the screen is logged and assessed.

An unintended consequence comes to light when it's noticed that the AI system, while effective in some regards, pressures students into feigning attention, thus lowering the authentic quality of engagement and making them feel perpetually monitored and anxious. To address this, the school holds an open forum for feedback and decides to implement key changes. They reassess what data is truly beneficial and necessary for educational purposes and opt to protect and restrict access according to the strictest privacy standards. This reversal toward a more mindful application of AI, focusing solely on crucial pedagogical factors while respecting student privacy, shifts the school culture back to a trust-based model, enhancing relationships and student wellbeing.

These hypothetical scenarios demonstrate complex issues around educational AI implementation, revealing that credible risks can emerge despite the best intentions. Effective response strategies are paramount—correcting biases and respecting privacy—and upholding education's role as a foundation for responsible and inclusive growth.

4.4 Fairness Paradox

The "Fairness Paradox" in AI illuminates a complex challenge: the prioritization or balancing of different fairness metrics can sometimes lead to unintended consequences (Corbett-Davies, 2023). Essentially, the process of tuning AI systems to optimize certain fairness outcomes might inadvertently aggravate other inequities. For instance, an AI algorithm adjusted to equalize false positive rates across different demographics might inadvertently lead to unbalanced false negative rates, difficulty recognizing this balancing act between different fairness metrics is vital to implementing ethical AI systems in education.

When we assess AI applications in the educational domain through an array of fairness metrics (like equality of opportunity, representation equity, etc.), we might inadvertently compromise one form of fairness while enhancing another. Thus, deploying AI solutions that are tailored to diverse educational settings without keen oversight might unintentionally perpetuate new modalities of bias and discrimination.

4.4.1 Fairness Paradox Illustrated with Examples from Hypothetical Case Studies

Example 1 Revisited (AI-Powered Tutoring System): In the AI-powered tutoring system in a university, suppose the tool was calibrated to ensure that all students, regardless of their backgrounds, showed improvement in their scores. In striving for this metric of fairness—performance equity—the AI algorithm might enhance content delivery according to the initial

performance inputs, whereby stagnating students might end up receiving slightly favored treatment with more repetitive and simpler materials adjusted to their learning. This optimization can unintentionally undermine the growth of quicker learners who may be put through the same pacing, not providing them with the challenges needed for advanced learning. Though this fairness management enables students from lower performance brackets to catch up, it might unjustly cap the progress opportunities for those who could advance more rapidly, hence disrupting the balance of fairness across varying academic capabilities.

Example 2 Revisited (Classroom Management AI Monitoring Student Engagement): The calibration of AI to ensure uniform engagement across all students could also be seen as a manifestation of the Fairness Paradox. If the classroom management AI prioritizes maintaining consistent, measurable engagement levels, it might unfairly penalize naturally less expressive or introverted students who might not outwardly display engagement but internalize and process information effectively. By misaligning the measure of engagement (visible activity versus intellectual engagement), the system could distinctly advantage the extroverted students, thereby instigating a fairness trade-off between visible engagement and cognitive absorption.

4.4.2 Strategies for Educators and Policymakers

To navigate through the fairness paradox, educators and policymakers in higher education need to adopt a multidimensional lens toward fairness. This entails continuous tweaking and real-time evaluations of AI systems to understand disparate impacts, revolving the strategies around dynamic, contextually apt definitions of fairness rather than static or over-generalized models. Having a robust feedback mechanism where students can report perceived inadequacies or biases in AI applications can also provide fresh insights into reconfiguring fairness heuristics. Furthermore, embracing multidisciplinary cooperation in developing these systems—integrating insights from pedagogy, sociology, and ethics besides technology—can synergize efforts to rectify and proactively guard against biases leading to an unfair paradox in educational settings. This comprehensive approach can elucidate and mitigate the intricate fairness paradoxes, guiding the responsible use of AI in education.

Chapter 5 What do the experts say?

The use of Artificial Intelligence in Higher Education, as we have seen, is growing, and its introduction into tutoring systems undoubtedly presents both opportunities and challenges for all stakeholders involved in the teaching-learning process. Understanding the perspectives of students, faculty, and tutoring experts is critical to designing, developing, and implementing effective, equitable, and user-centered ITS. This chapter presents key findings from the participatory research conducted to explore these perspectives, with the aim of providing valuable insights for creating enriching and personalized learning environments.

Data has been collected through focus groups and questionnaires, involving more than 500 Participants from 64 European universities. The methodology used combined a qualitative approach, using focus groups, which allowed for a deeper understanding of participants' experiences and opinions, with a quantitative analysis based on surveys, which provided statistical data on general trends and preferences. The diversity of the participants, which included 303 students, 109 professors and researchers, and 97 mentoring experts, ensures that the chapter reflects the varied needs, expectations, and concerns related to the design, development, and implementation of ITSs. Crucially, the quantitative data from the questionnaires complement the qualitative findings from the focus groups, enriching the analysis and providing a solid basis for the recommendations and guidelines presented in this handbook.

The remainder of the chapter is organized into different sections that present the specific findings of the focus groups and questionnaires for each participant group (students, researchers and university faculty, and tutoring experts), respectively. Finally, two more sections provide a comparative analysis of the similarities and differences between the groups, and a final section offers the main conclusions of the research and their implications for the future of ITS in higher education.

5.1 Students perspective

This section focuses on students' perspectives in higher education regarding tutoring and Intelligent Tutoring Systems (ITS). Students are the primary beneficiaries of ITS, and their opinions and experiences are critical to designing systems that effectively meet their needs and expectations. The following presents the main research findings regarding students' appreciation of tutoring, their needs and expectations regarding ITS, and their concerns and challenges regarding the implementation of these technologies.

