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Generative Artificial Intelligence & Education

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Thesis: Generative Artificial Intelligence & Education

Introduction

The rapid evolution of artificial intelligence (AI) and the advent of generative AI have created new opportunities in the world of education. This thesis explores the integration of AI into educational systems, considering both theoretical and practical aspects. The aim is to understand how AI can enhance learning experiences, through an analysis that includes a literature review, two surveys and the observation of a hackathon. The results offer not only academic insights, but also concrete applications that could transform educational processes.

The first chapter highlights the importance of AI in education, focusing on key areas such as personalised learning and administrative efficiency. These aspects are critical for addressing the diverse needs of students and optimising the educational experience. The chapter outlines research questions aimed at understanding AI's efficiency in education, its impact on students, and the importance of collaboration between technology and traditional teaching methods. The answers to these questions are explored throughout the thesis, providing a foundational understanding of AI's role in the education sector.

This thesis goes beyond theoretical analysis by examining practical benefits: socially, AI can democratise education, reaching a broader audience, including underserved communities. Economically, AI could reduce costs by automating administrative tasks and facilitating scalable, personalized learning solutions. Moreover, AI offers the potential to make education more accessible and tailored, ensuring that learning is more engaging and adaptive to individual needs, which in turn can enhance retention and comprehension.

The first chapter introduces AI's capacity to transform education, setting the stage for critical engagement with the topic in subsequent chapters. This includes discussions on personalised learning, AI's administrative uses (e.g., grading and lesson preparation), and the crucial role educators play in integrating AI. Educators must undergo ongoing training and development, not only to use AI effectively, but also to navigate ethical concerns, which remain significant barriers to AI adoption.

The second chapter builds on this foundation by offering a review of relevant literature (2018–2024) on generative AI (GenAI). It emphasises real-world case studies and discusses the ethical challenges inherent to AI's role in education. GenAI is a focal point,

allowing a deeper understanding of its impact on student engagement and the innovative possibilities it introduces.

Furthermore, the chapter discusses the increasing adoption rates of GenAI tools like ChatGPT and Grammarly, highlighting their growing presence in educational institutions. These studies make it evident that AI is not just a theoretical concept but an active and increasingly important tool shaping education.

In the third chapter, the analysis of surveys and a hackathon explores students' perceptions and the practical application of AI in education. The surveys reveal students' thoughts on AI's usefulness, frequency of use, and overall satisfaction. Meanwhile, the hackathon highlights AI's collaborative potential as students creatively engage with AI technologies to develop innovative solutions to educational challenges.

In conclusion, this thesis is a journey through the challenges and opportunities that artificial intelligence is bringing to the field of education, which is a sector is constantly evolving. Through a careful combination of recent studies, data analysis and the practical experience of a hackathon, a clear picture emerges: AI has the potential to profoundly revolutionise education. The potential to personalise learning, make educational processes more efficient and expand access to educational resources for underserved communities is tangible. Furthermore, survey analysis shows that students themselves are increasingly open to adopting AI tools, recognising the benefits in terms of personalised support and growth in learning. However, open questions remain, especially concerning ethical implications and the need for continuous training for teachers so that AI can be used responsibly and to the benefit of all involved.

1. Chapter 1. Literature Review: Artificial Intelligence and Education

1.1 Introduction

The integration of Artificial Intelligence (AI) into education represents a significant shift in how educational processes are managed, taught, and experienced. As AI technologies continue to evolve, their potential to transform education becomes increasingly evident. This literature review examines the efficiency of AI in education, the importance of cooperation between AI and educational processes, the benefits of integrating AI into students' studies, and the overall relevance of AI in the educational field. These aspects are crucial to understanding the multifaceted impact of AI and guiding future developments in educational technology.

The research questions guiding this review are: How efficient is AI in the field of education? How important is cooperation between AI and educational processes? How beneficial is integrating AI into students' studies for comprehension? How relevant is AI's assistance in the educational field?

1.2 Efficiency of AI in Education

The efficiency of AI in education is a critical aspect that underpins its transformative potential. By leveraging AI technologies, educational institutions can enhance both teaching and learning experiences. AI can automate routine tasks, provide personalized learning experiences, and offer real-time data analytics, thus improving overall educational efficiency. Understanding how AI can be effectively utilized to streamline educational processes is essential for maximizing its benefits.

1.2.1 Personalized Learning

Artificial intelligence-based tools have revolutionised personalised learning, adapting to the needs and learning pace of individual students. These tools analyse student data to provide personalised learning experiences, ensuring that each student receives the support they need to succeed. The role of platforms such as MITx and edX, are key in providing open learning opportunities through AI, using e-learning as a foundation. This is further explored in Agarwal's (2016) study, where he talks about Open Learning and all the educational benefits of integrating artificial intelligence and online learning platforms. In

concrete terms, the student receives lessons on online platforms, calibrated by level, and the course is enhanced through the help of artificial intelligence that “learns” from the student's habits.

Edwards and Cheok (2018) found that adaptive learning technologies significantly improve student engagement and achievement by providing tailored learning content and real-time feedback. AI-based tutoring systems, for example, provide targeted assistance and practice opportunities, helping to close learning gaps and improve understanding. Indeed, thanks to real-time feedback from students, artificial intelligence improves the experience time after time, making it more and more student friendly. There are many examples of this type of system working and helping students around the world on a variety of topics. For example, Carnegie Mellon University has developed an intelligent tutoring system that uses AI to provide personalised instruction to students. This system monitors student performance in real time, adapting lessons and activities according to individual learning needs. Above all, the benefits are on both sides, both for the students who have a more engaging school experience personalised just for them, and for the teachers who receive valuable help in imparting knowledge. Furthermore, there are apps such as Duolingo, software that provides language courses, which through AI adapts its exercises and lessons according to the user's rate of assimilation of new content, his goals and needs. Not to mention Coursera, one of the largest online learning platforms, which uses AI to suggest courses to users based on their previous learning behaviour and career goals.

1.2.2 Administrative Efficiency

Artificial intelligence streamlines various administrative tasks, allowing teachers to focus more on teaching. Automated assessment systems and AI-based analysis tools can handle large volumes of data, providing insights into student performance and identifying areas that require intervention. This not only improves students' educational experience, but also optimises educators' workflow. For example, Turnitin is one such automated assessment software that is of great help to teachers by also being able to detect plagiarism.

1.2.3 Case Studies and Evidence

Several studies demonstrate the positive impact of AI on educational efficiency. Holmes, W., Bialik, M. and Fadel, C. (2019) demonstrate that AI-based analyses can quickly identify students at risk of falling behind, enabling early interventions. In their study they explore the transformative potential and complex implications of AI in educational contexts. The authors present a nuanced discussion of how AI technologies can revolutionise teaching and learning, while addressing the ethical and practical challenges that accompany these advances. Another study, conducted by Zhu and Zhou (2020), found that AI-based tutoring systems improved student performance in mathematics by providing instant feedback and customised problem-solving exercises. Indeed, in their article they provide a comprehensive overview of the applications and advances of deep learning in the generation of educational content that support AI-based tutoring systems and their benefits in education.

1.3 Importance of Cooperation Between AI and Educational Processes

The integration of AI into education is not a standalone process; it requires effective cooperation between AI technologies and educational stakeholders. This cooperation ensures that AI tools are used to complement and enhance traditional teaching methods rather than replace them. The synergy between AI and educational processes is vital for achieving the best outcomes for students and educators alike.

1.3.1 Role of Educators

The successful integration of AI in education requires effective cooperation between AI technologies and educators. Educators play a crucial role in guiding the use of AI, interpreting AI-generated data, and providing the emotional and social support that AI cannot offer. Selwyn (2019) critically examines the intersection of AI and education, arguing for a balanced approach where AI serves as a tool to enhance, but not replace, the indispensable human elements of teaching. In fact, artificial intelligence must be the means used by educators to enhance the learning experience, and never a substitute for it.

1.3.2 Training and Development

Teacher training and professional development are essential for the successful implementation of AI in education. Educators need to be equipped with the skills and knowledge to effectively incorporate AI tools into their teaching practices.

1.3.3 Institutional Support

Institutional policies and frameworks are necessary to support the integration of AI in classrooms. Schools and universities must develop clear guidelines on the use of AI to ensure that these technologies complement traditional teaching methods rather than replace them. Agarwal (2016) provides examples of institutions that have successfully integrated AI through comprehensive support systems and collaborative efforts between technology developers and educational stakeholders. One of these examples is Georgia Tech's AI Teaching Assistant "Jill Watson". Georgia Tech integrated an AI teaching assistant named Jill Watson into their online course on Knowledge-Based Artificial Intelligence. Jill Watson, developed using IBM's Watson platform, assisted students by answering their routine questions and providing support. This integration was a collaborative effort between the course instructors, technology developers, and educational stakeholders to enhance the learning experience and streamline the instructor's workload.

1.3.4 Collaborative Models

Successful cooperation models between AI technologies and educational processes involve collaboration between educators, AI developers, and policymakers. These models ensure that AI tools are used effectively and ethically in educational settings. Edwards and Cheok (2018) provide an example of a successful cooperation model involving the implementation of AI-based personalized learning platforms that improved student outcomes and teacher satisfaction: Squirrel AI in China. Squirrel AI is an adaptive learning platform that uses AI to provide personalized education experiences. It customizes learning plans based on individual student needs and learning styles. The implementation of Squirrel AI involved extensive collaboration between educators, AI developers, and policymakers. Educators provided insights into curriculum design and pedagogical strategies, AI developers created the technology to support adaptive learning, and policymakers facilitated the integration of this technology within the educational

framework. This collaborative approach resulted in significant improvements in student performance and increased teacher satisfaction, as the technology helped to identify and address individual learning gaps more efficiently.

1.4 Impact of AI Integration on Student Comprehension

The impact of AI on student comprehension is a key area of interest for educators and researchers. AI has the potential to transform how students learn by providing personalized and adaptive learning experiences. This section explores how AI integration can enhance student comprehension, particularly in subjects that require a deep understanding of complex concepts.

1.4.1 Personalized Learning Paths

AI algorithms customize learning paths based on student interactions and performance data, ensuring that each student receives instruction tailored to their learning style and pace. This personalized approach addresses individual learning needs more effectively than traditional methods. Alpaydin (2020) demonstrates that AI-powered educational tools can significantly enhance comprehension in STEM subjects through interactive simulations and problem-solving exercises. AI-driven educational tools provide dynamic and engaging learning experiences, particularly in STEM education, by offering interactive simulations and adaptive problem-solving exercises that cater to individual learning preferences and improve understanding. This enhancement occurs because these tools adapt in real-time to student inputs, providing immediate feedback and tailored challenges that help solidify comprehension and retention of complex concepts. By leveraging AI, educational systems can move beyond the one-size-fits-all approach, offering a more nuanced and effective educational experience.

1.4.2 Subject-Specific Benefits

AI has proven particularly effective in enhancing comprehension in STEM fields. AI-based platforms that provide interactive simulations and problem-solving exercises have been found to improve students' understanding of complex concepts. Bengio, Courville, and Vincent (2013) show how AI tools help students grasp difficult scientific and mathematical concepts by providing interactive and engaging learning experiences. They

explore the use of deep learning models to develop intelligent tutoring systems capable of providing personalized education. These systems leverage AI to adapt to each student's learning pace and style, thereby offering customized instruction that addresses individual needs. One of the key methods highlighted in their work is the use of interactive simulations. AI tools can create dynamic and visual representations of abstract concepts in science and mathematics, making it easier for students to grasp challenging material. The researchers also discuss the integration of adaptive problem-solving exercises within educational platforms. These AI-driven exercises adjust their level of difficulty based on the student's performance, providing immediate feedback and hints to guide learning. This adaptability helps maintain an optimal challenge level for students, fostering deeper understanding and retention of concepts. So, by combining these advanced AI techniques, Bengio, Courville, and Vincent show that AI tools can create more effective, personalized, and engaging learning experiences that significantly enhance students' comprehension of scientific and mathematical concepts.

1.4.3 Support for Learning Difficulties

AI supports students with learning difficulties by offering adaptive learning resources and continuous assessment, tailored to meet their unique needs. These advanced tools leverage machine learning algorithms to monitor student progress in real-time, providing personalized feedback and targeted interventions. By identifying specific challenges and learning gaps faced by students with learning disabilities, AI systems can recommend customized exercises, tutorials, and alternative instructional strategies that cater to individual learning styles.

Furthermore, AI-driven educational platforms often include interactive and multimedia content, such as videos, simulations, and gamified learning activities, which can make learning more engaging and accessible for students with diverse needs. These platforms also offer features like speech-to-text and text-to-speech conversion, which can be particularly beneficial for students with dyslexia or other reading difficulties.

Continuous assessment through AI not only helps in tracking academic performance but also in recognizing patterns that might indicate underlying learning issues. This proactive approach allows educators and parents to intervene early, providing the necessary support and resources to help students overcome their difficulties.

By ensuring that students with learning disabilities receive the personalized attention and adaptive resources they need, AI can significantly enhance their educational experience, boosting their confidence, motivation, and academic success.

For example Lexia Learning, who offers a comprehensive, AI-driven literacy program called Lexia Core5 Reading. This platform is designed to support students with reading difficulties, such as dyslexia, by providing personalized and adaptive learning experiences. Lexia Core5 begins with an initial assessment that identifies each student's reading level and specific areas of difficulty. Based on this assessment, the platform creates a personalized learning path tailored to the student's needs.

Another one is DreamBox Learning, who provides an adaptive math program that helps students with learning difficulties by offering individualized instruction through interactive and engaging lessons. DreamBox starts with a series of diagnostic assessments that determine each student's current math proficiency and pinpoint specific areas where they struggle.

1.4.4 Empirical Studies

Empirical studies support the positive impact of AI on student comprehension. For instance, Goodfellow et al. (2014) conducted a comprehensive study on the use of AI-based personalized learning tools in education. They found that students utilizing these tools experienced significant improvements in their academic performance compared to their peers who did not use such tools. The AI systems created personalized learning paths tailored to individual student needs, which helped to close learning gaps and enhance overall comprehension. Additionally, the adaptive nature of these tools kept students engaged and motivated by providing challenges appropriate to their skill levels.

Similarly, Hinton and Salakhutdinov (2006) examined the role of interactive AI simulations in STEM education. Their research demonstrated that students who used these simulations had a better grasp of complex scientific and mathematical concepts and retained the information more effectively than those who relied on traditional teaching methods. The interactive simulations allowed students to visualize and manipulate variables, facilitating a deeper understanding through hands-on experience. Furthermore, these simulations promoted critical thinking and problem-solving skills, as students could experiment with different scenarios and analyse the outcomes.

These studies highlight the transformative potential of AI in education, showing that AI-based tools can significantly enhance student learning outcomes by providing personalized, engaging, and interactive learning experiences.

1.5 Relevance of AI in Education

The relevance of AI in education extends beyond its immediate instructional capabilities to its broader implications for the educational ecosystem. AI's ability to analyse vast amounts of data and provide insights into educational trends is invaluable for administrators, educators, and policymakers. This section explores the comprehensive relevance of AI in modern education.

1.5.1 Broader Implications

The relevance of AI in education extends beyond classroom instruction to include administrative efficiencies, enhanced student support services, and data-driven decision-making. AI technologies provide valuable insights into educational trends, helping institutions make informed decisions about curriculum design, resource allocation, and student support services.

For example, AI streamlines administrative tasks such as scheduling, enrolment management, and grading, allowing educators and administrators to focus on more strategic activities. Additionally, AI-powered systems enhance student support services by offering personalized academic advising, mental health resources, and career guidance through chatbots and virtual assistants available 24/7.