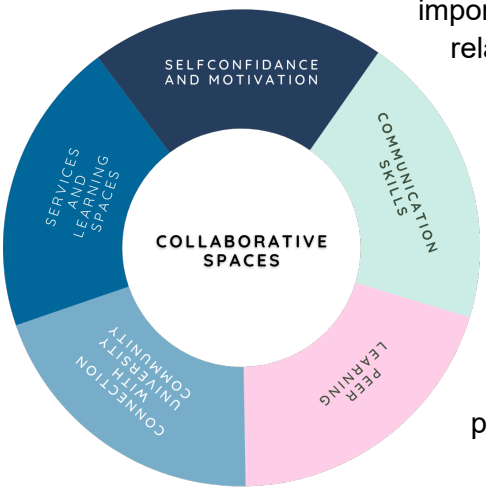
5.1.1 Assessment of tutoring

Students in higher education recognize the positive impact of tutoring on their academic experience and personal development. Focus group participants reported that tutoring not

only provides support with academic tasks but also significantly contributes to increasing their confidence and motivation. Furthermore, students highlight the critical role of tutoring in developing essential skills, such as time management, critical thinking, problem-solving, and communication. The psychological benefits of tutoring are also evident, as students experience a greater sense of academic support and an increase in their overall confidence. However, it is important to note that some students identified a lack of information and awareness about available tutoring services, suggesting a need to improve dissemination and access to these resources. Students also expressed a strong desire for more personalized tutorial support tailored to their individual needs and learning styles.

Two key aspects stand out in this section: on the one hand, higher education students emphasize the valuable role of peer support as an integral component of tutoring. Focus groups revealed that collaborative learning and the sharing of knowledge and experiences with peers are considered beneficial and contribute to a mutually supportive environment.

Building collaborative spaces in classrooms generates benefits for students:

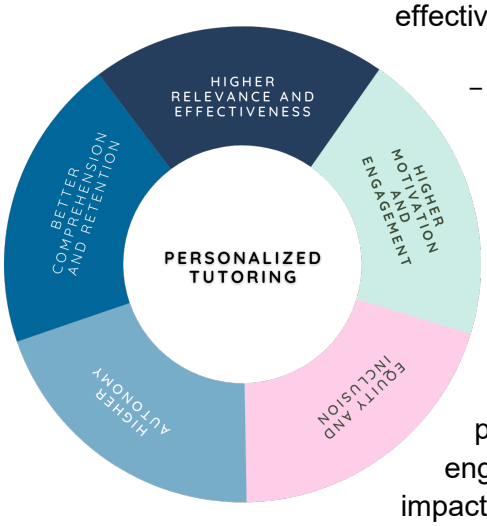


- It is indicated that tutoring contributes to the development of important skills such as communication, which is directly related to interaction and collaborative work.
- Peer learning is highlighted as a valuable and commonly used form of intervention. This suggests that the exchange of knowledge and experiences among peers is beneficial for students.
- It is mentioned that tutoring helps students feel more confident and motivated, which can be influenced by the support and collaboration they receive from their peers.
- Mentoring can generate a greater sense of purpose and connection with the university community, which is also related to interaction and collaborative work among students.
- The different learning spaces and services that universities offer to the educational community are presented.

On the other hand, students also express a strong desire for personalization in tutoring services, recognizing that each student has unique needs, learning styles, and individual rhythms. Participants emphasize the importance of tailoring tutoring support to their specific circumstances to maximize learning effectiveness. This aspect is important for the future ITS

tool, as it must focus on improving the effectiveness of the learning process and student support:

- Each student has a unique learning style, pace, strengths, weaknesses, interests, and motivations. Personalization allows ITS to adjust to these individual differences, delivering content, activities, and feedback that are more relevant and effective for each student.



- By presenting content in a way that suits the student's learning style, ITS can facilitate better comprehension and retention of information. This can lead to deeper and more meaningful learning and greater effectiveness in skill acquisition.

- When students feel that learning materials are relevant to their interests and needs, they are more likely to feel motivated and engaged in the learning process. Personalization can make learning more engaging and less frustrating, which can have a positive impact on students' attitudes toward studying.

- Personalization can help students develop greater autonomy in their learning by allowing them to make decisions about their own pace, style, and approach. This can foster important skills such as self-regulation, responsibility, and the ability to learn independently.

- Personalization can be especially important for ensuring equity and inclusion in education by providing additional support to students with disabilities or special needs. A personalized ITS can accommodate the needs of students with disabilities, students from different cultural or linguistic backgrounds, or students with different levels of academic readiness.

For students, tutoring represents invaluable support that transcends mere academic assistance. Beyond resolving doubts and improving performance, tutoring fosters the development of essential skills for long-term success, such as time management, critical thinking, problem-solving, and effective communication. It also contributes significantly to their emotional well-being, increasing confidence, motivation, and a sense of belonging to the academic community. Peer tutoring, in particular, stands out as an effective strategy for collaborative learning and the sharing of knowledge and experiences.

5.1.2 Needs and expectations

Students in higher education have expressed a number of clear needs and expectations regarding Intelligent Tutoring Systems (ITS). First, they emphasize the importance of a

student-centered tutoring system that is flexible, easy to use, and provides a comprehensive connection between the different types of support they need, including academic, personal, and professional support. Personalization emerges as a key factor, with students desiring tutoring systems that adapt to their individual needs and profiles, recognizing the diversity of learning styles and academic paths.

Clear communication and easy access to tutoring services are identified as key priorities, underscoring the need for intuitive platforms that facilitate interaction and timely access to support. Furthermore, students suggest the creation of a single platform that integrates all relevant tools and resources, providing a centralized course catalog and simplified navigation. Regarding the role of AI, students envision a model that acts as a personal guide for navigating existing digital resources, offering guidance and support without replacing interaction with instructors. Finally, students express a desire for a tool that helps them justify the relevance of what they are learning, providing content that highlights practical applications and the future importance of the topics.

One of the aspects most highlighted by students is the need for a unified and intuitive platform that centralizes the various functions and tools related to tutoring and learning. Students suggest creating an app that integrates all relevant platforms and resources, providing a course catalog where all information is accessible and navigable in one place. Overall, there is a consensus that an intuitive and easy-to-use platform that reduces bureaucracy and facilitates communication between all users is essential for the successful adoption of ITS and for improving the teaching-learning experience.

On the other hand, there are the expectations generated by these advances in comprehensive student training, identifying a need for adaptive learning and personalized feedback as another priority shared by the different stakeholder groups. Students express a strong desire for tutoring systems that adapt to their individual needs and profiles, offering personalized support, rapid feedback, and relevant resources. Overall, there is a recognition that ITSs must be capable of learning from the user, utilizing data about their trajectory and performance to provide more focused and relevant responses and support, thus maximizing the effectiveness of the teaching-learning process.

5.1.3 Concerns and challenges

While students recognize the potential of ITS, they have also expressed several significant concerns and challenges regarding their implementation. A recurring theme is a feeling of unpreparedness to adopt new platforms without adequate digital education, highlighting the need for appropriate training and support to ease the transition. The protection of personal data emerges as a key concern, with students emphasizing the importance of reliability in the protection of their information. The digital divide and equity issues are also raised as significant challenges, with students emphasizing the need to ensure that all students, regardless of their access to technology or digital skills, can benefit from ITS. The potential loss of human

connection in the tutoring process is another significant concern, as students fear that technology could replace valuable interaction with educators. Finally, potential resistance to change on the part of some educators is recognized as a challenge that must be addressed for successful ITS implementation.

In conclusion, students in higher education view Intelligent Tutoring Systems (ITS) as a tool with the potential to positively transform their learning experience, provided they are designed and implemented with their specific needs and expectations in mind. For students, an ideal ITS would be a unified, easy-to-use platform that provides centralized access to various types of support (academic, personal, and professional), adapts to their individual learning styles, and offers personalized guidance and timely feedback. However, they also express significant concerns about equity in access to technology, the protection of their personal data, and the need to preserve human interaction in the tutoring process. Ultimately, students advocate for a user-centered design approach that prioritizes transparency, flexibility, and the ability of ITSs to justify the relevance of what they are learning.

5.2 Perspective of Professors, Researchers and Tutors

This section focuses on the perspectives of faculty, researchers, and tutors in higher education regarding tutoring and Intelligent Tutoring Systems (ITS). Educators play a pivotal role in the implementation and effective use of ITS, and their views and experiences are crucial to ensuring that these technologies meet the needs of both students and teaching staff. Key research highlights are presented below regarding educators' appreciation of tutoring, their needs and expectations regarding ITS, and their concerns and challenges regarding the implementation of these technologies.

5.2.1 Assessment of tutoring

Educators in higher education recognize the intrinsic value of mentoring as an essential component of academic life. Mentoring not only provides an avenue for offering personalized guidance to students but also serves as a catalyst for their holistic development, extending beyond the classroom. Educators emphasize that participating in mentoring activities fosters their own professional growth, allowing them to refine their mentoring strategies, improve their communication skills, and engage in critical reflection on their teaching practices.

Furthermore, mentoring facilitates the building of stronger and more meaningful relationships between educators and students, fostering a deeper understanding of the individual challenges the latter face. Finally, educators believe that mentoring plays a crucial role in identifying specific areas where institutions can improve their student support systems, thereby optimizing the overall learning environment.

From the educators' perspective, mentoring not only represents an opportunity to guide and support students in their academic journey, but also a space for professional growth and

reflection. Participating in mentoring activities allows educators to refine their pedagogical strategies, improve their communication skills, and develop a deeper understanding of students' individual needs.

Here begins one of the great debates among teachers: What role will tutors/teachers play in the future in intelligent tutoring systems?

In an AI-enriched educational environment, the role of the tutor/teacher undergoes a fundamental transformation. Traditionally viewed as a mere transmitter of knowledge, the teacher becomes an essential guide and mediator in the learning process. Their primary role is no longer limited to imparting information but expands to help students navigate the vast sea of available information, discern between reliable and unreliable sources, and use AI tools effectively and ethically. The teacher facilitates the development of 21st-century skills, such as critical thinking, problem-solving, creativity, and collaboration, which are crucial for success in an increasingly digitalized and automated world.

Tutors/teachers play a crucial role in designing learning experiences that leverage the potential of AI to personalize education and foster collaboration. This involves creating activities that allow students to interact with AI tools in active and meaningful ways, promoting exploration, experimentation, and project-based learning. Tutors/teachers are also responsible for designing pedagogical strategies that integrate AI to support the development of critical thinking and creativity, encouraging students to question, analyze, synthesize, and evaluate information, and generate innovative ideas and original solutions.

Beyond academic development, tutors/teachers remain essential in supporting students' social and emotional development. In an increasingly digitalized educational environment, teachers provide individualized guidance, fostering a sense of community and belonging, and creating a safe and inclusive learning environment where students feel valued, respected, and supported. The tutor/teacher acts as a mentor who guides students in their personal growth, helping them develop interpersonal skills, manage stress, and build positive relationships with their peers and the wider community.

On the other hand, tutors/teachers have a fundamental responsibility to ensure that AI is used ethically and responsibly in education. This involves addressing crucial issues such as algorithmic bias, which can perpetuate existing inequalities; the privacy and security of student data, which must be protected at all times; and equity in access to technology, ensuring that all students have equal opportunities to benefit from ITS. Tutors/teachers should promote transparency and accountability in the use of AI, explaining to students how these technologies work and how their data is used, and assuming responsibility for the decisions made by AI systems.

Finally, to play a leading role in future mentoring processes, mentors/teachers require ongoing training and professional development to acquire the skills and knowledge necessary to integrate AI into their teaching practices. This includes training in the use of AI tools,

understanding their pedagogical and ethical implications, and developing strategies to design meaningful learning activities that leverage the potential of AI. Educational institutions must provide teachers with collaborative learning opportunities, mentoring, and access to up-to-date resources to support their professional development in the AI era.

5.2.2 Needs and expectations

Tutors/lecturers in higher education have expressed several key needs and expectations regarding Intelligent Tutoring Systems (ITS). First, there is a strong desire for ITS to be more effectively integrated into the existing academic structure. This entails the need for systems that provide clear guidelines for tutoring, tools for efficiently tracking student progress, and seamless opportunities for collaboration among colleagues. Furthermore, tutors/lecturers value tools that are inherently easy to use and accessible through a variety of devices, including mobile apps and virtual environments, facilitating their widespread adoption and use. Educators use various digital tools for teaching and tutoring, including online learning platforms (such as Moodle and Google Classroom), video conferencing tools (such as Zoom and Google Meet), Microsoft Office Suite, and educational gaming platforms (such as Khan Academy and Duolingo).