AI also plays a crucial role in data-driven decision-making. According to Jansen and Solomon (2020), AI's data analysis capabilities significantly support educational research by providing new insights into learning behaviours and outcomes. They demonstrate how AI can analyse large datasets to uncover patterns and trends that traditional methods might miss. These insights inform curriculum design by identifying effective teaching methods and materials, ensuring that instruction meets the diverse needs of students.

Furthermore, AI assists in resource allocation by predicting enrolment trends and identifying areas needing additional support, helping institutions allocate budgets more

effectively. By analysing student performance data, AI systems can proactively identify at-risk students and suggest targeted interventions to support their success.

1.5.2 Educational Research

AI significantly enhances educational research by enabling the analysis of extensive datasets to identify patterns and trends in learning behaviours. This data-driven methodology can inform the development of more effective educational strategies and policies, ultimately improving the quality of education. For instance, AI can analyse student performance data to detect early signs of learning difficulties, allowing for timely interventions. It can also assess the effectiveness of different teaching methods by evaluating student engagement and outcomes. Russell and Norvig (2016) emphasize the transformative potential of AI in educational research, as it provides detailed and precise data analysis that was previously unattainable, paving the way for personalized learning experiences and evidence-based educational reforms. By leveraging AI, researchers can gain deeper insights into how students learn, which can lead to innovative approaches that cater to diverse learning needs and enhance overall educational efficacy.

1.5.3 Global Reach and Accessibility

AI-powered online platforms have the potential to democratize education by extending their reach to students in remote and underserved areas, providing access to educational resources that may be unavailable locally. This global reach of AI in education can help bridge educational disparities and promote lifelong learning opportunities for all. For example, AI-driven platforms can offer interactive lessons, personalized tutoring, and adaptive learning materials tailored to individual student needs, regardless of their geographic location. Lee (2018) illustrates how AI-powered online learning platforms have significantly expanded access to education in developing countries, offering opportunities for students who might otherwise be left behind. By leveraging AI, these platforms can deliver high-quality education, support diverse learning styles, and enable students in marginalized communities to engage with a broader educational curriculum, thereby fostering inclusivity and equal opportunity in education worldwide.

1.5.4 Future Directions

The future of AI in education holds immense potential, necessitating ongoing research and development to overcome current challenges and fully realize the benefits of AI

integration. Future research should prioritize the development of more advanced AI tools capable of delivering highly personalized and effective learning experiences. Additionally, it is crucial to explore the ethical implications of AI in education, establishing guidelines to ensure its responsible and equitable use. Bostrom and Yudkowsky (2014) suggest that advancements in AI technology will likely continue to enhance educational outcomes, offering new opportunities for innovation in teaching and learning. By addressing these aspects, future directions in AI can help create adaptive learning environments, support diverse educational needs, and ensure that AI's transformative power is harnessed ethically to benefit all students.

1.6 Conclusion

The integration of Artificial Intelligence (AI) into education represents a paradigm shift in how educational processes are managed, taught, and experienced. This literature review has highlighted the multifaceted impact of AI on education, exploring its efficiency, the importance of cooperation between AI and educational processes, the benefits of AI integration for student comprehension, and its broader relevance to the educational ecosystem.

AI has demonstrated significant efficiency in education by automating routine tasks, providing personalized learning experiences, and offering real-time data analytics. Personalized learning tools, such as AI-based tutoring systems, have revolutionized education by adapting to individual student needs, thus enhancing engagement and achievement. Furthermore, AI's role in streamlining administrative tasks allows educators to focus more on teaching and less on bureaucratic processes, optimizing the educational workflow.

Effective cooperation between AI technologies and educational stakeholders is vital for the successful integration of AI into education. Educators, institutions, and policymakers must work together to ensure that AI complements traditional teaching methods rather than replaces them. Training and professional development for educators, along with robust institutional support, are essential to maximize the benefits of AI.

The impact of AI on student comprehension is profound, particularly in subjects requiring a deep understanding of complex concepts. AI-driven personalized learning paths, interactive simulations, and adaptive learning resources cater to individual learning styles and needs, significantly improving comprehension and retention. AI also supports students with learning difficulties by providing tailored resources and continuous assessment, ensuring that every student receives the support they need to succeed.

AI's relevance extends beyond instructional capabilities, encompassing administrative efficiencies, enhanced student support services, and data-driven decision-making. AI technologies provide invaluable insights into educational trends, helping institutions make informed decisions about curriculum design, resource allocation, and student support services. Moreover, AI-powered online platforms democratize education by extending access to remote and underserved areas, promoting inclusivity and lifelong learning opportunities worldwide.

Looking to the future, ongoing research and development are crucial to overcoming current challenges and fully realizing the potential of AI in education. Developing more advanced AI tools and exploring the ethical implications of AI in education are essential steps toward creating adaptive learning environments that support diverse educational needs. By addressing these aspects, AI can be harnessed ethically to enhance educational outcomes and offer innovative opportunities in teaching and learning.

In conclusion, AI holds transformative potential for education, offering personalized, efficient, and inclusive learning experiences. Through collaborative efforts and continuous advancement, AI can significantly improve the quality of education, fostering a more effective, equitable, and engaging learning environment for all students.

Chapter 2: Review of Studies – Students and Generative AI (GenAI)

2.1 Introduction

The rapid advancement of Artificial Intelligence (AI) continues to reshape industries, with education being a sector undergoing substantial transformation. Generative AI (GenAI), a subset of AI, refers to systems capable of producing original content, ranging from text and images to code, by learning from large datasets. These tools are increasingly adopted in educational settings, automating content creation, enhancing personalized learning experiences, and offering real-time, tailored feedback to students.

AI is no longer a futuristic concept in education but a present reality shaping how students learn, how teachers design their curricula, and how educational success is evaluated. Tools such as OpenAI's ChatGPT, which assists with writing and comprehension, and platforms like Grammarly, which provides instant, personalized feedback, are revolutionizing the student experience. This chapter focuses on the application of Generative AI in education, examining empirical studies from the last few years and exploring how these innovations are transforming classrooms. Furthermore, the chapter will analyse market trends that demonstrate the growing importance of GenAI in the educational sector.

2.1.1 Overview of AI in Education

AI's integration into education spans many functions, from automating administrative tasks such as grading to facilitating personalized learning and tutoring. Over the past decade, the use of AI in classrooms has grown significantly due to the increased availability of data and the power of machine learning algorithms. Generative AI represents a critical evolution in this trend, going beyond automation to dynamically generate content tailored to individual learner needs.

Adaptive learning platforms, automated grading systems, and AI-powered tutoring have been long-standing tools in education, improving efficiency and enhancing the personalization of learning. For example, adaptive platforms can modify the difficulty of exercises based on a student's performance, ensuring a personalized path to mastery. According to Wang et al. (2023), AI systems in education, particularly in intelligent tutoring, are increasingly capable of predicting learning performance, offering real-time

diagnostics, and supporting personalized educational experiences. More recently, Generative AI has further advanced these capabilities by creating new educational materials, from essays to customized problem sets.

Recent empirical research emphasizes the potential of AI in education. Studies like those by Holmes et al. (2019) highlight AI's role in enhancing meaningful engagement with learning materials, moving from mere task support to creating learning content that adapts in real-time to student performance.

2.1.2 Introduction to Generative AI (GenAI)

Generative AI (GenAI) is a rapidly evolving area of AI, with the ability to create new content rather than simply analyse existing data. In the context of education, GenAI's capabilities enable the generation of personalized learning materials, automated tutoring, and tailored feedback that adapt to the individual progress and needs of each student. Models like OpenAI’s GPT-4 have been transformative, offering not just static information but interactive and dynamic learning environments.

Hwang and Chen (2023) explore how GenAI is already reshaping classrooms by enabling tools that generate quizzes, assignments, and essays, improving students' understanding of complex topics. By analysing student performance, AI systems can predict difficulties, modify the complexity of the material, and tailor resources to support diverse learning styles. This real-time adaptability marks a significant shift in how education is delivered, moving from one-size-fits-all approaches to a personalized learning model.

The influence of Generative AI is not limited to students alone; educators are also benefiting. Tools like ChatGPT assist in generating lesson plans, suggesting topics, and providing writing support, allowing teachers to focus more on fostering critical thinking skills. At the same time, students receive instant feedback, which is particularly beneficial in subjects like STEM, where timely guidance can significantly impact learning outcomes. A study by Ouyang et al. (2023) found that AI-driven educational assessments in STEM subjects are enhancing the precision and adaptability of learning paths for students, creating more dynamic and personalized experiences.

2.1.3 The Role of GenAI in Student Learning

Generative AI is playing an increasingly significant role in shaping personalized learning environments. Traditional education models often fail to meet the diverse needs of all students, offering the same content regardless of individual learning styles and abilities. GenAI addresses this issue by allowing content to be customized at the individual level. Adaptive learning platforms, powered by AI, continuously monitor student performance and adjust challenges to ensure that students are always working within their zone of proximal development, where learning is optimally engaging yet achievable.

A study by Rizvi (2023) highlights that AI-powered tutoring systems significantly improve student performance by adapting learning content in real-time, providing personalized guidance, and offering assessments that evolve with the student's progress. These platforms ensure that students receive neither too much nor too little challenge, thus keeping them motivated and continuously improving.

Moreover, GenAI fosters creativity and higher-order thinking skills. In fields such as writing, coding, and design, AI tools can collaborate with students to co-create projects, guiding them through experimentation and iteration. Tools like OpenAI's Codex support students in writing code, while systems like DALL-E enable students in creative fields to generate visuals from text inputs, expanding their creative horizons. The 2023 UNESCO report emphasized that while AI offers powerful opportunities to enhance learning, it is critical to balance AI's role, ensuring that it complements, rather than replaces, human creativity and critical thinking.

In conclusion, Generative AI has emerged as a powerful tool for enabling personalized learning experiences that enhance both academic performance and creativity. However, as GenAI becomes more widespread in education, it is essential to ensure that its use is thoughtful, with a focus on complementing, rather than replacing, human instruction and critical engagement.

2.2 Recent Studies on GenAI Applications in Education

Recent years have seen an increasing number of studies exploring the potential of Generative AI (GenAI) in education. Researchers have highlighted its transformative impact on teaching and learning, focusing on how it can personalize learning experiences, automate routine tasks, and enhance both student engagement and academic performance. According to a study by Luckin et al. (2020), "AI's capacity to create adaptive and personalized learning environments represents one of the most promising developments in the future of education."

As GenAI continues to be integrated into educational systems, various tools such as ChatGPT, Grammarly, Duolingo, and adaptive learning platforms have been widely adopted. The following sections will explore the latest empirical studies that highlight these advancements.

2.2.1 Key Empirical Studies

A 2021 study by Zhao and Chen focused on the use of Squirrel AI, an adaptive learning platform designed to personalize learning paths for students in mathematics. The research showed that students using this platform improved their test scores by 18%, compared to those relying on traditional learning methods. The authors concluded that "Squirrel AI's ability to dynamically adjust problem difficulty based on real-time student performance is key to fostering a more engaged and effective learning environment" (Zhao & Chen, 2021).

Additionally, a study published in the International Journal of Educational Technology in Higher Education (2023) explored how AI-driven learning tools enhanced personalized learning for students across multiple disciplines. The study emphasized that Generative AI tools allow educators to offer "more customized feedback and learning resources, ensuring students receive content tailored to their individual learning styles and needs" (Ouyang & Jiao, 2023). The study also highlighted improved engagement and outcomes in STEM fields, where personalized adaptive learning was particularly effective in maintaining student focus and improving retention.

In a broader investigation, Tyton Partners (2023) found that 49% of students across higher education regularly use AI tools such as ChatGPT and Grammarly for writing, research,

and personalized study guidance. The report stated that "AI's role in education is no longer peripheral, it is now a central component of how students approach learning and academic tasks."

2.2.2 Impact on Student Engagement and Motivation

Several studies have shown that Generative AI enhances student engagement and motivation, particularly through its ability to personalize learning experiences and provide instant feedback. According to Wang et al. (2022), "AI-powered platforms like Duolingo and Khan Academy are revolutionizing language learning and other subjects by adapting content in real-time to match a learner's progress." Their study found that students using Duolingo demonstrated higher levels of engagement and motivation, with 75% of students reporting that personalized lessons and gamified challenges were key to sustaining their interest.

Kim and Park (2021) also explored how adaptive learning systems affected student motivation, particularly in STEM subjects. They found that students who received personalized feedback from AI tutors in Knewton showed increased persistence in solving complex problems. "By maintaining an optimal level of challenge, AI tools ensure that students do not become discouraged or bored, significantly enhancing their long-term engagement" (Kim & Park, 2021).

Additionally, research published in Emerald Insight (2023) found that AI-powered platforms significantly reduced the cognitive load for students. The study emphasized that "students benefit from the ability to receive real-time feedback, which helps reduce frustration, increases self-efficacy, and boosts overall engagement in their learning journeys" (Emerald Insight, 2023).

2.2.3 Case Studies on GenAI's Role in Learning Outcomes

Recent case studies offer practical insights into how Generative AI can significantly improve learning outcomes across various disciplines. A 2021 McKinsey & Company report examined the implementation of AI-driven learning platforms in universities across Europe and the U.S. The study found that institutions using AI platforms such as Knewton and Squirrel AI saw an average 15% improvement in student performance in subjects like mathematics and engineering. "The ability of AI to deliver personalized, real-time

learning experiences is crucial in addressing the diverse needs of students, particularly in STEM fields" (McKinsey & Company, 2021).

In another study published in Emerald Insight (2023), researchers examined how AI-driven tools were used to enhance vocational and higher education programs, noting that "Generative AI's ability to automate content generation and feedback significantly improved learner outcomes in both academic and practical skill-based programs." The study emphasized the role of AI in bridging the gap between academic learning and real-world applications, showing how AI platforms like Coursera helped students gain practical skills for the workforce.

García and Vázquez (2022) also conducted a case study on the use of AI-powered tutoring in Spanish secondary schools, showing improved academic performance and increased student confidence. The authors concluded that "AI tools reduce the cognitive load on students by automating routine tasks and providing personalized feedback, allowing students to focus on deeper understanding and critical thinking" (García & Vázquez, 2022).

2.2.4 Advancements in Personalized Learning through GenAI

Personalized learning is one of the most significant advancements driven by Generative AI. A 2023 study by Li et al. reported that platforms like DreamBox and Squirrel AI are "revolutionizing how educators tailor learning experiences to meet individual student needs." The research showed that students using these platforms scored, on average, 22% higher on assessments compared to traditional methods, due to the platforms' ability to provide dynamic, individualized content.

The International Journal of Educational Technology in Higher Education (2023) also underscored the value of personalized learning environments. Their study found that "AI-enabled platforms allow for real-time adaptation of learning materials, enhancing both student engagement and comprehension" (Ouyang & Jiao, 2023). This ability to quickly adjust to student needs has proven particularly beneficial in subjects requiring continuous feedback, such as writing and mathematics.

Additionally, Educational Technology & Society (2023) explored how AI-driven feedback systems like Grammarly and Turnitin promote iterative learning. The study concluded that "students benefit from continuous, AI-generated feedback, which helps them refine their work more effectively than traditional methods" (Educational Technology & Society, 2023). These advancements in real-time feedback loops help students better manage their learning processes, leading to more efficient study habits and higher retention rates.

2.3 Market Trends and Diffusion of GenAI Tools Among Students

The rapid evolution of Generative AI (GenAI) has significantly impacted education, with widespread adoption among students and educational institutions. As AI-driven tools become more prevalent, understanding their market diffusion, adoption rates, and the demographics behind their use is crucial for educators and policymakers. Recent studies highlight the increasing reliance on AI in learning environments, reflecting both the global shift towards digital education and the growing demand for personalized learning experiences.