Beyond purely academic support, there is also significant interest in systems that can contribute to students' overall well-being and support their professional development. To ensure successful implementation of ITS, educators emphasize the importance of ongoing training and support to enable them to use these technologies effectively and stay up-to-date with the latest updates and features. This training should address not only the technical use of the tools but also the pedagogical implications and best practices for integrating them into teaching. The pandemic experience has highlighted the need for ongoing and structured training, as many educators had to quickly adapt to digital teaching without preparation.

Tutors have also articulated a number of specific needs and expectations regarding Intelligent Tutoring Systems (ITS). A primary need is for a centralized platform that allows them to manage all their tutoring activities in one place. This ideal platform should include an integrated schedule manager, a shared resource library for easy access to relevant materials, and a dedicated space for taking notes and tracking student progress.

Furthermore, tutors emphasize the importance of effective communication, requesting an easy way to report issues or request assistance when needed, as well as clear and efficient communication channels with faculty and administration.

Finally, educators want the opportunity to actively participate in the design of ITS, ensuring that these systems are relevant to their practical needs, adhere to ethical principles, and truly enhance the educational experience.

5.2.3 Concerns and challenges

Along with recognizing the potential benefits of ITS, educators have also expressed several significant concerns and challenges related to their implementation. One of the main concerns centres on the costs associated with implementing and maintaining these systems.

Educators note that the financial investment required can be significant, posing a particular obstacle for institutions with limited resources. Furthermore, there is widespread concern about potential resistance to change on the part of some teachers, who may be reluctant to adopt new technologies or modify their traditional teaching methods.

On the other hand, algorithmic bias is another major concern, as educators fear that AI systems may inadvertently perpetuate existing biases in training data, potentially leading to unfair or discriminatory outcomes. This concern is significant as it also entails the potential loss of the essential "human element" of tutoring when implementing Intelligent Tutoring Systems (ITS). While they recognize AI's potential to automate tasks and provide personalized support, they emphasize the importance of preserving the human interaction, emotional connection, and social component that they consider fundamental to effective tutoring.

Educators fear that an excessive focus on technology could lead to a dehumanization of the teaching-learning process, diminishing tutors' ability to understand and respond to individual students' needs, build meaningful relationships with them, and foster a sense of community and belonging.

Data privacy is also emerging as a critical issue, with educators emphasizing the need for strong protection of student data and clear transparency regarding how this data will be used within AI-powered platforms.

Finally, despite the positive assessment of tutoring, tutors also face a number of concerns and challenges in performing their role. One of the main challenges is the lack of structure and initial support, with some tutors feeling ill-prepared and expressing the need for better training and clearer expectations. Furthermore, many tutors find it difficult to balance their tutoring responsibilities with their own studies, especially when managing multiple students or a wide variety of subjects. Tutors also point to the need for greater recognition for their work, as well as more training opportunities and access to resources that facilitate the preparation of tutoring sessions, monitoring student progress, and effective communication with university staff.

In conclusion, educators and tutors recognize the transformative potential of Intelligent Tutoring Systems (ITS) to improve teaching and learning in higher education. Both groups agree on the need for systems that are better integrated into the academic structure, that are easy to use and accessible, and that provide effective tools for student progress tracking and peer collaboration. Ongoing training and technical support are considered essential to ensure that educators and tutors can effectively use ITSs and adapt to new features and updates.

However, significant concerns are also expressed about implementation costs, potential resistance to change, algorithmic bias, and the need to protect student data privacy.

Furthermore, educators and tutors emphasize the importance of preserving human interaction and personal connection in the tutoring process, warning of the risks of dehumanizing teaching. Ultimately, both groups advocate for a thoughtful, user-centered approach to ITS design and implementation, balancing the potential of technology with the pedagogical and ethical needs of higher education.

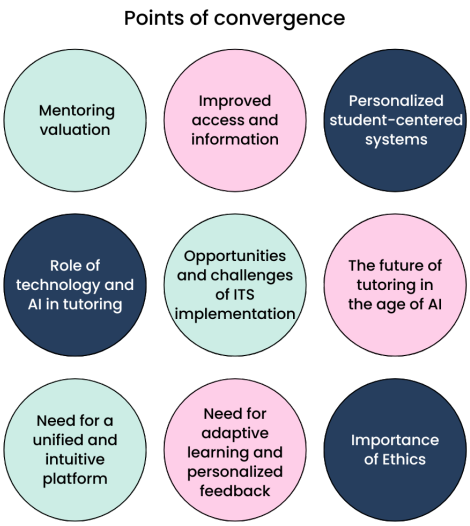
5.3 Comparative Analysis: Points of Convergence and Divergence

This chapter presents a comparative analysis of the findings that emerged from the focus groups conducted across different partner countries. It explores both the shared insights and the distinctive perspectives expressed by participants, highlighting areas of convergence in terms of needs, challenges, and expectations, as well as points of divergence shaped by national contexts, institutional frameworks, and cultural attitudes.

5.3.1. Points of convergence

This section presents a comparative analysis of the findings from the focus groups and questionnaires conducted with students, educators, and tutors/experts, with the aim of identifying points of convergence and consensus among the different participant groups. Despite differences in their roles, experiences, and perspectives, students, educators, and tutors/experts share a number of common opinions and expectations regarding tutoring and Intelligent Tutoring Systems (ITS) in higher education.

Understanding these areas of agreement is critical to designing and implementing ITS that are relevant, effective, and acceptable to all users, and that contribute to improving the overall teaching-learning experience.



- Valuation of mentoring. There is general consensus among the three groups on the value and importance of mentoring in higher education. Students, educators, and tutors/experts all recognize the fundamental role of mentoring in supporting students' academic success and personal development.

- Need to improve access and information. All three groups agree on the need to improve access to and information related to tutoring services. They emphasize the importance of greater dissemination of information, better organization of services, and the creation of centralized platforms that facilitate the search and use of these resources.

- Desire for personalization and student-centered systems. Personalization and a student-centered approach emerge as key priorities for all three groups. There is a shared desire for tutoring systems that adapt to students' individual needs and learning styles, offering personalized support, rapid feedback, and relevant resources.

- The role of technology and AI in tutoring. All three groups recognize the potential of technology and AI to improve tutoring in higher education. However, concerns are also expressed about potential drawbacks, such as the loss of human connection, equity in access to technology, and ethical risks.

- Opportunities and challenges of ITS implementation. All three groups identify a number of opportunities and challenges associated with ITS implementation. Among the opportunities, they highlight the potential of ITS to make tutoring more accessible, flexible, and efficient, as well as to personalize the learning experience and improve communication and collaboration. Among the challenges, they mention the need to ensure digital equity, protect data privacy, and address ethical issues such as algorithmic bias.

- The future of tutoring in the age of AI. There is consensus that AI should not completely replace human interaction in tutoring. All three groups emphasize the importance of designing ITS that complement and support the work of human educators and tutors, facilitating communication and collaboration, but without eliminating personal contact and empathy.

- Need for a unified and intuitive platform. All three groups agree on the need for a unified and intuitive platform that centralizes the various functions and tools related to tutoring and learning. The importance of a user-friendly interface, simplified navigation, and reduced bureaucracy to facilitate the adoption and effective use of ITS is emphasized.

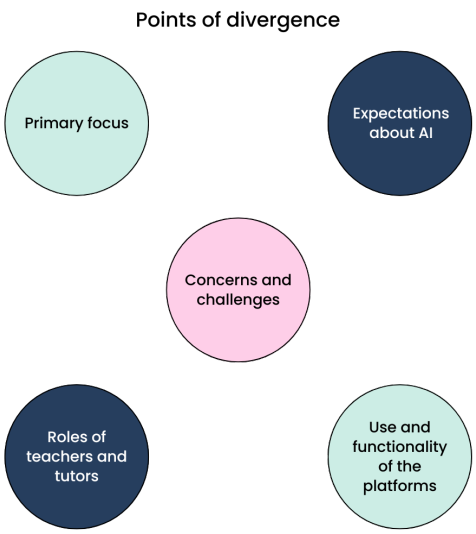
- Need for adaptive learning and personalized feedback. All three groups express a strong desire for tutoring systems that offer adaptive learning and personalized feedback. The potential of AI to analyze student data and provide support and guidance tailored to their individual needs and learning styles is recognized.

- Importance of Ethics. All three groups agree on the importance of addressing ethical considerations related to the use of AI in tutoring, including data privacy, algorithmic bias, fairness, and transparency.

5.3.2. Points of divergence

While there is widespread consensus on the potential of Intelligent Tutoring Systems (ITS) to improve higher education, several key differences have also been identified in the perspectives, priorities, and concerns of different stakeholder groups. Understanding these areas of divergence is critical to designing and implementing ITS that are capable of addressing the specific needs of each group and minimizing potential conflicts or misunderstandings.

The main points of divergence identified in the research are presented below:



- Differences in primary focus. One of the main areas of divergence lies in the primary focus of each group. Students tend to focus on the user experience, prioritizing how ITSs can facilitate their learning and improve their academic performance. Professors and researchers, on the other hand, take a broader perspective, considering the pedagogical, institutional, and ethical implications of ITS implementation. Tutors/experts, on the other hand, show greater concern about the impact of mentoring on their own professional development and the need for adequate support and resources to effectively perform their role.

- Differences in expectations about AI. Differences are also observed in expectations about the role of AI in tutoring. While students tend to view AI primarily as a tool for personalizing learning, automating tasks, and accessing relevant information, professors and researchers, in addition to personalization, emphasize its potential to provide timely feedback, identify at-risk students, and improve teaching effectiveness. Tutors/experts, while open to the use of AI, focus primarily on its ability to support, but not replace, human interaction and the flexibility they consider essential in tutoring.

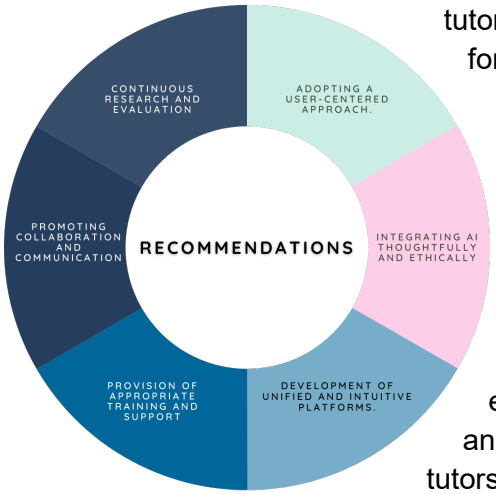
- Differences in concerns and challenges. Concerns and challenges associated with implementing ITSs also vary across different participant groups. Students show greater concern about the potential loss of human connection in the tutoring process, equity in access to technology, and the protection of their personal data. Teachers and researchers, on the other hand, emphasize the costs of implementing ITSs, potential resistance to change on the part of some educators, and the need to address important ethical issues, such as algorithmic bias and data privacy. Tutors/experts, on the other hand, focus primarily on the need for adequate training to effectively use digital tools and the importance of ongoing technical support to resolve any issues that may arise.

- Differences in the roles of teachers and tutors. Differences are observed in how different groups perceive the role of teachers and tutors in relation to ITS. Students tend to view both as facilitators of their learning, but do not delve into the specific roles they should play in the context of these technologies. Teachers and researchers, on the other hand, emphasize the fundamental role of teachers in the AI era, which includes guiding the use of technology, designing meaningful learning activities, and supporting the development of students' skills. Tutors/experts, on the other hand, see themselves as active collaborators in the learning process, but emphasize the importance of educational institutions providing them with the necessary tools and support to effectively perform their role.