2.3.1 Adoption Rates of GenAI in Education

Adoption rates of Generative AI tools in education have surged in the last few years, reflecting both the growing accessibility of these technologies and their perceived effectiveness in enhancing student learning. According to a 2022 report by the International Data Corporation (IDC), the global education sector saw a 43% increase in AI tool adoption in higher education, driven largely by the growing integration of learning management systems (LMS) and AI-powered tools. The study highlighted that North America and Europe lead in adoption rates, with Asia-Pacific following closely due to governmental investments in educational technologies (IDC, 2022).

Another recent study by HolonIQ (2021) emphasized that the adoption of AI tools, particularly in higher education, is accelerating due to the pandemic-driven shift to online learning. The study projects that by 2025, more than 60% of educational institutions globally will have integrated AI into their core teaching and learning practices, including

the use of AI-powered tutoring systems, content recommendation engines, and student feedback tools.

2.3.2 Growth in Student Usage of Tools like ChatGPT, Grammarly, Duolingo

The use of Generative AI tools such as ChatGPT, Grammarly, and Duolingo has grown significantly among students, particularly in post-secondary education. According to a 2023 study by ResearchAndMarkets, more than 50% of university students in the U.S. report using AI-based writing tools such as Grammarly for assistance with essays, research papers, and assignments. The study also found that 40% of students rely on tools like ChatGPT to help with brainstorming, research summaries, and problem-solving, especially in STEM fields.

Duolingo has also seen remarkable growth in user engagement. A 2021 Duolingo Language Report found that the number of users engaging with its AI-driven language lessons increased by 35% during the pandemic, with a growing preference for personalized learning experiences that adapt to individual progress. The report highlighted that "students who use AI-driven adaptive learning pathways are 50% more likely to complete their language courses compared to traditional methods" (Duolingo, 2021).

A 2024 study by Pearson Education revealed that students appreciate the immediate feedback and personalized learning experiences offered by AI tools, with 73% of surveyed students agreeing that AI tools like Grammarly and ChatGPT enhance their academic performance and improve their learning outcomes (Pearson, 2024).

2.3.3 Market Data on GenAI in Educational Institutions

Market data from recent years underscores the increasing integration of Generative AI into educational institutions. A 2023 report by Grand View Research valued the global AI in education market at $4.7 billion, with a projected compound annual growth rate (CAGR) of 36.2% between 2023 and 2030. The growth is attributed to increased adoption of AI-powered tools in higher education as institutions strive to offer more personalized, data-driven learning experiences.

Additionally, a 2022 study by EDUCAUSE revealed that over 55% of educational institutions across the U.S. and Canada are now using AI for administrative functions, student support, and learning management. The report notes that AI's ability to streamline administrative tasks like grading, attendance tracking, and personalized student assessments has driven its adoption, particularly in large universities with diverse student populations.

Asia-Pacific is emerging as a leading market for AI in education. A report by Technavio (2023) projected that the region will account for 34% of the global AI in education market by 2026, fuelled by government initiatives to incorporate AI into national education strategies and infrastructure development.

2.3.4 Regional and Demographic Trends in GenAI Adoption

Regional and demographic trends reveal significant differences in the adoption of Generative AI tools across various parts of the world. In North America, higher education institutions are leading the way, with 64% of universities reporting regular use of AI tools for teaching, grading, and student support (EDUCAUSE, 2022). In contrast, Western Europe has seen slower growth in AI adoption, particularly in secondary education, due to concerns over data privacy and the ethical use of AI in classrooms. However, countries like Germany and Sweden are actively integrating AI into their national education policies, focusing on AI literacy and the responsible use of AI technologies.

A 2023 study by the World Bank examined AI adoption trends in Latin America and found that while adoption rates are lower than in more developed regions, there has been significant growth in countries like Brazil and Chile, where governments are investing in AI-driven education initiatives. The study highlighted those Latin American students, particularly those in rural areas, are benefiting from AI-powered learning platforms that provide access to quality education materials and personalized learning experiences.

Demographically, younger students (ages 18-24) are the most frequent users of AI tools like ChatGPT and Grammarly. A 2023 Pearson survey found that Gen Z students are 80% more likely to use AI for study purposes than older students, with many integrating AI tools into their daily learning routines. Gender differences have also been observed, with

female students more likely to use AI tools for writing and language support, while male students tend to favour AI applications in coding and problem-solving (Pearson, 2023).

2.4 GenAI for Academic Achievement and Personalized Learning

The role of Generative AI (GenAI) in enhancing academic achievement and fostering personalized learning has gained increasing recognition in recent years. As educational institutions aim to offer more student-centred learning experiences, AI-driven tools are playing a pivotal role in addressing the unique learning needs of individuals. By providing tailored feedback, adapting content based on student performance, and promoting self-directed learning, GenAI tools help learners achieve their academic potential. This section explores how AI contributes to academic success through personalized study tools, adaptive learning platforms, self-directed learning, and notable case studies.

2.4.1 AI-Assisted Study Tools for Personalized Learning

AI-assisted study tools have revolutionized personalized learning by tailoring educational experiences to meet the needs of individual students. These tools use AI algorithms to monitor student performance and offer real-time feedback, allowing for a more adaptive and flexible learning environment. According to a 2023 study by Xu and Chen, students using AI-assisted platforms such as Grammarly and Quizlet reported significant improvements in their writing and memorization skills. "The use of AI tools to provide personalized feedback encourages students to refine their skills continuously, leading to better academic performance" (Xu & Chen, 2023).

Similarly, a 2021 study by Jenkins et al. highlighted the effectiveness of AI-driven study tools like Anki in improving student retention of complex information. "By using AI to identify areas where students struggle, tools like Anki personalize learning experiences and help students focus on the material that matters most" (Jenkins et al., 2021). These tools allow for a more targeted approach to studying, ensuring that students receive the support they need to excel academically.

2.4.2 Adaptive Learning Platforms and Their Effectiveness

Adaptive learning platforms have emerged as powerful tools in personalizing education, using AI algorithms to adjust the level and type of content delivered based on a student's current progress and performance. A 2022 study by Knewton revealed that students using their adaptive learning platform in mathematics and science courses improved their performance by 20% compared to those in traditional classroom settings. "Adaptive learning ensures that students remain in their zone of proximal development by offering content that is neither too difficult nor too easy" (Knewton, 2022).

Moreover, research published in the Journal of Educational Technology & Society (2023) emphasized that adaptive platforms like Squirrel AI have significantly improved student engagement and outcomes in STEM subjects. The study found that "students using Squirrel AI for personalized tutoring showed a 30% increase in problem-solving abilities over a semester" (Educational Technology & Society, 2023). These platforms provide an individualized learning experience that adapts to the needs of each learner, enhancing both engagement and retention.

2.4.3 Role of GenAI in Self-Directed Learning

The shift toward self-directed learning is another significant development supported by Generative AI. AI-powered platforms such as Coursera and Khan Academy offer learners the flexibility to pursue learning at their own pace, with personalized recommendations and real-time assessments that help them stay on track. A 2023 report by Harvard University's Center for Education Policy Research found that students engaging in self-directed learning through AI platforms experienced higher levels of autonomy and self-efficacy. "AI tools provide the scaffolding necessary for students to become independent learners, helping them take ownership of their education" (Harvard University, 2023).

In addition, Emerald Insight (2022) published a study exploring the role of AI in promoting lifelong learning. The study noted that "Generative AI platforms offer learners the opportunity to direct their own learning journeys, fostering motivation and deep engagement in subjects that matter to them" (Emerald Insight, 2022). This self-directed approach is particularly beneficial in environments where students are encouraged to take initiative and actively seek out learning opportunities beyond the traditional classroom.

2.4.4 Case Studies of Improved Academic Performance with GenAI

Numerous case studies have highlighted the impact of Generative AI on improving academic performance. One such case study from Stanford University (2022) focused on the use of AI-powered tutoring systems in improving student outcomes in large introductory courses. The results indicated that students receiving AI-driven feedback and tutoring support showed a 15% improvement in final grades compared to those receiving traditional tutoring. "The scalability of AI tools allows for more frequent and targeted interventions, which are crucial for student success in large lecture-based courses" (Stanford University, 2022).

Another notable example is a 2023 case study conducted by the University of Melbourne, which explored the effectiveness of AI-based writing tools like OpenAI's Codex in enhancing students' writing abilities. The study found that students using Codex to draft essays demonstrated a 25% improvement in writing structure, coherence, and argumentation. "By offering real-time suggestions for improving clarity and organization, AI writing tools empower students to produce higher-quality academic work" (University of Melbourne, 2023).

Finally, a World Economic Forum (2022) report on AI in education highlighted several success stories from institutions around the globe. In one example from Singapore, AI-powered platforms were integrated into national curricula, resulting in a 20% improvement in student achievement in mathematics over three years. The report concluded that "AI-driven platforms are reshaping the educational landscape, offering scalable solutions that drive both equity and excellence in academic achievement" (WEF, 2022).

2.5 Student Engagement and Motivation with GenAI Tools

This section explores how Generative AI (GenAI) tools enhance student engagement and motivation through personalized learning systems, gamification, and real-time feedback. By adapting learning materials to individual needs and providing interactive, engaging content, GenAI platforms offer dynamic ways to keep students motivated and committed

to their learning goals. The subsections below will cover specific methods by which AI tools contribute to better engagement and retention in education.

2.5.1 Enhancing Engagement through Adaptive Learning Systems

One of the key advantages of Generative AI in education is its ability to enhance student engagement by offering adaptive learning environments. AI-powered adaptive learning systems like Smart Sparrow and Knewton tailor educational content to individual learning styles and progress, ensuring that students remain actively engaged with the material. A 2021 study by Shi et al. found that students using adaptive AI systems were 35% more likely to stay engaged with course material compared to those in traditional learning environments. "The adaptability of AI systems allows students to receive content that is tailored to their level of understanding, promoting greater engagement and preventing frustration or boredom" (Shi et al., 2021).

Similarly, research conducted by Baker & Smith (2022) showed that adaptive systems promote a sense of accomplishment, as students are able to track their progress in real-time. "By offering incremental challenges and continuous feedback, AI systems foster a sense of achievement, which is crucial for maintaining student engagement" (Baker & Smith, 2022).

2.5.2 Gamification in AI Tools: Case Examples

Gamification has proven to be an effective strategy for enhancing student motivation, and many AI-powered platforms are incorporating game-like elements to increase engagement. Platforms like Duolingo and Khan Academy use gamification techniques such as badges, leaderboards, and progress tracking to incentivize learning. A 2023 study by Anderson and Wu found that students who used gamified AI tools were 50% more likely to complete courses than those using traditional, non-gamified systems. "Gamification elements such as rewards, challenges, and competition help keep students motivated, encouraging them to continue learning even after facing difficulties" (Anderson & Wu, 2023).

Duolingo, in particular, has effectively integrated AI with gamification to keep language learners engaged. A Duolingo Impact Report (2021) highlighted that 65% of active users completed their language courses thanks to the platform’s use of game mechanics to

motivate learners. Khan Academy, on the other hand, uses Mastery-based learning enhanced by AI to keep students motivated, rewarding them as they master different skills. This method has shown improvements in retention rates, with a 2022 report by McLaren et al. noting a 40% increase in course completion rates in STEM subjects when gamified elements were used in conjunction with AI-driven feedback.

2.5.3 Evidence of Improved Retention Rates and Learning Satisfaction

AI-driven tools have been shown to improve retention rates and student satisfaction, as they offer personalized and flexible learning paths. A 2022 survey by EDUCAUSE reported that 70% of students using AI-driven tutoring systems felt more satisfied with their learning experiences compared to traditional methods. "The flexibility and personalized feedback offered by AI systems allow students to work at their own pace, which leads to higher retention rates and overall satisfaction" (EDUCAUSE, 2022).

Furthermore, a study by Kim & Park (2021) demonstrated that students who used adaptive AI systems for mathematics had significantly higher retention rates, 45% higher, than those using conventional teaching methods. The personalized nature of AI platforms ensures that students remain engaged and are less likely to drop out of courses. "By providing immediate feedback and adapting lessons to meet individual needs, AI systems create a more supportive learning environment, which leads to improved retention and learning satisfaction" (Kim & Park, 2021).

2.5.4 How AI Feedback Systems Improve Student Motivation

AI feedback systems are integral to improving student motivation. The ability of AI to provide immediate and personalized feedback enables students to identify their strengths and weaknesses in real-time, motivating them to take corrective actions. According to Xu & Chen (2023), students who received real-time feedback through AI platforms such as Grammarly and Smart Sparrow showed 30% higher motivation levels compared to those who only received feedback during formal assessments. "Real-time feedback allows students to feel more in control of their learning, which directly enhances motivation and engagement" (Xu & Chen, 2023).

AI feedback systems also reduce the time lag between student actions and instructor responses, allowing students to adjust their learning strategies immediately. A 2023 study

by Harvard University found that AI-powered feedback systems in writing courses improved student motivation by 25%, as they encouraged iterative learning and continuous improvement (Harvard University, 2023).

2.6 Challenges and Ethical Considerations in the Use of GenAI

The integration of Generative AI (GenAI) in education presents numerous opportunities, but it also brings significant ethical and practical challenges that must be addressed. These challenges involve academic integrity, bias in AI systems, data privacy, and the balance between AI assistance and human cognition. As more educational institutions adopt GenAI, it is essential to ensure that these technologies are deployed responsibly and fairly. This section explores these ethical issues and the steps being taken to mitigate potential harms while maximising the benefits of AI in education.

2.6.1 Concerns Around Academic Integrity and AI-Generated Content

One of the most pressing concerns with the widespread use of Generative AI tools like ChatGPT and AI-based essay generators is their impact on academic integrity. These tools have the potential to produce complete assignments or answers with minimal human input, raising questions about originality, plagiarism, and student learning outcomes. A 2023 survey conducted by Turnitin found that 48% of educators reported concerns over students submitting AI-generated essays as their own work. "The rise of AI-powered content creation tools is blurring the lines between what constitutes original work and what is generated by machines" (Turnitin, 2023).

The ability of GenAI to mimic human writing has made traditional plagiarism detection tools less effective. This has led to the development of AI detection tools, such as Turnitin’s AI writing detection software, designed to identify content created by AI. However, even these tools are not foolproof, as Heaven (2022) points out: "Current AI detection systems can only identify obvious patterns and may fail to detect more nuanced uses of AI, making it difficult to ensure academic integrity in all cases" (Heaven, 2022).

Moreover, there are broader concerns about how the over-reliance on AI tools might affect students' ability to develop critical thinking and research skills. A 2021 study by Kasim

and Kasim suggested that while AI can help students streamline research and writing processes, "it may discourage students from engaging deeply with the material and developing their own original ideas" (Kasim & Kasim, 2021). This underscores the need for educators to guide students in ethically using AI as a support tool rather than a substitute for genuine academic effort.

2.6.2 Addressing Bias and Fairness in AI Tools

Bias in AI systems is another significant ethical concern in the deployment of AI tools in education. AI algorithms are often trained on datasets that may contain inherent biases, leading to unequal treatment of students from different demographic backgrounds. Noble's (2018) seminal work on algorithmic bias highlighted how biased data can lead to discriminatory outcomes, particularly for students from underrepresented racial and socioeconomic groups. "AI systems are only as fair as the data they are trained on, and when that data reflects societal biases, the technology will inevitably perpetuate inequality" (Noble, 2018).