- Differences in the use and functionality of the platforms. In addition to the differences mentioned above, the data from the "Needs and Prioritization Map.docx" document reveals a discrepancy in tutoring experts' perceptions of the functionality of university platforms. A high percentage of tutoring experts (55.6%) believe the university platform is not functional for offering their services, citing student preferences for direct communication and platform limitations as the main reasons.

5.4 Recommendations and conclusions.

Based on the analysis of the perspectives of students, educators, and tutors/experts, the following recommendations can be formulated for the design, development, and implementation of Intelligent Tutoring Systems (ITS) in higher education:



1 Adopting a user-centered approach. ITSs should be designed taking into account the needs, preferences, and learning styles of all users, including students, educators, and tutors/experts. This entails creating personalized, adaptable, accessible, and easy-to-use systems that promote student autonomy and engagement and facilitate the work of educators and tutors.

2 Integrating AI thoughtfully and ethically. AI should be used as a tool to enhance mentoring, but not to replace human interaction and personal connection. It is crucial to address concerns about equity, privacy, algorithmic bias, and transparency, and to ensure that ITS are used responsibly and ethically.

3 Development of unified and intuitive platforms. Higher education institutions should prioritize the development of centralized platforms that integrate the various functions and tools related to tutoring and learning. These platforms should be easy to use, accessible from different devices, and well integrated into the existing academic structure, reducing bureaucracy and facilitating communication and collaboration among all users.

4 Provision of appropriate training and support. It is essential to provide educators and tutors with comprehensive training and ongoing support to ensure they can effectively use ITS and adapt to new features and updates. This training should address both the technical and pedagogical and ethical aspects of ITS implementation.

5 Promoting collaboration and communication. ITS should be designed to facilitate communication and collaboration between students, educators, and tutors/experts. This includes creating virtual spaces for interaction, resource sharing, and teamwork, as well as promoting a sense of community and mutual support.

6 Continuous research and evaluation. Ongoing research and evaluation are needed to better understand the impact of ITS on teaching and learning, identify areas for improvement, and adapt systems to changing user needs.

In conclusion, the findings of this research highlight the transformative potential of Intelligent Tutoring Systems (ITS) to enhance higher education, but also underscore the importance of carefully addressing the diverse needs, expectations, and concerns of students, educators, and tutors/experts.

ITS have the potential to personalize learning, increase student engagement, facilitate the work of educators and tutors, and improve the efficiency of academic processes. However, to fully realize this potential, it is critical to adopt a user-centered design approach, prioritize ethics and equity, and ensure that technology is used to support, not replace, human interaction and personal connection.

Moreover, it is essential to recognize that the adoption of Intelligent Tutoring Systems (ITS) should not be viewed merely as a technological innovation, but rather as part of a broader cultural shift within higher education institutions. Stakeholders must receive adequate training not only in how to use these tools effectively, but also in how to integrate them pedagogically. This involves rethinking instructional strategies, assessment methods, and student engagement practices to fully leverage the advantages offered by ITS while maintaining a human-centered learning environment.

Therefore, the successful implementation of ITS requires a collaborative effort among all stakeholders, including students, educators, tutors/experts, administrators, technology developers, and policymakers. By working together to address the challenges and seize the opportunities presented by ITS, we can create a future of higher education that is more personalized, accessible, equitable, and effective for all.

Chapter 6 Needs and priorities of HE educators in relation to ITS. Lessons learnt

The educators at higher education institutions (HEI) are the professionals responsible for developing students' knowledge, skills, and abilities through formal education. Due to technological advancements that have the potential to revolutionize the education system, educators have certain needs and priorities regarding the use of the Intelligence tutoring system to support students in their academic journey and to provide individualized support and guidance during their learning process (Merrienne & Woolf, 2019). To sensitize educators about the use of generative AI (Sancar et al., 2021), we reviewed the scientific, up-to-date literature to distill their needs and priorities.

Therefore, as technology advances, it is crucial to understand educators' needs and priorities to fully realize the potential of ITS: An in-depth look.

6.1 Needs

Innovations in EdTech (education technologies) and digital technology advancements increased the application of personalized learning. Personalized learning is essential because it tailors education to meet each learner's unique needs, strengths, and interests and allows them to progress at their own pace. It provides content and features that are adaptive to individual needs and is effective and efficient in supporting and promoting desired learning outcomes (Spector, 2016; Outhwaite & Van Herwegen, 2023). To support personalised learning the intelligent tutoring systems play an important role (Shemshack & Spector, 2020), because it uses advanced algorithms and data analytics to assess individual learning styles, preferences, and performance. However, personalized learning yet remains among the biggest challenges in the educational systems, as it requires a novel approach and the re-development and orchestration of the existing digital solutions to achieve the required customisation, quality and outcomes.

Need: Provide each student with a personalized learning experience that adapts to their pace, learning style, and individual needs.

Priorities:

- Systems that can accurately assess each student's knowledge, skills, and preferences.
- Algorithms that adapt content, activities, feedback and learning pace based on individual progress.

- Options for educators to customize the system to their specific needs and those of their students.
- Customizable Learning Paths. Enabled customization of learning paths within the HITS to cater to different courses, subjects, and student needs.
- Seamless Integration with Existing Curriculum. Align the HITS with the university's curriculum to ensure that it complements and enhances traditional teaching methods rather than replacing them.

6.1.1 Personalization of learning

In accordance with the 2030 Sustainable Development Goal 4, which aims to ensure inclusive and equitable education and promote lifelong learning opportunities for all, inclusive education shall cover all aspects of educational policy and its implementation (Ainscow, 2020). Higher education institutions need to provide inclusive education to ensure equal opportunities for all students, regardless of their diverse backgrounds, abilities, or socio-economic statuses. By embracing inclusivity, high education institutions enhance their academic community and fulfill their social responsibility to contribute to a more equitable and just society. However, research shows that students with disabilities are yet marginalized from inclusive and equitable quality education (McLinden et al., 2023), especially in less developed economies (Hennessy et al., 2021). In accordance with the inclusion policies and practices, the university's digital infrastructure should effectively support the needs of all students, especially if they require assistive technologies to close the gap.