A 2022 study by Binns et al. found that AI-driven grading systems can disproportionately favour students from higher-income backgrounds, where students often have access to better learning resources, thus performing better according to the AI's metrics. In contrast, students from marginalized communities may be unfairly penalized due to the algorithm's inability to account for their unique learning contexts. "The deployment of biased AI systems in education risks exacerbating existing educational inequalities, particularly in automated grading systems and admissions processes" (Binns et al., 2022).

To address these concerns, there has been a push toward ensuring algorithmic transparency and fairness audits in educational AI tools. Whittaker et al. (2021) emphasized the importance of conducting regular audits on AI systems to ensure that they are not disproportionately disadvantaging certain student groups. "Algorithmic fairness is critical for maintaining trust in AI systems, especially in sensitive applications like education, where unequal treatment can have lasting consequences on students' futures" (Whittaker et al., 2021). There is also a growing demand for the diversification of training datasets to include more representative samples, ensuring that AI tools are more equitable in their application.

2.6.3 Data Privacy and Ethical Use of AI in Education

The widespread adoption of Generative AI in education has raised substantial concerns about data privacy and the ethical use of student information. AI-driven platforms often rely on extensive data collection, including student performance metrics, behavioural data, and even personal identifiers, to deliver personalized learning experiences. However, this data collection poses serious risks, particularly when it comes to data security and consent.

A 2023 report by the Electronic Frontier Foundation (EFF) warned that many AI-powered educational tools collect far more data than necessary, often without transparent communication about how that data is stored, used, or shared with third parties. "The lack of robust data protection frameworks in the educational AI sector leaves students vulnerable to data breaches and unauthorized use of their personal information" (EFF, 2023). This is particularly concerning in regions where data protection laws are weak or non-existent.

In regions like the European Union, regulations such as the General Data Protection Regulation (GDPR) have set strict standards for the collection and processing of personal data. GDPR mandates that any AI tool used in educational institutions must have explicit informed consent from users, including students and their guardians, and ensure that data is anonymized wherever possible. A 2022 study by Villaronga and Galdon emphasized the need for ethically designed AI systems that prioritize student privacy, particularly in K-12 environments. "The education sector needs to adopt privacy-by-design principles to ensure that AI systems do not infringe on students' rights to privacy" (Villaronga & Galdon, 2022).

Educational institutions are increasingly turning to privacy-centric AI platforms, which ensure that student data is protected, with clear guidelines on how data is used and stored. However, as the EFF report noted, more work is needed to develop comprehensive data protection policies that can keep pace with the rapidly evolving AI landscape.

2.6.4 Balancing AI Assistance with Human Learning Processes

A critical question in the deployment of AI tools in education is how to strike a balance between AI assistance and the cultivation of human learning processes. While AI can

provide significant support in terms of personalized feedback and adaptive learning, there is a risk that students may become over-reliant on AI, using it as a crutch rather than a supplement to their own learning efforts.

Luckin et al. (2021) raised concerns about the potential for AI overuse to inhibit the development of essential critical thinking skills. "If students are constantly turning to AI for solutions, they may lose the ability to engage deeply with problems and think critically about their responses" (Luckin et al., 2021). This concern has prompted educators to advocate for the use of AI as a complementary tool that supports, rather than replaces, human cognition.

Educational institutions are now focusing on designing AI-integrated curricula that promote human-AI collaboration. In these models, AI is used to provide instant feedback, help students identify areas for improvement, and suggest resources, but the human educator remains central to the learning process. Zhao and Zhou (2023) suggested that "educators should emphasize the role of AI in enhancing the learning experience while encouraging students to take an active role in their learning journey, fostering autonomy and independent thought" (Zhao & Zhou, 2023).

In addition, pedagogical approaches such as flipped classrooms and project-based learning have been adapted to include AI tools while maintaining a focus on problem-solving and collaborative learning. These strategies ensure that while AI provides valuable support, students are still required to engage critically with the material, interact with their peers, and develop solutions through active learning.

2.7 Empirical Studies and Success Stories

The increasing application of Generative AI (GenAI) in education has led to a number of empirical studies that document its positive impact on student learning outcomes, engagement, and personalized education. Additionally, a range of case studies from schools and universities illustrate the success of these AI-powered systems in real-world settings. This section reviews the empirical evidence and provides success stories from

various educational institutions that have successfully integrated GenAI into their teaching and learning frameworks.

2.7.1 Case Studies of Successful GenAI Implementation in Education

Numerous case studies highlight the success of Generative AI tools in enhancing learning experiences. One such case study from Georgia State University (2021) focused on the implementation of AI-powered chatbots to support student engagement and academic advising. The university deployed an AI chatbot named Pounce, designed to provide 24/7 support for students. Results showed that first-year students who interacted with the chatbot were 11% more likely to stay enrolled compared to those who didn't use the service. "AI chatbots provide an efficient, scalable way to support students, particularly in large institutions where personalized advising is difficult to implement" (Georgia State University, 2021).

Arizona State University (ASU) is another success story, having implemented adaptive learning platforms powered by AI in their Mathematics and Biology courses. A 2022 study showed that students enrolled in AI-adaptive courses had a 20% higher pass rate and exhibited greater confidence in their subject matter. According to the study, "The ability of AI to tailor instruction to the needs of each student has had a profound impact on student outcomes, particularly among first-generation college students" (ASU, 2022).

In K-12 education, the Squirrel AI adaptive learning system was implemented in Chinese secondary schools to provide personalized tutoring. A 2020 report by Squirrel AI showed that students using the platform achieved a 22% improvement in their math scores. This AI-driven system analyses individual student weaknesses in real-time and provides tailored exercises to address those gaps. "AI platforms like Squirrel AI are game-changers in large classrooms where individualized attention is difficult" (Squirrel AI, 2020).

A further case from Singapore's Nanyang Technological University (NTU) in 2023 demonstrated the integration of Generative AI in the engineering curriculum. NTU leveraged AI to create virtual laboratories where students could conduct experiments in a simulated environment. A report by Lee and Koh (2023) found that students using AI-enabled virtual labs performed 30% better in lab-based assessments compared to those

using traditional methods. The authors stated that "virtual labs not only provide flexibility but also democratize access to expensive lab resources" (Lee & Koh, 2023).

2.7.2 Meta-Analyses of GenAI's Impact on Learning Outcomes

Meta-analyses have played a crucial role in providing a broader view of the effectiveness of Generative AI in improving educational outcomes. A 2023 meta-analysis by Henderson et al. reviewed 75 studies focusing on the use of AI-based adaptive learning platforms in secondary and higher education. The analysis concluded that AI tools improved student performance by an average of 14% across all subjects, with particularly significant effects in STEM fields. "Our review shows that the ability of AI to provide real-time, personalized feedback is a major factor in driving better academic outcomes" (Henderson et al., 2023).

Another significant meta-analysis was conducted by Li and Zhang (2022), focusing on the use of Generative AI in language learning and writing improvement. Their analysis of 40 studies found that AI-powered platforms like Grammarly and WriteLab led to a 16% improvement in writing quality, with students receiving more constructive feedback compared to traditional teaching methods. "Students benefited from the real-time feedback provided by AI, which allowed them to make quick adjustments and refine their writing before submission" (Li & Zhang, 2022).

A 2021 meta-analysis by Kafai et al. explored how AI systems impact self-directed learning and student autonomy. The analysis covered 60 empirical studies and found that AI tools encouraged self-paced learning, particularly in project-based environments. The authors noted that "students using AI platforms demonstrated higher levels of motivation and persistence in their studies, as the tools allowed them to take control of their learning process" (Kafai et al., 2021).

2.7.3 Review of Best Practices in GenAI Use Among Students

As Generative AI continues to be integrated into classrooms, a number of best practices have emerged to ensure its effective use. A 2023 EDUCAUSE study emphasized the importance of guiding students in the ethical use of AI tools. According to the study, "Students should be taught not only how to use AI tools effectively but also how to critically evaluate AI-generated content to avoid over-reliance on automation"

(EDUCAUSE, 2023). The report further recommends that educators provide clear guidelines on when and how to use AI tools, particularly for assignments requiring originality and creativity.

A report from Vanderbilt University (2023) highlighted the importance of AI literacy as a key competency for students. The university integrated AI workshops into the undergraduate curriculum to ensure students understood both the capabilities and limitations of AI tools. "Our goal is to equip students with the skills to use AI tools responsibly, while also fostering a deep understanding of how these tools can enhance, but not replace, critical thinking and problem-solving" (Vanderbilt University, 2023).

Incorporating AI into collaborative learning environments has also been identified as a best practice. A 2022 study by Watson and Williams found that students who used AI tools in group projects reported higher levels of engagement and collaborative efficiency. "AI tools helped distribute tasks more evenly and provided students with real-time feedback, which improved group dynamics and overall project outcomes" (Watson & Williams, 2022).

Another best practice involves using AI-generated feedback in combination with human assessment. A 2021 study by Green and Clark suggested that AI tools should provide the first layer of feedback, followed by more nuanced, human-led feedback from instructors. "While AI can offer immediate and objective feedback, the human element remains critical in assessing more subjective elements such as creativity and original thought" (Green & Clark, 2021).

2.8 Transition to Empirical Research on Student Perceptions

Throughout this chapter, we've delved into the ways in which Generative AI (GenAI) is reshaping education. From personalized learning environments to enhancing student engagement and improving academic outcomes, the potential of AI seems boundless. However, while we've explored many empirical studies and success stories from around the world, a crucial question remains: How do students actually experience these AI tools?

The research thus far has offered us a wealth of data from the perspective of educational institutions and researchers. Yet, to truly understand the impact of AI, we must turn our focus toward the students themselves, the very individuals using these tools day-to-day. That's where the next chapter comes in. This upcoming chapter is dedicated to exploring student perceptions of AI through two surveys and a hands-on hackathon project. By transitioning from a review of the literature to the real-world insights provided by students, we gain a more complete picture of how AI is being received and what its future in education may look like.

2.8.1 Summary of Key Themes in the Literature

Before diving into the findings of our empirical research, it's worth summarizing some of the key themes that emerged from the studies reviewed in this chapter. These themes not only highlight AI's transformative potential but also set the stage for understanding how students interact with AI tools in practice.

First, the literature points to the immense power of personalized learning. Tools like Squirrel AI and adaptive platforms have demonstrated remarkable success in tailoring learning experiences to individual students. This adaptability is a major advantage, allowing learners to move at their own pace and focus on areas where they need the most help. But how do students perceive this flexibility in practice? Are they truly benefiting from AI's personalized approach, or do challenges remain?

Another major theme is the impact of AI on student engagement and motivation. Platforms that incorporate gamification and instant feedback, such as Duolingo and Khan Academy, have consistently shown that students are more likely to stay engaged when learning feels interactive and responsive. However, the question remains: Is this increase in engagement sustainable, or does the novelty of AI-driven tools wear off over time?

In addition, we've discussed the benefits of efficiency brought about by tools like Grammarly and ChatGPT, which have streamlined tasks like writing, editing, and research. Students have access to a 24/7 AI assistant, but do they feel empowered by these tools, or are there risks of over-reliance on technology?

Finally, we can't ignore the ethical concerns surrounding AI in education. Issues of data privacy, bias, and the potential for AI to undermine academic integrity are still hotly debated. In the next chapter, we'll see how students weigh these concerns, particularly regarding the trustworthiness of AI systems and their implications for academic honesty.

These themes give us a strong foundation to approach the student-centred research that follows, allowing us to compare what the literature suggests with what students themselves are experiencing.

2.8.2 Introducing Chapter 3: Survey of Student Experiences and Hackathon Project

Now, let us turn our attention to what comes next. Chapter 3 takes us into the real world of students' experiences. We will examine data collected from two surveys of students actively using AI tools in their academic lives. These surveys explore the practical side of AI integration, how students use AI-driven tools, how they perceive them and the impact of these tools.

But that's not all. Chapter 3 also introduces the outcomes of a hackathon project where students had the opportunity to collaborate and create AI-driven solutions for educational challenges. In this hands-on, collaborative environment, students applied their knowledge of AI in innovative ways, tackling problems and creating tools like AI-based lesson planners or interview simulators. The hackathon reveals the students' technical skills and also how they envision AI's role in shaping the future of education.

What makes this hackathon particularly interesting is that it moves beyond theory into practical application. By working together in a competitive, creative environment, students were able to explore the boundaries of what AI can do in education. Their projects highlight both the opportunities and limitations of current AI tools, giving us insights into how students feel about using AI in real-world problem-solving contexts.

2.8.3 How This Study Adds to Existing Knowledge

So, how does this research add to what we already know about Generative AI in education? Up until now, much of the literature has focused on the institutional and technical aspects of AI, how it performs, how it improves grades, and how it personalizes learning. But what's often missing from these discussions is the student voice. This study

attempts to fill that gap by centring on the experiences and perspectives of students, the people actually using these tools on a daily basis.

By interviewing students directly and analysing their feedback, this study poses insights into how AI tools are influencing their academic journey. Are students benefiting from AI in the way we expect? Are they aware of ethical issues and do they feel confident in using AI responsibly?

Furthermore, the hackathon adds a unique layer of practical insight. Not only does it show how students are using AI in their coursework, but it also demonstrates how they apply these tools in creative, real-world scenarios. The projects developed during the hackathon offer valuable clues about what students want from AI in the future, giving educators and developers critical feedback on where to take these technologies next.

Thanks to the responses of the surveys, students provided an understanding of what it means to use AI ethically in an academic setting, contributing to ongoing discussions about the responsible deployment of AI in education.

In conclusion, this study not only reinforces what we've seen in the literature but also brings new insights by focusing on student perceptions and hands-on AI applications. The findings in Chapter 3 will give us a clearer picture of the challenges and opportunities ahead, as we continue to integrate AI into educational systems.

Chapter 3: Data Analysis and Hackathon Project Results

3.1 Introduction

The combination of artificial intelligence (AI) and education marks a transformative phase for the future of learning. This thesis addresses the rapid integration of artificial intelligence models in education and after a careful analysis of recent studies, aims to focus on qualitative and quantitative analyses from two surveys and a hackathon.

The thesis aims to contribute to the growing body of knowledge by offering an examination of the impact of AI on education, focusing in particular on real-world applications and perceptions. To make this possible, two types of experiments were conducted: two surveys, which focus on the understanding of artificial intelligence, frequency of use and perceptions of it, as well as students' general satisfaction with AI; and a hackathon, which examines how AI innovations can drive new learning strategies in an AI-driven society, through the creative minds of the students themselves. These components are intended to give value to the study and highlight its importance. The findings that emerge in the chapter will provide a richer insight into the purpose of the study and give practical application to the empirical discourses addressed in the previous chapters.

3.1.1 Overview of the Surveys and Hackathon

The objective data to be analysed in this chapter of the thesis are based on three separate but complementary initiatives: two surveys and a hackathon.

The surveys were designed to assess people's general perceptions, understanding, interaction with AI tools in education and their satisfaction. Respondents, including students and recent graduates, offered insights into the awareness, benefits and challenges associated with integrating AI into educational environments. The surveys sought to provide concrete answers, useful for the purposes of this thesis, through their findings.

In parallel, a hackathon was conducted as an experimental project to explore innovative solutions for the integration of AI in education. Unlike the surveys, which collected perceptions, the hackathon focused on generating creative, real-time AI applications

through collaboration among participants. The participants were a group of students, who were then divided into two different teams to compete in creating the best AI and education implementation project. The hackathon had a totally different purpose than the surveys but served as a platform for practical experimentation with AI in an educational context. Participants developed AI-based tools and prototypes designed to improve teaching, learning and the future of education.

3.1.2 Objectives and Significance

The aim of this chapter is to investigate the integration of AI in education through data analysis and practical innovation.

Combining the surveys data with the results of the hackathon, the research aims to:

- Assess current perceptions and use of AI in educational contexts.
- Identifying the potential benefits and challenges faced in integrating AI in education.
- To explore innovative applications of AI that could redefine traditional learning and teaching paradigms.

The use of a dual approach not only captures the theoretical implications of AI in education through surveys, but also demonstrates tangible applications through the hackathon. This experimental examination should contribute to both the academic literature and the practical discourse on how AI can be effectively and ethically integrated into education.

3.2 First Survey Data Analysis

This section provides an analysis of the first survey conducted to gather insights into the perceptions and usage of Generative Artificial Intelligence (GAI) in education. The survey's primary aim was to understand how participants, who are in the educational field, perceive and interact with AI, focusing on their frequency of usage, awareness, perceived benefits and challenges.

3.2.1 Survey Methodology

The survey was disseminated online, targeting people in educational field from various educational backgrounds, particularly within university settings.

The questionnaire consisted of both closed-ended and open-ended questions. This dual approach allowed for the collection of quantitative data as well as qualitative insights into participants' experiences and attitudes toward AI.

Closed-ended questions focused on understanding respondents' attitudes towards technology in general, with questions on mindset, critical thinking, optimism, insecurities, discomforts and innovations, then questions on the types of AI tools used, frequency of use and demographics. The open-ended questions encouraged respondents to reflect on their personal experiences with AI, including perceived benefits, challenges and areas for improvement.

3.2.2 Demographics of Respondents

The demographic breakdown of the 44 participants revealed 25 male respondents, 18 female respondents, and 1 non-binary respondent.

Gender: - Selected Choice

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	Male	25	56,8	56,8	56,8
	Female	18	40,9	40,9	97,7
	Non binary	1	2,3	2,3	100,0
	Totale	44	100,0	100,0	

Figure 1a: Gender distribution of participants (Table)[1]

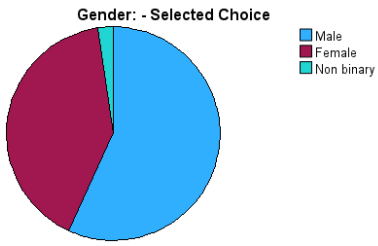

Figure 1b: Gender distribution of participants (Pie chart)[2]

The age range was wide, with participants between 19 and 30 years old, which reflects a predominantly young-adult sample, aligning with typical university demographics. The

[1] Source: SPSS data analysis performed by the author.
[2] Source: SPSS data analysis performed by the author.

average age of respondents is approximatively 23 years, suggesting that many respondents were either undergraduate or graduate students.

Age (in numbers):

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	19,00	3	6,8	6,8	6,8
	20,00	6	13,6	13,6	20,5
	21,00	5	11,4	11,4	31,8
	22,00	1	2,3	2,3	34,1
	23,00	16	36,4	36,4	70,5
	24,00	6	13,6	13,6	84,1
	25,00	1	2,3	2,3	86,4
	26,00	2	4,5	4,5	90,9
	27,00	1	2,3	2,3	93,2
	28,00	2	4,5	4,5	97,7
	30,00	1	2,3	2,3	100,0
	Totale	44	100,0	100,0	

Figure 2a: Age distribution of participants (Table)[3]

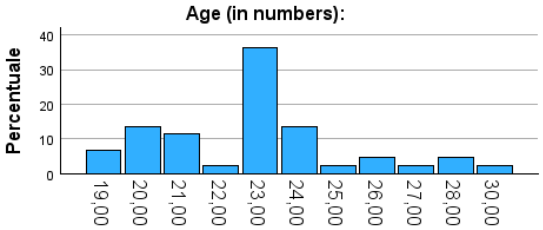

Figure 2b: Age distribution of participants (Bar graph)[4]

In terms of educational qualifications, 47.7% of respondents held a high school diploma or equivalent degree (21 respondents), followed by 31.8% with a master's degree (14 participants), and 20.5% holding a bachelor's degree (9 participants). This spread indicates a range of educational levels, providing a broad perspective on AI usage across different academic stages.

What is your highest qualification?

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	High school diploma or equivalent degree	21	47,7	47,7	47,7
	Bachelor's degree	9	20,5	20,5	68,2
	Master's degree	14	31,8	31,8	100,0
	Totale	44	100,0	100,0	

Figure 3a: Distribution of participants' educational qualifications (Table)[5]

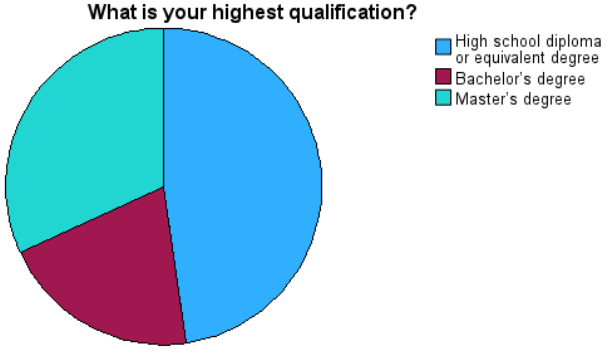

Figure 3b: Distribution of the participants' educational qualification (Pie chart)[6]

[3] Source: SPSS data analysis performed by the author.
[4] Source: SPSS data analysis performed by the author.
[5] Source: SPSS data analysis performed by the author.
[6] Source: SPSS data analysis performed by the author.

3.2.3 General Perceptions of AI in Education

This section delves into the perceptions of AI in education among survey respondents by analysing their responses. It focuses perceived benefits and challenges associated with AI integration into educational environments.

3.2.3.1 Understanding and Awareness of AI

Most respondents exhibited a moderate to high level of awareness regarding AI tools, particularly generative AI applications such as ChatGPT, Canva, and Chat PDF. Daily and weekly users were more likely to demonstrate a deeper understanding of AI's capabilities and limitations, reflecting their consistent engagement with these technologies.

A recurring theme in the qualitative feedback is that respondents are becoming increasingly aware of the use of artificial intelligence and its potential. Indeed, in the positive responses, many have experiences that denote their own use of the tools. For example, one student says: 'I believe that in today's society, the use of artificial intelligence is now basic, so we have to learn to use it consciously and find the right tools that can best help us in everyday life and in specific tasks.'

This leads us to realize that the students themselves are also aware that artificial intelligence must be used in an appropriate and conscious manner. It highlights that the use is done in a careful manner and that there is already a certain awareness of use on their part.

3.2.4 Usage and Interaction with AI Tools

This section explores how respondents interact with AI tools, including the frequency of usage and the types of AI tools they employ. The analysis aims to provide a detailed overview of the current trends in AI usage within educational settings and highlight key factors that influence these patterns.

3.2.4.1 Frequency of Use

The survey revealed diverse usage patterns among respondents, with **AI tools** becoming an integral part of their academic and personal routines. The frequency of AI tool usage varied significantly across the sample.

- **Never Use (2.3%)**: Only one participant reported that they had never used AI tools, suggesting that AI is becoming increasingly integrated into the lives of most students.
- **Two-Three Times a Year (20.5%):** 9 respondents expressed that they use artificial intelligence only two to three times a year.
- **Every Two-Three Months (4.5%):** 2 respondents only use AI every two to three months. This expresses an infrequent use only at the actual moment when a specific need arises.
- **Monthly Use (18.2%)**: 8 participants stated that they used AI tools on a monthly basis.
- **Weekly Use (29.5%)**: This was the most common frequency, with 13 respondents indicating that they used AI tools at least once a week.
- **Daily Use (25%)**: A significant portion of respondents (11 participants) reported using AI tools daily. This group consisted of individuals who integrated AI deeply into their daily academic workflows.

The overall pattern of AI usage highlights its growing importance as a tool for academic support, with **54.5% of respondents** using AI tools **weekly or more frequently**. This trend indicates a shift toward more regular and sustained engagement with AI technologies across various educational activities.

How frequently do you use applications or tools of generative artificial intelligence?

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	Mai	1	2,3	2,3	2,3
	Due-tre volte l'anno	9	20,5	20,5	22,7
	Ogni due-tre mesi	2	4,5	4,5	27,3
	Una volta al mese	8	18,2	18,2	45,5
	Settimanalmente	13	29,5	29,5	75,0
	Quotidianamente	11	25,0	25,0	100,0
	Totale	44	100,0	100,0	

Figure 4a: Frequency of participants' AI use (Table)[7]

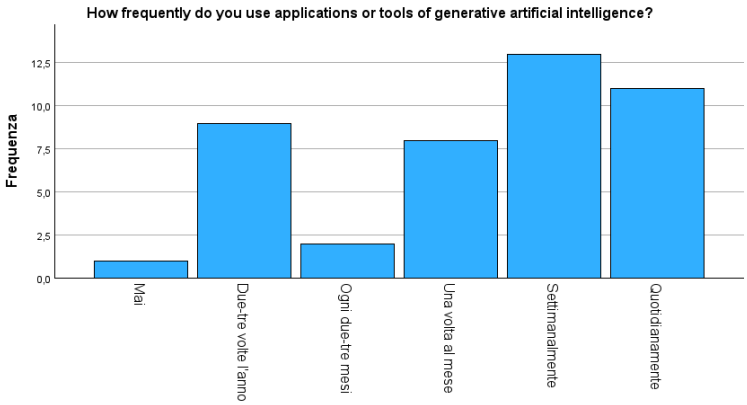

Figure 4b: Frequency of participants' AI usage (Bar graph)[8]

3.2.4.2 Types of AI Tools Used

The survey responses indicated that participants were utilizing a wide variety of AI tools for different purposes.

For academic purposes, more comprehensive and generic artificial intelligence tools are mainly used, even if there are more specific tools. The same tools were also used in a personal way, for hobbies for example. These Artificial Intelligence tools have become precious resources for students, helping them tackle various academic challenges. The versatility of these tools reflects their potential in meeting diverse educational needs, whether for routine tasks or more complex academic work.

Despite the completeness of the first AI tools described, there are few AI tools mentioned that address more specific topics, such as tools for creating art or for helping to write

[7] Source: SPSS data analysis performed by the author.
[8] Source: SPSS data analysis performed by the author.

essays more specifically. In fact, other respondents highlighted the use not only of the more generic tools but also of those specialized in more precise categories.

3.2.5 Statistical Analysis and Trends

In this section, we delve into the statistical analysis of the survey data, focusing on a linear multiple regression analysis and correlations that emerged. The correlations aim to provide insights into the relationships between demographic variables and frequency of AI use.

3.2.5.1 Linear Multiple Regression Analysis and Correlations

The data collected through the questionnaire provided by the survey generated on Qualtrics XM were exported to the statistical software SPSS (Statistical Package for Social Science) for analysis.

In order to test the statistical significance of all effects of the independent variables (Growth Mindset, Critical Thinking, Optimism, Innovativeness, Discomfort and Insecurity) against the dependent variable (Frequency of Usage of AI), a linear multiple regression analysis was conducted. After conducting the regression, the model summary table was observed, in which the value of the adjusted R squared was examined, which was found to be 0.245. Thus, 24.5% of the variance of the Y (Frequency of Usage of AI) was explained by the independent variables. Subsequently, the ANOVA table was analysed, in which a p-value for the F-test (Fisher's exact test) of 0.010 emerged, which was found to be statistically significant (p-value $< \alpha = 0.05$), thus confirming the success of the regression analysis. In addition, looking at the Coefficients table, all effects of the six independent variables were examined with respect to the dependent variable in order to be able to decree their statistical significance or otherwise. Furthermore, before being able to observe the significance levels of the six relationships contained within the Coefficients table, the VIF (Variance Inflation Factor) column was observed in order to determine any problems related to multicollinearity, i.e. the phenomenon according to which two or more independent variables are highly correlated with each other. Specifically, all VIFs were found to be less than 10, ruling out any multicollinearity. Therefore, it was possible to continue with the analysis of all six effects of X versus Y.

With regard to the effect between X1 (Growth Mindset) and Y (Frequency of Usage of AI), a p-value of 0.420 emerged, which was not statistically significant and thus had no effect with regard to Y.

With regard to the effect between X2 (Critical Thinking) and Y (Frequency of Usage of AI), a p-value of 0.674 emerged, which was not statistically significant and thus had no effect with regard to Y.

With regard to the effect between X3 (Optimism) and Y (Frequency of Usage of AI), a p-value of 0.004 emerged, which was statistically significant and thus had a positive effect with regard to Y of 0.881 (unstandardized β coefficient value).

With regard to the effect between X4 (Innovativeness) and Y (Frequency of Usage of AI), a p-value of 0.550 emerged, which was not statistically significant and thus did not have an effect with regard to Y.

With regard to the effect between X5 (Discomfort) and Y (Frequency of Usage of AI), a p-value of 0.632 emerged, which was not statistically significant and thus had no effect with regard to Y.

With regard to the effect between X6 (Insecurity) and Y (Frequency of Usage of AI), a p-value of 0.215 emerged, which was not statistically significant and thus did not have an effect with regard to Y.

Riepilogo del modello

Modello	R	R-quadrato	R-quadrato adattato	Errore std. della stima
1	,592[a]	,350	,245	1,330

a. Predittori: (costante), INS, OPT, INN, CRITHI, GROMIN, DIS

Figure 5a: Summary of the regression model[9]

[9] Source: SPSS data analysis performed by the author.

ANOVA[a]

Modello		Somma dei quadrati	gl	Media quadratica	F	Sign.
1	Regressione	35,305	6	5,884	3,328	,010[b]
	Residuo	65,422	37	1,768		
	Totale	100,727	43			

a. Variabile dipendente: How frequently do you use applications or tools of generative artificial intelligence?

b. Predittori: (costante), INS, OPT, INN, CRITHI, GROMIN, DIS

Figure 5b: ANOVA of the regression model[10]

Coefficienti[a]

Modello		Coefficienti non standardizzati		Coefficienti standardizzati			Statistiche di collinearità	
		B	Errore standard	Beta	t	Sign.	Tolleranza	VIF
1	(Costante)	-1,442	2,602		-,554	,583		
	GROMIN	-,418	,513	-,137	-,816	,420	,620	1,613
	CRITHI	,158	,372	,071	,424	,674	,617	1,620
	OPT	,881	,291	,489	3,026	,004	,674	1,484
	INN	,165	,273	,100	,603	,550	,637	1,571
	DIS	-,137	,284	-,093	-,483	,632	,473	2,115
	INS	,366	,290	,240	1,261	,215	,485	2,063

a. Variabile dipendente: How frequently do you use applications or tools of generative artificial intelligence?

Figure 5c: Coefficients of the regression model[11]

Diagnostiche di collinearità[a]

Modello	Dimensione	Autovalore	Indice contenuti	Proporzioni varianza (Costante)	GROMIN	CRITHI	OPT	INN	DIS	INS
1	1	6,857	1,000	,00	,00	,00	,00	,00	,00	,00
	2	,074	9,629	,00	,00	,01	,03	,04	,15	,07
	3	,026	16,105	,01	,01	,06	,06	,55	,02	,02
	4	,018	19,744	,02	,00	,01	,03	,04	,43	,74
	5	,012	23,693	,10	,18	,02	,59	,06	,09	,01
	6	,009	27,560	,01	,40	,29	,27	,22	,15	,04
	7	,004	43,529	,86	,40	,61	,02	,08	,16	,13

a. Variabile dipendente: How frequently do you use applications or tools of generative artificial intelligence?

Figure 5d: Collinearity diagnostics of the regression model[12]

After carrying out the regression analysis, it was decided to perform three correlation analyses between the frequency and three demographic variables (educational qualification, age and gender).