Need: provide each student, especially students from marginalized groups, regardless of their diverse backgrounds, abilities, or socio-economic statuses, with technologically orchestrated solutions for their better engagement in the education process.

Priorities:

- Digital systems that operate in accordance with assistive technologies;
- Options for high education institutions to integrate multiple and innovative technological solutions to ensure the usability and accessibility to the HITS.

6.1.2 Effective assessment

The recently organized discussion for diverse groups of academic personnel, including educators, administrators, and in-service teachers participated in the professional development session (Nyaaba, M., & Zhaı, X. 2024), highlighted the need for the automatic scoring and other assistance provided with the use of generative AI.

Need: Offer students timely, quality evaluation and feedback that helps them improve their learning.

Priorities:

- Systems that can automatically evaluate student work in different formats (written, oral, practical, etc.). HE educators have an increasing demand for the students assignments' evaluation using GAI (Nyaaba & Zhaı, 2024).
- Automated, personalized feedback that identifies areas of strength and improvement, including specific suggestions for action.
- Options for educators to review and customize system-generated feedback, adding relevant comments and examples.

6.1.3 Workload reduction

The increasing administrative and grading workload faced by educators is a significant challenge that can detract from their primary responsibilities of teaching, interacting with students, and conducting research. There is a pressing need to alleviate these burdens to allow educators to focus more on qualitative aspects of education and student engagement.

To meet this need, universities should prioritize the implementation of systems that can automatically grade assignments, exams, exercises, and written work, thereby freeing up valuable time for educators to provide in-depth, qualitative feedback. Additionally, incorporating classroom management tools that automate routine administrative tasks—such as tracking attendance, creating schedules, communicating with students, and organizing group activities—can further reduce the workload on educators. It is also crucial to provide options for educators to configure and customize assignments and assessments according to their specific requirements, ensuring flexibility and relevance in their teaching methods. By focusing on these priorities, universities can significantly reduce the administrative and grading workload, enabling educators to dedicate more time to enriching the student learning experience and advancing their research initiatives.

Need: Reduce administrative and grading workload, so educators can devote more time to teaching, interacting with students, and research.

Priorities:

- Systems that can automatically grade assignments, exams, exercises and written assignments, freeing up time for qualitative evaluation.
- Classroom management tools that automate administrative tasks such as attendance, creating calendars, communicating with students, and organizing groups.

- Options for educators to configure and customize assignments and assessments to their needs.

6.1.4. User Experience and Engagement

With the rapid advancement of technology, educational institutions are increasingly focused on leveraging intelligent tutoring systems (ITS) to enhance the learning experience for students. These AI-driven platforms significantly improve student engagement and academic outcomes. However, despite their potential, many universities face challenges in effectively integrating these systems into their educational frameworks. To fully realize the benefits of ITS, it is crucial for universities to address specific needs and make strategic improvements and develop intuitive and engaging digital infrastructure

Need: Improved student ‘s experience during the education process.

Priorities:

- Intuitive User Interface. Design an intuitive and user-friendly interface that makes it easy for students to navigate and use the ITS.

- Gamification and Interactive Elements. Incorporate gamification elements and interactive features to boost student engagement and motivation.

6.1.5. Improved communication and collaboration.

In today's interconnected educational landscape, effective communication and collaboration are essential for enhancing the learning experience and fostering a sense of community within universities. The need to improve communication and collaboration among students, between students and educators, and among educators themselves is critical for creating a dynamic and supportive educational environment.

To address this need, universities should prioritize the development and deployment of tutoring platforms that enable real-time interaction between students and educators, both on an individual basis and within group settings. It is important to allow students to work together as a team, share ideas, and efficiently manage projects and to equip educators with the ability to moderate and manage online interactions, ensuring that the virtual learning environment remains positive, inclusive, and conducive to collaboration.

Need: Foster communication and collaboration between students, between students and educators, and between educators.

Priorities:

- Tutoring platforms that facilitate interaction between students and educators in real time, both individually and in groups.
- Collaboration tools that allow students to work as a team, share ideas and carry out projects effectively.
- Options for educators to moderate and manage online interactions, fostering a positive and collaborative learning environment.

6.1.6. Early detection of difficulties.

Early detection of students facing academic difficulties is vital for ensuring timely intervention and support. Early and effective identification of students at risk of failure or in need of additional assistance is increasingly recognized as a critical factor in improving student retention and success rates. High intelligent tutoring systems (HITS) can play a pivotal role in this process by providing sophisticated tools for analyzing student performance, online interactions, and engagement patterns to identify early signs of academic struggle.

To address this need, universities must prioritize the development and integration of systems capable of conducting comprehensive analyses of various data points to detect potential difficulties. These systems should be equipped with features that generate timely alerts and notifications, enabling educators to intervene promptly with personalized support tailored to each student's specific needs. Additionally, it is essential to provide educators with options to customize difficulty detection criteria and receive actionable recommendations, ensuring that interventions are both targeted and effective.

Need: Early and effective identification of students at risk of failure or in need of additional support.

Priorities:

- Systems that can analyze student performance, online interactions, and engagement patterns to detect signs of difficulty.
- Timely alerts and notifications so that educators can intervene early and personalized.
- Options for educators to customize difficulty detection criteria and receive specific action recommendations.

6.1.7. Infrastructure and Accessibility

In accordance with the 2030 Sustainable Development Goal 4, which aims to ensure inclusive and equitable education and promote lifelong learning opportunities for all, inclusive education shall cover all aspects of educational policy and its implementation (Ainscow, 2020). Higher

education institutions need to provide inclusive education to ensure equal opportunities for all students, regardless of their diverse backgrounds, abilities, or socio-economic statuses. By embracing inclusivity, high education institutions enhance their academic community and fulfill their social responsibility to contribute to a more equitable and just society. However, research shows that students with disabilities are yet marginalized from inclusive and equitable quality education (McLinden et al., 2023), especially in less developed economies (Hennessy et al., 2021). In accordance with the inclusion policies and practices, the university's digital infrastructure should effectively support the needs of all students, especially if they require assistive technologies to close the gap.