With regard to the first correlation analysis between educational qualification and frequency, a positive Pearson correlation index of 0.067 and a p-value relative to the T-

[10] Source: SPSS data analysis performed by the author.
[11] Source: SPSS data analysis performed by the author.
[12] Source: SPSS data analysis performed by the author.

test of 0.666 emerged, which was not statistically significant (p-value > α/2 = 0.025), decreeing a failure of the correlation in question.

Correlazioni

		What is your highest qualification?	How frequently do you use applications or tools of generative artificial intelligence?
What is your highest qualification?	Correlazione di Pearson	1	,067
	Sign. (a due code)		,666
	N	44	44
How frequently do you use applications or tools of generative artificial intelligence?	Correlazione di Pearson	,067	1
	Sign. (a due code)	,666	
	N	44	44

Figure 6: Correlation between participants' educational qualification and frequency of use[13]

With regard to the second correlation analysis between age and the frequency of use of AI, a negative Pearson correlation index of -0.210 and a p-value relative to the T-test of 0.171 emerged, which was not statistically significant (p-value > α/2 = 0.025), decreeing a failure of the correlation in question.

Correlazioni

		Age (in numbers):	How frequently do you use applications or tools of generative artificial intelligence?
Age (in numbers):	Correlazione di Pearson	1	-,210
	Sign. (a due code)		,171
	N	44	44
How frequently do you use applications or tools of generative artificial intelligence?	Correlazione di Pearson	-,210	1
	Sign. (a due code)	,171	
	N	44	44

Figure 7: Correlation between participants' age and frequency of use[14]

[13] Source: SPSS data analysis performed by the author.
[14] Source: SPSS data analysis performed by the author.

With regard to the third correlation analysis between gender and the frequency of use of AI, a negative Pearson correlation index of -0.179 and a p-value for the T-test of 0.245 emerged, which was not statistically significant (p-value > α/2 = 0.025), declaring the failure of the correlation in question.

Correlazioni

		Gender: - Selected Choice	How frequently do you use applications or tools of generative artificial intelligence?
Gender: - Selected Choice	Correlazione di Pearson	1	-,179
	Sign. (a due code)		,245
	N	44	44
How frequently do you use applications or tools of generative artificial intelligence?	Correlazione di Pearson	-,179	1
	Sign. (a due code)	,245	
	N	44	44

Figure 8: Correlation between participants' gender and frequency of use[15]

3.2.5.2 Significant Findings

The statistical analysis revealed several findings that shed light on how AI is currently being used in education and what it could mean for the future.

The data show that there are no effective correlations between the frequency of AI use and educational qualification, age and gender. Unfortunately, although in the open-ended response part of the data might suggest that educational qualifications could positively influence the use of AI-driven tools, in the quantitative data there was no significant correlation.

On the other hand, with regard to the multiple linear regression analysis, the only data that had a significant influence on the frequency of use was optimism. This can be translated into a strong desire on the part of the respondents to want to use AI tools more

[15] Source: SPSS data analysis performed by the author.

frequently and this is dictated by a strong optimism in the performance that can be achieved through these.

Without having a positive correlation analysis, it can be deduced that the sample analysed, and the responses produced were not sufficient to find an independent variable that influenced frequency of use and thus could give us insights into how to increase the use of AI tools.

There are still many challenges for GenAI within the education sector. Indeed, we need to think about the future and stratagems that can capture the interest of students to make them integrate AI consistently within their school routines.

Looking to the future, there seems to be a strong sense of optimism about the potential of AI to further transform education. However, for AI to realize its full potential in education, it will be essential to address current concerns about ethics, data privacy and the limitations of current AI technologies.

3.3 Second Survey Data Analysis

This section provides an analysis of the second survey conducted to gather information specifically on perceptions of Generative Artificial Intelligence (AI) in education and satisfaction with it. The main objective of the second survey conducted was to understand how participants perceive and interact with AI, focusing on overall satisfaction with AI tools. Through specific and non-specific questions, it was possible to conduct analyses showing concrete data on satisfaction.

3.3.1 Survey Methodology

The second survey was offered as an online survey, mainly targeting students, particularly university students.

The questionnaire consisted of multiple-choice questions and demographic questions. The multiple-choice questions proposed questions on mindset, critical thinking,

optimism, insecurities, discomforts and innovations, frequency of use, types of AI tools used and levels of satisfaction.

3.3.2 Demographics of Respondents

The sample analysed was 102 participants, with 70 male respondents, 29 female respondents and 3 respondents preferred not to disclose their gender.

Gender:

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	Male	70	68,6	68,6	68,6
	Female	29	28,4	28,4	97,1
	Prefer not to say	3	2,9	2,9	100,0
	Totale	102	100,0	100,0	

Figure 9a: Gender distribution of participants (Table)[16]

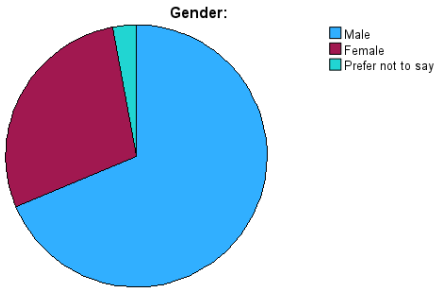

Figure 9b: Gender distribution of participants (Pie chart)[17]

The age range was wide, with participants aged between 18 and 30, reflecting a young-adult sample, in line with university demographics. The average age of the respondents was around 23 years, suggesting that many of them were university students or graduates.

Age (in numbers):

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	18,00	1	1,0	1,0	1,0
	19,00	2	2,0	2,0	2,9
	20,00	3	2,9	2,9	5,9
	21,00	12	11,8	11,8	17,6
	22,00	9	8,8	8,8	26,5
	23,00	33	32,4	32,4	58,8
	24,00	20	19,6	19,6	78,4
	25,00	14	13,7	13,7	92,2
	26,00	3	2,9	2,9	95,1
	27,00	1	1,0	1,0	96,1
	28,00	1	1,0	1,0	97,1
	29,00	1	1,0	1,0	98,0
	30,00	2	2,0	2,0	100,0
	Totale	102	100,0	100,0	

Figure 10a: Age distribution of participants (Table)[18]

[16] Source: SPSS data analysis performed by the author.
[17] Source: SPSS data analysis performed by the author.
[18] Source: SPSS data analysis performed by the author.

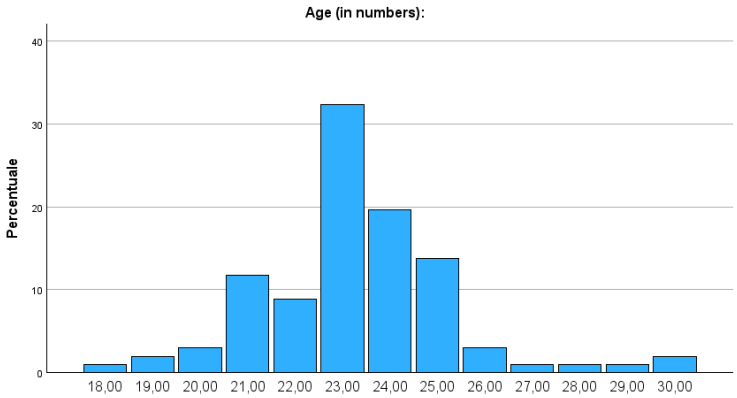

Figure 10b: Age distribution of participants (Bar graph)[19]

In terms of educational qualifications, 27.5% of respondents held a high school diploma, followed by 31.4% with a master's degree, and 28.4% holding a bachelor's degree. Smaller percentages were represented by those with some college education (8.8%), doctorate degrees (2%), professional degrees (1%), and less than a high school diploma (1%). This distribution reflects a wide range of educational levels, offering varied perspectives on AI usage across academic stages.

What is your highest qualification?

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	Less than high school	1	1,0	1,0	1,0
	High school graduate	28	27,5	27,5	28,4
	Some college	9	8,8	8,8	37,3
	Bachelor degree	29	28,4	28,4	65,7
	Master degree	32	31,4	31,4	97,1
	Professional degree	1	1,0	1,0	98,0
	Doctorate	2	2,0	2,0	100,0
	Totale	102	100,0	100,0	

Figure 11a: Distribution of participants' educational qualifications (Table)[20]

[19] Source: SPSS data analysis performed by the author.
[20] Source: SPSS data analysis performed by the author.

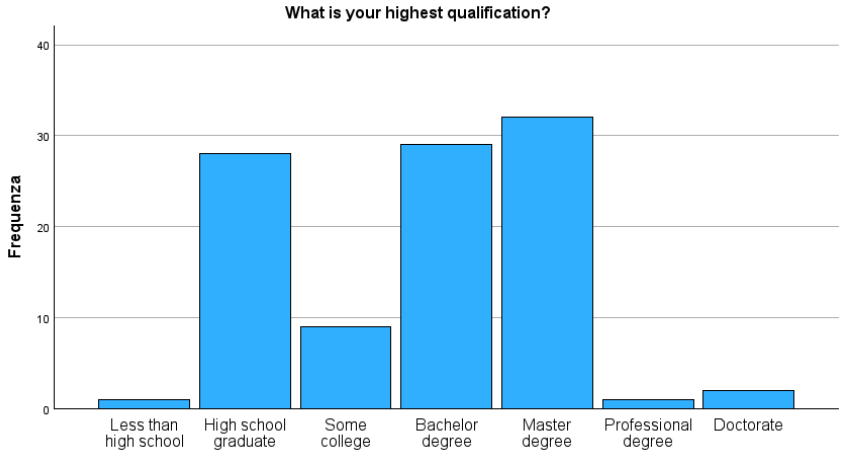

Figure 11b: Distribution of the participants' educational qualification (Bar graph)[21]

The analysed sample was also asked to indicate whether the faculty they attended belonged to the scientific or humanistic branch. It turned out that 22.5% of the respondents attend/had attended a humanistic faculty, while 77.5% (the majority) attend/had attended a scientific faculty.

Which faculty are you currently attending?

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	Humanistic faculty	23	22,5	22,5	22,5
	Scientific faculty	79	77,5	77,5	100,0
	Totale	102	100,0	100,0	

Figure 12a: Distribution of the faculty the participants attend (Table)[22]

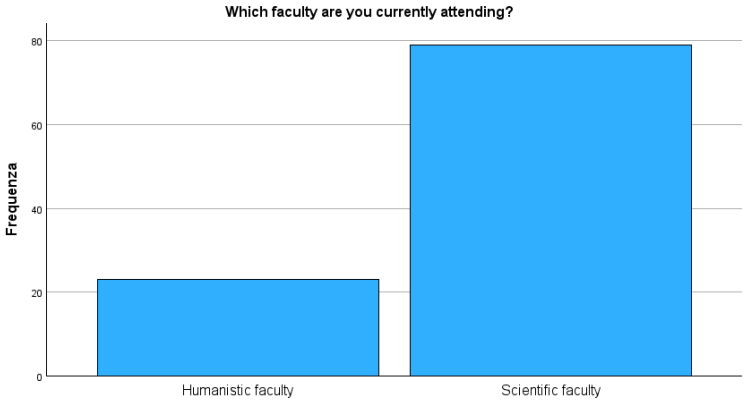

Figure 12b: Distribution of the faculty the participants attend (Bar graph)[23]

[21] Source: SPSS data analysis performed by the author.
[22] Source: SPSS data analysis performed by the author.
[23] Source: SPSS data analysis performed by the author.

3.3.3 Usage and Interactions with AI Tools

This section analyses how respondents interact with AI tools. Frequency of use, types of AI tools used, and satisfaction are analysed. The analysis aims to provide a detailed overview of current trends in the use of AI within educational contexts and to highlight the key factors influencing these patterns.

3.3.3.1 Frequency of Use

The survey collected data on the frequency with which participants use generative artificial intelligence applications or tools. The results indicate a varied distribution, with a predominance of regular use. Details on the frequency of use are given below:

- **Never:** 7.8% of participants indicated that they never use generative artificial intelligence tools.
- **Once a year**: 12.7% use such tools only once a year.
- **Two to three times a year**: 7.8% of respondents also reported using them two to three times a year.
- **Every two to three months**: Only 6.9% reported using them every two to three months.
- **Once a month**: 14.7% use the tools once a month.
- **Weekly**: The most represented category, with 33.3% of participants reporting that they use them weekly.
- **Daily**: 16.7% of participants reported using the tools daily.

Overall, 64.7% of respondents use generative AI tools at least monthly, confirming a significant impact of these technologies on participants' daily and professional habits.

How frequently do you use applications or tools of generative artificial intelligence?

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	Mai	8	7,8	7,8	7,8
	una volta all'anno	13	12,7	12,7	20,6
	Due-tre volte l'anno	8	7,8	7,8	28,4
	Ogni due-tre mesi	7	6,9	6,9	35,3
	Una volta al mese	15	14,7	14,7	50,0
	Settimanalmente	34	33,3	33,3	83,3
	Quotidianamente	17	16,7	16,7	100,0
	Totale	102	100,0	100,0	

Figure 13a: Frequency of participants' AI use (Table)[24]

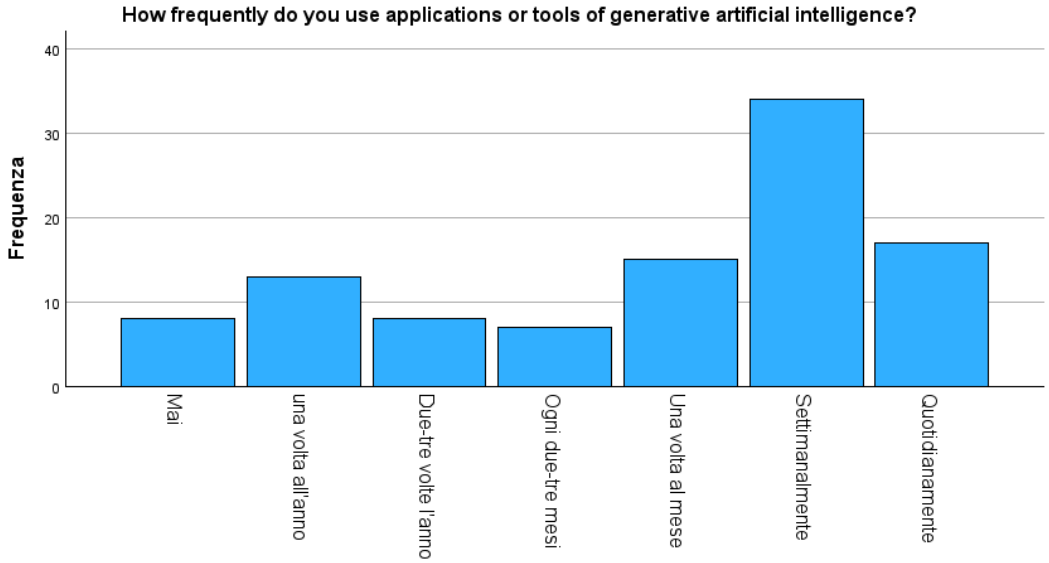

Figure 13b: Frequency of participants' AI usage (Bar graph)[25]

3.3.3.2 Types of AI Tools Used

In the survey there was also a question on the types of AI tools used. It was possible to select from several options, which were: Chat GPT, Google Gemini, DALL-E, Grammarly, Wolfram Alpha, Turnitin and DeepL.

The use of this tools on the sample of 102 participants is:

[24] Source: SPSS data analysis performed by the author.
[25] Source: SPSS data analysis performed by the author.

- **ChatGPT (OpenAI):** 94,1%
- **Google Gemini:** 29,4%
- **DALL-E**: 13,7%
- **Grammarly**: 19,6%
- **Wolfram Alpha**: 4,9%
- **Turnitin**: 3,9%
- **DeepL**: 25,5%

Considering that participants could select more than one option.

Statistiche

		ChatGPT (OpenAI)	Google Gemini	DALL-E	Grammarly	Wolfram Alpha	Turnitin	DeepL
N	Valido	96	30	14	20	5	4	26
	Mancante	6	72	88	82	97	98	76

Figure 14a: Types of AI tools used by participants (table)[26]

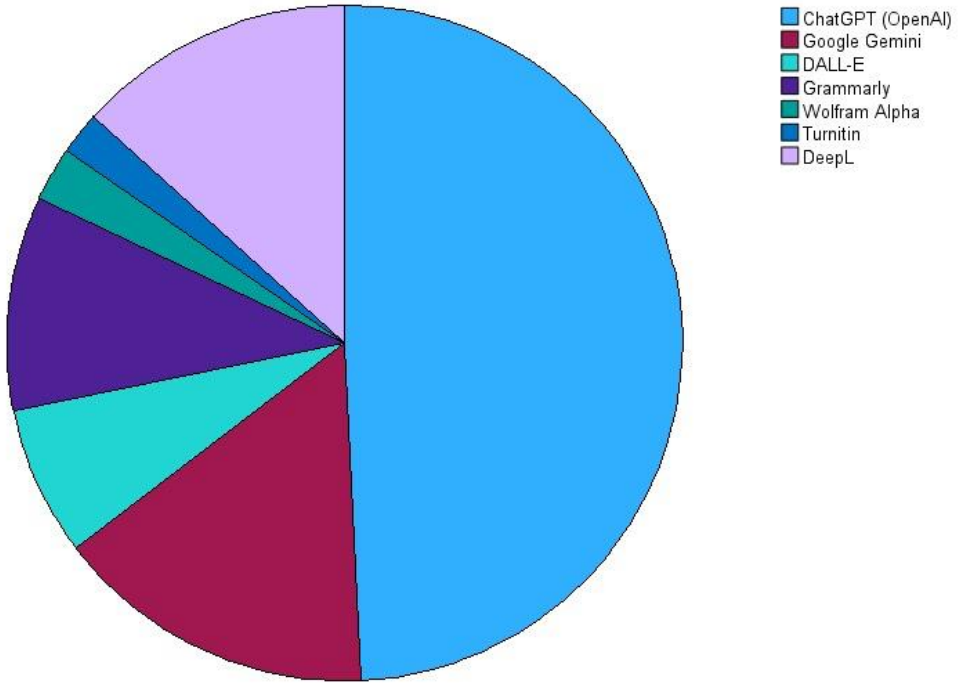

Figure 14b: Types of AI tools used by participants (pie chart)[27]

[26] Source: SPSS data analysis performed by the author.
[27] Source: SPSS data analysis performed by the author.

3.3.3.3 Satisfaction Level

Three questions were proposed in the survey aimed at capturing the respondents' satisfaction with generative artificial intelligence. The results showed that satisfaction tends to be high, but still varied.

SAT

		Frequenza	Percentuale	Percentuale valida	Percentuale cumulativa
Valido	Extremely dissatisfied	5	4,9	4,9	4,9
	1,33	6	5,9	5,9	10,8
	1,67	2	2,0	2,0	12,7
	Moderately dissatisfied	9	8,8	8,8	21,6
	2,33	5	4,9	4,9	26,5
	2,67	4	3,9	3,9	30,4
	Slightly dissatisfied	3	2,9	2,9	33,3
	Neither satisfied nor dissatisfied	2	2,0	2,0	35,3
	4,33	1	1,0	1,0	36,3
	4,67	1	1,0	1,0	37,3
	Slightly satisfied	4	3,9	3,9	41,2
	5,33	6	5,9	5,9	47,1
	5,67	7	6,9	6,9	53,9
	Moderately satisfied	21	20,6	20,6	74,5
	6,33	11	10,8	10,8	85,3
	6,67	11	10,8	10,8	96,1
	Extremely satisfied	4	3,9	3,9	100,0
	Totale	102	100,0	100,0	

Figure 15a: Satisfaction of participants regarding AI (Table)[28]

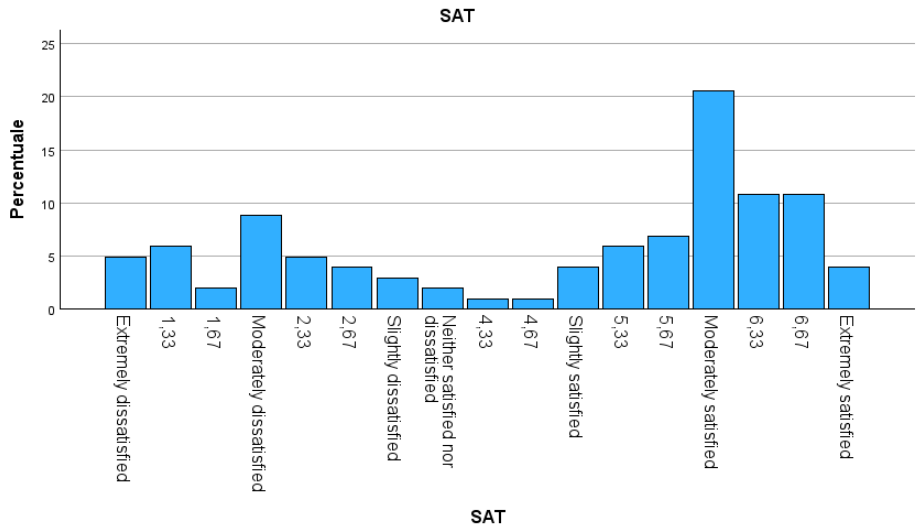

Figure 15b: Satisfaction of participants regarding A (Bar graph)[29]

[28] Source: SPSS data analysis performed by the author.
[29] Source: SPSS data analysis performed by the author.

3.3.4 Statistical Analysis and Trends

In this section, we delve into the statistical analysis of the survey data, focusing on a linear multiple regression analysis between six independent variables (Growth Mindset, Critical Thinking, Optimism, Innovativeness, Discomfort and Insecurity) and the dependent variable (Satisfaction) and correlations between demographic variables and satisfaction of AI that emerged.

3.3.4.1 Linear Multiple Regression Analysis and Correlations

The data collected through the questionnaire provided by the survey generated on Qualtrics XM were exported to the statistical software SPSS (Statistical Package for Social Science) for analysis.

In order to test the statistical significance of all effects of the independent variables (Growth Mindset, Critical Thinking, Optimism, Innovativeness, Discomfort and Insecurity) against the dependent variable (Satisfaction), a linear multiple regression analysis was conducted. After conducting the regression, the model summary table was observed, in which the value of the adjusted R squared was examined, which was found to be 0.830. Thus, 83.0% of the variance of the Y (Satisfaction) was explained by the independent variables. Subsequently, the ANOVA table was analyzed, in which a p-value for the F-test (Fisher's exact test) of 0.001 emerged, which was found to be statistically significant (p-value $< \alpha = 0.05$), thus confirming the success of the regression analysis. In addition, looking at the Coefficients table, all effects of the six independent variables were examined with respect to the dependent variable in order to be able to decree their statistical significance or otherwise. Furthermore, before being able to observe the significance levels of the six relationships contained within the Coefficients table, the VIF (Variance Inflation Factor) column was observed in order to determine any problems related to multicollinearity, i.e. the phenomenon according to which two or more independent variables are highly correlated with each other. Specifically, all VIFs were found to be less than 10, but the only VIFs greater than 10 resulted the ones of Critical Thinking and Discomfort. They had a problem with multicollinearity, and they were excluded from the analysis. For the others independent variables, the VIFs resulted less

than 10. Therefore, it was possible to continue with the analysis of all six effects of X versus Y.

With regard to the effect between X1 (Growth Mindset) and Y (Satisfaction), a p-value of 0.002 emerged, which was statistically significant and thus had a negative effect with regard to Y of –0.380 (unstandardized β coefficient value).

With regard to the effect between X2 (Critical Thinking) and Y (Satisfaction), a p-value of 0.503 emerged, which was not statistically significant and thus had no effect with regard to Y.

With regard to the effect between X3 (Optimism) and Y (Satisfaction), a p-value of 0.002 emerged, which was statistically significant and thus had a positive effect with regard to Y of 0.354 (unstandardized β coefficient value).

With regard to the effect between X4 (Innovativeness) and Y (Satisfaction), a p-value of 0.074 emerged, which was marginally significant (considering a $\alpha = 0.10$) and thus had a negative effect with regard to Y of –0.194 (unstandardized β coefficient value).

With regard to the effect between X5 (Discomfort) and Y (Satisfaction), a p-value of 0.449 emerged, which was not statistically significant and thus had no effect with regard to Y.

With regard to the effect between X6 (Insecurity) and Y (Satisfaction), a p-value of 0.037 emerged, which was statistically significant and thus had a negative effect with regard to Y of –0.256 (unstandardized β coefficient value).

Riepilogo del modello

Modello	R	R-quadrato	R-quadrato adattato	Errore std. della stima
1	,917[a]	,840	,830	,83301

a. Predittori: (costante), INS, OPT, GROWMIN, INN, DIS, CRITHI

Figure 16a: Summary of the regression model[30]

[30] Source: SPSS data analysis performed by the author.

ANOVA[a]

Modello		Somma dei quadrati	gl	Media quadratica	F	Sign.
1	Regressione	346,088	6	57,681	83,126	<,001[b]
	Residuo	65,921	95	,694		
	Totale	412,009	101			

a. Variabile dipendente: SAT

b. Predittori: (costante), INS, OPT, GROWMIN, INN, DIS, CRITHI

Figure 16b: ANOVA of the regression model[31]

Coefficienti[a]

Modello		Coefficienti non standardizzati		Coefficienti standardizzati			Statistiche di collinearità	
		B	Errore standard	Beta	t	Sign.	Tolleranza	VIF
1	(Costante)	6,144	,850		7,232	<,001		
	GROWMIN	-,380	,119	-,365	-3,181	,002	,128	7,808
	CRITHI	,095	,141	,092	,673	,503	,089	11,181
	OPT	,354	,114	,354	3,117	,002	,131	7,652
	INN	-,194	,107	-,190	-1,809	,074	,153	6,532
	DIS	-,105	,138	-,103	-,760	,449	,091	10,969
	INS	-,256	,121	-,243	-2,120	,037	,129	7,776

a. Variabile dipendente: SAT

Figure 16c: Coefficients of the regression model[32]

After carrying out the regression analysis, it was decided to perform fifth correlation analyses between the satisfaction and five demographic variables (educational qualification, age, gender, faculty and frequency).

With regard to the first correlation analysis between educational qualification and the satisfaction, a positive Pearson correlation index of 0.035 and a p-value for the T-test of 0.728 emerged, which was not statistically significant (p-value > $\alpha/2 = 0.025$), declaring the failure of the correlation in question.

[31] Source: SPSS data analysis performed by the author.
[32] Source: SPSS data analysis performed by the author.

Correlazioni

		SAT	What is your highest qualification?
SAT	Correlazione di Pearson	1	,035
	Sign. (a due code)		,728
	N	102	102
What is your highest qualification?	Correlazione di Pearson	,035	1
	Sign. (a due code)	,728	
	N	102	102

Figure 17: Correlation between participants' satisfaction and educational qualification [33]

With regard to the second correlation analysis between age and the satisfaction, a negative Pearson correlation index of –0.049 and a p-value relative to the T-test of 0.623 emerged, which was not statistically significant (p-value > α/2 = 0.025), decreeing a failure of the correlation in question.

Correlazioni

		SAT	Age (in numbers):
SAT	Correlazione di Pearson	1	-,049
	Sign. (a due code)		,623
	N	102	102
Age (in numbers):	Correlazione di Pearson	-,049	1
	Sign. (a due code)	,623	
	N	102	102

Figure 18: Correlation between participants' satisfaction and age[34]

With regard to the third correlation analysis between gender and the satisfaction, a negative Pearson correlation index of –0.091 and a p-value for the T-test of 0.364 emerged, which was not statistically significant (p-value > α/2 = 0.025), declaring the failure of the correlation in question.

[33] Source: SPSS data analysis performed by the author.
[34] Source: SPSS data analysis performed by the author.

Correlazioni

		SAT	Gender:
SAT	Correlazione di Pearson	1	-,091
	Sign. (a due code)		,364
	N	102	102
Gender:	Correlazione di Pearson	-,091	1
	Sign. (a due code)	,364	
	N	102	102

Figure 19: Correlation between participants' satisfaction and gender[35]

With regard to the fourth correlation analysis between faculty and the satisfaction, a positive Pearson correlation index of 0.136 and a p-value for the T-test of 0.174 emerged, which was not statistically significant (p-value > α/2 = 0.025), declaring the failure of the correlation in question.

Correlazioni

		SAT	Which faculty are you currently attending?
SAT	Correlazione di Pearson	1	,136
	Sign. (a due code)		,174
	N	102	102
Which faculty are you currently attending?	Correlazione di Pearson	,136	1
	Sign. (a due code)	,174	
	N	102	102

Figure 20: Correlation between participants' satisfaction and the faculty the participants attend [36]

With regard to the fifth correlation analysis between frequency and satisfaction, a positive Pearson correlation index of 0.828 and a p-value relative to the T-test of 0.001 emerged, which was statistically significant (p-value < α/2 = 0.025), decreeing a success of the correlation in question.

[35] Source: SPSS data analysis performed by the author.
[36] Source: SPSS data analysis performed by the author.

Correlazioni

		SAT	How frequently do you use applications or tools of generative artificial intelligence?
SAT	Correlazione di Pearson	1	,828**
	Sign. (a due code)		<,001
	N	102	102
How frequently do you use applications or tools of generative artificial intelligence?	Correlazione di Pearson	,828**	1
	Sign. (a due code)	<,001	
	N	102	102

**. La correlazione è significativa a livello 0,01 (a due code).

Figure 21: Correlation between participants' satisfaction and the frequency of use[37]

3.3.4.2 Significant Findings

The statistical analysis revealed several findings that shed light on how AI is currently perceived and used in education, but also what degree of satisfaction respondents have with artificial intelligence.

The data show that there is a great correlation between satisfaction and frequency. Those who make frequent use of AI-tools tend to be more satisfied than those who use them less frequently.

On the other hand, with regard to multiple linear regression analysis, optimism is the data that positively influences satisfaction, whereas mentality and insecurity are data that have a negative influence on satisfaction. This can be translated into a general satisfaction dictated by optimism, which, however, tends to be negatively influenced by a mentality that may still be narrow and insecurity in the use of artificial intelligence tools.

[37] Source: SPSS data analysis performed by the author.

The education sector and AI still have many challenges to face. We have to think about the future and stratagems that can give more confidence in the use of AI and how to open up mindsets to more people so that AI tools become part of everyone's routine.

3.4 Hackathon Project Results

This section presents the results of the hackathon, which served as a hands-on experimental component of the thesis, aiming to explore innovative AI-driven solutions for education. The hackathon brought together participants from diverse academic disciplines, challenging them to apply their theoretical understanding of AI to develop practical, real-world solutions. These projects addressed critical educational needs such as personalized learning, student engagement, and administrative efficiency. The event showcased the creative and transformative potential of AI within the educational landscape.

3.4.1 Overview of the Hackathon

The hackathon, titled "Exploring New Learning Strategies in an AI-Driven Society," was structured as a collaborative competition where participants were grouped into teams and tasked with developing AI-driven solutions that addressed challenges in education. The hackathon followed a design thinking approach, emphasizing creativity, practical application, and the future impact of AI in educational contexts.