Need: provide each student, especially students from marginalized groups, regardless of their diverse backgrounds, abilities, or socio-economic statuses, with technologically orchestrated solutions for their better engagement in the education process.

Priorities:

- **Accessibility for All Students**: Implement solutions that make HITS accessible to students with disabilities, ensuring compliance with accessibility standards and promoting inclusivity.

- **Digital systems that operate in accordance with assistive technologies.** Options for high education institutions to integrate multiple and innovative technological solutions to ensure the usability and accessibility to the HITS.

- **Robust IT Infrastructure:** Ensure that the university's IT infrastructure can support the deployment and scaling of high-intelligence tutoring systems. This includes high-speed internet, reliable servers, and adequate storage solutions.

- **Data Privacy and Security.** Implement stringent data privacy policies to protect student information and ensure compliance with relevant data protection regulations. Use advanced security measures to safeguard data and prevent unauthorized access.

6.1.8. Training, Support and continuous improvement

The implementation of high intelligent tutoring systems (HITS) in universities holds great promise for transforming the educational landscape by offering personalized and adaptive learning experiences. However, to maximize the effectiveness of these systems, it is essential for both faculty and students to be adequately prepared and supported. Comprehensive faculty training programs are crucial to equip educators with the skills necessary to seamlessly integrate ITS into their teaching practices, ensuring they can leverage the full potential of these advanced tools. Similarly, student orientation sessions are vital to familiarize learners with the ITS interface, functionalities, and benefits, enabling them to utilize the system effectively from the outset.

Moreover, establishing regular feedback mechanisms is essential to gather valuable input from both students and faculty regarding their experiences with the ITS. This feedback is indispensable for identifying areas of improvement and making informed decisions about necessary enhancements. Finally, ongoing system updates, informed by this continuous feedback and technological advancements, are critical to maintaining the relevance and efficacy of the ITS. By addressing these key areas, universities can significantly enhance the overall student experience and drive better academic outcomes through the effective use of intelligent tutoring systems.

Need: to prepare university staff and students for the effective use of HITS.

Priorities:

- **Faculty Training Programs**: Develop comprehensive training programs to equip faculty and staff with the skills needed to effectively utilize and integrate ITS into their teaching practices.
- **Student Orientation Sessions**: Conduct orientation sessions for students to familiarize them with the ITS interface, functionalities, and benefits.
- **Regular Feedback Mechanisms**: Establish regular feedback channels for students and faculty to provide input on their experience with the ITS.
- **Ongoing System Updates**: Continuously update and improve the ITS based on feedback and technological advancements to ensure it remains effective and relevant.

6.2 Priorities

The successful integration of High Intelligent Tutoring Systems (HITS) into academic environment requires a careful prioritisation of needs to ensure their effectiveness. Based on previously reviewed needs and priorities, it was identified that usability and seamless system integration with existing platforms and workflows are crucial to minimise disruption in daily practices. Additionally, providing thorough training for administrative staff and educators helps bridge the gap between technological innovation and practical use, making HITS accessible in everyday practice. Prioritizing these aspects is essential to avoid underutilisation of the system and to maximize its potential for enhancing academic success, ensuring that all stakeholders feel confident and supported in leveraging its capabilities.

6.2.1 Best practice Usability and ease of use

One of the most critical priorities for High-Intelligence Tutoring Systems (HITS) is **usability**. Usability refers to how easily users—both educators and students—can interact with and

benefit from the system. **An intuitive interface** that requires minimal training is essential to ensure that the system is accessible to individuals with varying levels of technical proficiency. **Ease of use** includes simplifying navigation, offering clear instructions, and providing a seamless experience across devices. Usable systems allow educators to focus on teaching and students to concentrate on learning without being hindered by the technology itself. According to research in EdTech, systems with high usability improve student engagement and retention because they minimize frustration and cognitive load. Therefore, HITS should prioritize a design that facilitates smooth learning processes, reducing the barrier to adoption and allowing educators to integrate it effortlessly into their pedagogical practices.

6.2.2 System integration

For HITS to be effective, **system integration** is a top priority. Integration refers to the ability of HITS to work in conjunction with existing Learning Management Systems (LMS), institutional data systems, and educational resources. When integrated well, these systems can pull data from existing student records, allowing for seamless personalization of content. For example, HITS should integrate with a university's grading systems, communication platforms, and curriculum management software to streamline workflow for educators and students. Effective integration reduces redundant data entry, aligns ITS functionalities with the current curriculum, and ensures that the system enhances rather than disrupts the existing educational framework. The ability to sync with other systems also allows educators to customize learning paths, making HITS a powerful tool that complements traditional methods rather than functioning as a standalone entity. Therefore, universities should prioritize integration as a strategic goal when implementing HITS

6.2.3 Educators' training

Teacher's and administration staff training is another significant priority for the successful adoption and utilization of High-Intelligence Tutoring Systems. Even the most advanced system will not realize its full potential unless educators are properly trained to use it effectively. Training should focus on both the technical aspects of the system and its pedagogical applications. This includes training educators to set learning objectives, track student progress, interpret system-generated reports, and provide supplemental guidance based on data insights from HITS. Moreover, ongoing professional development and support are crucial to ensure that teachers remain up to date with system updates and new features. Universities should develop comprehensive training programs that not only cover the initial use but also encourage continuous learning, offering educators the confidence and tools to maximize HITS in their classrooms. When educators are empowered with the right skills, they can better leverage the technology to enhance student outcomes, make data-driven decisions, and provide personalized support.

In conclusion, the successful implementation of High Intelligent Tutoring Systems (HITS) hinges on addressing key needs and setting clear priorities. Usability and ease of use must

remain central to design and development, ensuring that all users—students, educators, and administrators—can interact with the system efficiently and effectively. Seamless integration with existing educational infrastructures is crucial to avoid disruption and to foster smoother transitions in daily operations. Additionally, comprehensive training programs for teachers and administrative staff will be vital for ensuring widespread adoption and consistent use of HITS. By prioritizing these factors, educational institutions can maximize the potential of HITS, transforming it from a technological tool into a vital resource that promotes long-term academic success.

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