3.4.1.1 Objectives and Goals

The primary objective of the hackathon was to foster innovation in AI applications for education. Participants were encouraged to think creatively and work collaboratively to design AI tools that could address specific problems in educational settings. The goals included: creating AI solutions to enhance personalized learning and educator support; demonstrating the feasibility and impact of these AI solutions in real educational environments and cultivating skills that will be critical in an AI-driven future, such as collaborative problem-solving and design thinking.

3.4.1.2 Structure and Format

The hackathon was structured into three main phases:

1. Understanding and Defining the Problem: Teams were introduced to the challenge and engaged in brainstorming sessions to define educational problems that AI could address.
2. Ideation and Prototyping: Participants developed their AI-driven solutions through structured design thinking activities. They created detailed project plans and prototypes based on their ideas.
3. Presentations and Evaluation: Each team presented their project to a panel of judges, who evaluated the submissions based on creativity, innovation, feasibility, and impact on education.

3.4.2 Description of Projects

The hackathon resulted in several innovative AI-driven projects. Two standout teams, GPTeam and NinjAI, developed unique solutions that demonstrated the potential of AI to transform the educational landscape.

1. GPTeam's Projects:

   "Insight AI": This project aimed to enhance the teaching and learning experience by providing personalized lesson planning tools for teachers. The AI-driven system would analyze student data to suggest lesson adjustments tailored to the needs and learning progress of individual students. It aimed to streamline the administrative workload for teachers while offering real-time insights into student performance.

   "ChronoConverse": This platform sought to bring history to life by enabling students to interact with AI-generated avatars of historical figures. By facilitating real-time conversations with these AI avatars, the platform offered a new, engaging way for students to learn about historical events and figures, making history more immersive and interactive.

2. NinjAI's Projects:

   "AI Job Interview Simulator": This project aimed to help students prepare for job interviews by providing a simulated AI-driven interview environment. The tool would allow students to practice answering questions, receiving feedback on their responses, and improving their interview skills in a controlled, low-pressure setting.

   "AI Student Assistant": This AI tool was designed to provide personalized academic support to students, particularly those with learning disabilities. It offered tailored assistance based on each student's unique learning profile, helping them navigate their academic challenges more effectively.

   "AI Adapted Assignment Developer": This project proposed an AI system that could help professors design customized assignments for students based on their individual strengths and weaknesses. By leveraging student performance data, the tool could create assignments that cater to different learning needs and encourage personalized educational growth.

These projects showcased the diverse applications of AI in education, addressing both the needs of students and educators while offering innovative solutions to enhance learning and teaching experiences.

3.4.3 Evaluation Criteria

The hackathon projects were evaluated based on four main criteria: innovation and creativity, practicality and usability, impact on education, and feedback from judges and participants.

3.4.3.1 Innovation and Creativity

The evaluation of innovation and creativity centred on the originality of the projects and their ability to offer fresh solutions to common educational challenges. Teams were encouraged to think beyond conventional methods and reimagine how education could be transformed with the help of AI.

One standout project was GPTeam's "ChronoConverse," which earned praise for its inventive approach to teaching history. By making the subject more dynamic and interactive, the project allowed students to engage with the past in a way that felt both engaging and immersive.

Another notable project was NinjAI's "AI Job Interview Simulator," which was commended for its creative application of AI to a real-world issue: helping students prepare for the job market. This tool addressed a pressing need for students and offered a practical, AI-driven solution to one of the key challenges they face as they transition into their careers.

Both projects exemplified the kind of innovative thinking that was encouraged throughout the evaluation, demonstrating how AI can be leveraged to rethink and enhance traditional educational practices.

3.4.3.2 Practicality and Usability

This criterion focused on the practicality of the projects, evaluating how well they could be implemented in real-world educational environments. The judges looked at whether these ideas could be effectively put into practice and whether they addressed genuine needs within the educational system.

One project that stood out for its practical approach was GPTeam’s "Insight AI." This tool was praised for its potential to significantly reduce the administrative workload for teachers by automating lesson planning and offering actionable insights based on student data. Its ability to streamline these tasks made it a particularly valuable solution in everyday educational settings.

Similarly, NinjAI’s "AI Student Assistant" received high praise for its potential to offer personalized support to students with learning disabilities. By addressing this critical gap in the system, the project showed a deep understanding of the needs of students who require additional support, and it presented a practical solution that could have a meaningful impact on their learning experiences.

Both projects demonstrated a strong focus on real-world applicability, showing that innovation in education is not just about creativity but also about meeting actual needs in a way that can be feasibly implemented.

3.4.3.3 Impact on Education

The potential impact on education played a key role in how the projects were evaluated. Judges looked at how each AI solution could reshape learning and teaching practices, enhance educational outcomes, and address broader challenges within the educational system.

GPTeam's "ChronoConverse" stood out for its ability to make history more engaging for students. Instead of relying on passive learning methods, the project offered an interactive and immersive experience that could help students connect with historical events in a more memorable way.

Similarly, NinjAI's "AI Adapted Assignment Developer" was recognized for its potential to revolutionize how assignments are created and customized to meet individual student needs. By offering a more personalized approach to learning, this tool could help foster deeper understanding and more effective educational experiences for students.

Both projects exemplified how AI can be harnessed to not only enhance traditional educational methods but also address the unique needs of students, ultimately creating more meaningful and impactful learning experiences.

3.4.3.4 Feedback from Judges and Participants

Both judges and participants provided valuable feedback on the projects, emphasizing the strengths and areas for improvement. Judges noted that while the projects were innovative and had significant potential, continued development and refinement would be necessary to fully realize their benefits.

Participants reflected positively on the hackathon experience, noting that it provided them with practical insights into the application of AI in education. They highlighted the

importance of collaborative problem-solving and expressed excitement about further exploring the potential of AI in educational contexts.

3.4.4 Outcomes and Insights

The hackathon produced several important results and insights, showing the potential of AI to transform educational practices and highlighting key areas for future development. Thanks to the students' active participation in the project, it was possible to get direct answers through their development of ideas, understanding what the students themselves would like in the future.

3.4.4.1 Potential for Future Development

The projects developed during the hackathon revealed significant potential for future growth and enhancement. For instance, GPTeam's "Insight AI" could be further developed by incorporating more advanced analytics and integrating with existing educational platforms. This would not only increase its capabilities but also make it easier for schools and universities to adopt and implement the tool on a larger scale.

Similarly, NinjAI's "AI Job Interview Simulator" has the potential to evolve into a comprehensive career preparation resource. By offering students more personalized feedback and refining the simulations, the tool could play a crucial role in helping students better navigate the job market and prepare for interviews with greater confidence.

These projects underscored the importance of ongoing collaboration between AI developers and educators. Ensuring that AI tools are user-friendly, effective, and aligned with the real needs of the educational community is essential for their success. It is also crucial to actively involve future users of these services to gather their feedback and insights, ensuring that the tools continue to meet their evolving needs and expectations.

3.5 Conclusion

This final section summaries the key findings of the two surveys and the hackathon, reflecting on the extended implications of AI in education while identifying potential avenues for future research and development.

3.5.1 Summary of Key Findings

The results from the two surveys and hackathon paint a picture of how AI is actually used and perceived.

During the data analysis of the two surveys, we could see how students interacted with AI tools and how their ideas influenced their usage tendencies and satisfaction. Very recurrent within the surveys was the fact that optimism was an influencing point for frequency of use and satisfaction. In fact, it could be noted that optimism is a crucial variable in the integration of AI in daily life. Furthermore, it could be seen that variables such as insecurity and critical thinking are obstacles in the satisfaction with AI-tools.

These data gave us the opportunity to do an in-depth analysis of perceptions about artificial intelligence and how frequency of use and satisfaction can be influenced both positively and negatively.

No technology is without its challenges and AI is no exception. Despite the optimism that it positively influences frequency of use and satisfaction, there are still some significant concerns that need to be addressed. Indeed, the insecurity that negatively influences these aspects is a major hurdle to overcome. There is still work to be done to convince young people, and not only them, that AI is a powerful tool to use and that with the right care it can be truly indispensable.

The hackathon highlighted the idea that innovation flourishes when people collaborate. It was clear to see, that creativity emerged during the event. Projects like "Insight AI," which tailored learning experiences to individual students, and "ChronoConverse," which engaged learners in new ways, showcased the potential of AI to make education more dynamic. Another standout was NinjAI’s "AI Job Interview Simulator," which offered a glimpse of how AI could prepare students for real-world challenges like job interviews.

These projects highlighted how AI, when developed with educators and students in mind, can go beyond just automating tasks and can truly enrich the learning experience.

3.5.2 Reflections on the Surveys and Hackathon

Both the surveys and the hackathon provided insights into the role of AI in education, each offering a unique perspective on where things stand today and what the future might hold.

The surveys attempted to paint a picture of how AI is perceived and used by students. They provided us with both quantitative and qualitative data, revealing that although AI is optimistically perceived, there are still challenges that need to be addressed.

On the other hand, the hackathon offered a more practical exploration of the potential of AI in education. It was an inspiring demonstration of what can happen when students and professionals come together to collaborate on innovative solutions. Projects that emerged from the hackathon showed the transformative power of AI when creatively applied to real-world educational challenges. The event also highlighted the importance of design thinking and interdisciplinary collaboration in developing AI tools that are not only effective, but also designed to meet the needs of educators and students.

Together, the surveys and the hackathon emphasized the importance of approaching AI in education with a broad understanding of its challenges and an open mind to its possibilities. By combining data with creative and collaborative innovation, we can better address the complexities of integrating AI into the educational landscape, maximizing its potential to enrich learning experiences.

3.5.3 Future Research Directions

This thesis paves the way for several directions in future research and development. In fact, with the topics covered in the previous chapters and through the results obtained from surveys and hackathon, there are various future directions that could be taken in improving the relationship between AI and education and its integration into it.

Firstly, the ethical use of AI in education is a critical area that needs further exploration. As AI becomes more integrated into learning environments, it's essential that we develop robust ethical frameworks to guide its use. These frameworks should address pressing concerns around bias, data privacy, and the autonomy of AI systems. Creating AI tools that are transparent and accountable will be vital to building trust among users and ensuring that AI is employed in a responsible and fair manner.

Another important avenue for future work lies in enhancing AI's capability to handle more complex educational tasks. While AI has already proven effective in managing repetitive and administrative duties, it still has a long way to go when it comes to supporting tasks that demand critical thinking, creativity, and nuanced understanding. Advancing AI's natural language processing and developing more sophisticated analytical tools will be essential steps toward enabling AI to contribute more meaningfully to deeper learning processes.

The spirit of collaboration will also be key to the successful development of AI in education. The hackathon provided a glimpse of how students, educators, and AI developers can come together to create tools that are both practical and impactful. Moving forward, we should prioritize fostering more of these collaborative environments. Initiatives like pilot projects in schools and universities, where AI tools can be tested and refined with direct input from users, will help ensure that the technology remains user-friendly and aligned with the real-world needs of education.

Lastly, there is a need for longitudinal studies that examine the long-term impact of AI on education. These studies would track how AI influences learning outcomes, student engagement, and teaching practices over time, offering a deeper and more nuanced understanding of its role in transforming the educational landscape. Such research could provide valuable insights into the sustained effects of AI and guide its ongoing integration in education.

By focusing on these areas, future research can help shape AI into a more powerful and responsible force within education, ultimately enhancing both teaching and learning experiences.

Conclusion

The integration of artificial intelligence (AI) into education marks a revolutionary shift in how teaching, learning, and administrative processes are conducted. Over recent years, the potential of AI to transform education has become increasingly obvious, particularly through generative AI technologies capable of creating personalized content and automating routine tasks. The research presented in this thesis provides a comprehensive analysis of AI's efficiency in education, its role in enhancing student engagement, and the challenges associated with its widespread adoption.

One of the most significant contributions of AI to education is its ability to provide personalized learning experiences. AI-based tutoring systems and adaptive learning platforms tailor educational content to the needs of individual students, allowing them to progress at their own speed. Tools like Duolingo, Grammarly, and Coursera have demonstrated how AI can adapt lessons based on real-time feedback, enhancing student comprehension and retention. This personalized approach benefits both students and educators by enabling more focused, efficient learning and improving overall academic outcomes. However, while AI is effective in providing customized learning paths, it is essential that these technologies complement rather than replace traditional teaching methods.

The role of human educators remains critical in the AI-integrated educational ecosystem. AI tools can offer personalized feedback and streamline administrative tasks, but they cannot replicate the emotional and social guidance provided by teachers. As the research suggests, successful AI implementation in education requires collaboration between educators, developers, and policymakers to ensure that AI tools are used effectively and ethically. Teachers play an irreplaceable role in interpreting AI-generated data, guiding students through critical thinking, and providing the human support that technology cannot deliver.

Despite the many benefits of AI in education, its integration does not come without challenges. One of the main concerns highlighted in the research is the potential for over-reliance on AI tools, which may undermine the development of critical thinking skills among students. With the ability of AI systems to generate content quickly and efficiently,

there is a risk that students may become passive recipients of information rather than active learners. Additionally, issues of academic integrity arise as students may misuse AI tools for completing assignments or generating content without truly engaging with the material. These ethical concerns need to be addressed to ensure that AI enhances, rather than diminishes, educational standards.

Another significant challenge is the issue of data privacy and bias in AI systems. AI tools rely on large datasets to function, and these datasets often contain inherent biases that can lead to unequal treatment of students. An additional concern is related to the different demographic backgrounds of the students. This aspect can easily affect the possibility of accessing to the AI tools, leading to spread the gap between different social classes or countries. Furthermore, the collection and use of personal data by AI-driven platforms raise concerns about student privacy. To mitigate these risks, educational institutions must implement strong ethical frameworks and privacy protections. Ensuring that AI systems are fair, transparent, and equitable is crucial to maintaining trust in these technologies and safeguarding the rights of students.

AI has also proven effective in boosting student engagement and motivation, particularly with adaptive learning systems and gamification. Many AI tools incorporate elements that make learning more interactive and responsive, such as real-time feedback and personalized challenges. Studies have shown that students using these AI-driven platforms are more likely to stay engaged and retain information longer. Platforms like Squirrel AI and Khan Academy, which adjust the difficulty of tasks based on student performance, have resulted in higher academic achievement and increased student satisfaction.

The surveys conducted as part of this research further demonstrate that students generally have a positive perception of AI in education. Many respondents indicated that AI tools have become an essential part of their academic routines, helping them manage workloads, improve learning efficiency, and provide valuable feedback. However, students also expressed some insecurity in the use of AI tools, highlighting how although these tools are widely used, they are still not 100% integrated into each student's routine. This balance between the benefits of AI and the need for conscious and ethical use and

more security in its use is a recurring theme in both the literature and the empirical research presented in this thesis.

In addition to the surveys, a hackathon was conducted to explore how students could apply AI in creative ways to solve educational challenges. The hackathon results showed that students are not only users of AI technologies but also active innovators. Through collaboration, they developed practical AI-driven solutions, such as tools for improving lesson planning and enhancing student assessments. These projects illustrate the growing potential of AI to transform education by empowering students to shape how these technologies are used in real-world educational settings.

In conclusion, AI holds immense potential to transform education by offering more personalized, efficient, and engaging learning experiences. However, its successful integration requires careful consideration of the ethical, social, and educational challenges associated with its use. Collaboration between educators, institutions, and AI developers is essential to ensuring that AI tools are deployed in ways that enhance learning without compromising critical thinking or academic integrity. As AI continues to evolve, ongoing research and development will be necessary to address these challenges, refine AI technologies, and ensure that education systems can harness AI's transformative power ethically and equitably. By doing so, we can create more inclusive, adaptive, and effective learning environments that benefit all students.

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