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LUIZ FELIPE ACCIOLY CAVALCANTE

ANÁLISE DO IMPACTO DA IA GENERATIVA NAS PERSPECTIVAS DE ENSINO E APRENDIZAGEM EM CONTEXTOS EDUCACIONAIS: UMA REVISÃO TERCIÁRIA DA LITERATURA

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TCC apresentado ao Curso de Sistemas de Informação da Universidade Federal de Pernambuco, como requisito para a obtenção do título de Bacharel em Sistemas de Informação.

Orientador(a): Prof. Simone Cristiane dos Santos Lima

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Aprovado em: 24/03/2025

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Analysis of the Impact of Generative AI on Teaching and Learning Perspectives in Educational Contexts: A Tertiary Literature Review

Investigating Teachers' and Students' Perceptions of Generative AI in Learning Environments

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Resumo—**A inteligência artificial generativa tem ganhado destaque significativo nos últimos anos, impulsionada por sua vasta gama de aplicações, muitas das quais ainda permanecem pouco exploradas. Um dos campos profundamente impactados pelos avanços dessa tecnologia é a educação. A integração da IA generativa em contextos educacionais traz consigo oportunidades promissoras e desafios complexos, que demandam uma análise cuidadosa e reflexiva. Este estudo mapeou o cenário temático de 13 revisões sistemáticas da literatura indexadas em bases de dados renomadas, como ERIC, Scopus, Emerald, Web of Science e IEEE Xplore, e realiza uma revisão terciária da literatura com o objetivo de sintetizar revisões sistemáticas e meta-análises existentes. O trabalho busca oferecer insights para uma utilização responsável e eficaz da IA generativa, além de abrir caminho para investigações futuras sobre seu potencial transformador no âmbito educacional.**

Abstract—Generative artificial intelligence has gained significant attention in recent years, driven by its wide range of applications, many of which remain underexplored. One of the fields profoundly impacted by advancements in this technology is education. The integration of generative AI into educational contexts presents promising opportunities and complex challenges, requiring careful and thoughtful analysis. This study mapped the thematic landscape of 13 systematic literature reviews indexed in renowned databases such as ERIC, Scopus, Emerald, Web of Science, and IEEE Xplore, and conducts a tertiary literature review aimed at synthesizing existing systematic reviews and meta-analyses. The work seeks to provide insights for the responsible and effective use of generative AI, while paving the way for future investigations into its transformative potential in education.

'CCS CONCEPTS

• Computing methodologies → Artificial intelligence;

• Applied computing → Education;

• Information systems → Learning management systems;

• Human-centered computing → Collaborative and social computing;

• Security and privacy → Social aspects of security and privacy.

KEYWORDS

systematic review; education; generative AI; impact; tertiary literature review

1 INTRODUCTION

In recent years, criticism of traditional educational models has intensified, as they remain largely unchanged since the 16th century. While many of these criticisms highlight the rigidity and lack of personalization in teaching, few effective solutions have emerged so far. However, Generative Artificial Intelligence (AI), with its vast potential for applications, has been gaining prominence as a possible catalyst for profound transformation in

education. Tools like ChatGPT, for instance, have already demonstrated the ability to personalize learning, dynamically generate content, and provide real-time feedback, adapting to the individual needs of each student [12].

Traditional education, often criticized for its rigidity and lack of personalization, struggles to address the diverse needs of learners. Generative AI, however, provides innovative solutions: tools like ChatGPT and Google Bard can translate complex content in real time, generate captions for hearing-impaired students, or adapt texts for dyslexic learners — features that would require significant effort in conventional teaching. This ability to democratize access to knowledge, combined with generating explanations in plain language (as highlighted by SS03), redefines education as an inclusive right. Yet, to fully realize this potential, it is crucial to examine the ethical and pedagogical impacts of this shift, the core aim of this research.

The integration of AI into educational environments could revolutionize how knowledge is transmitted and acquired, making education more adaptive and inclusive. With the growing demand for personalized learning and the need to prepare students for a technology-driven future, generative AI offers a promising solution to enhance the educational experience. Additionally, by providing continuous and personalized support, AI can assist both students and teachers, addressing educational gaps and improving classroom interactions [11, 12].

To assess the real impact of generative AI in education, it is essential to understand how teachers and students perceive this technology. Their views help identify the challenges and benefits of adopting AI in learning environments. In this context, our research seeks to answer the central question: "How does Generative AI impact education from the perspective of learning and teaching?"

To address this question, this article conducts a tertiary literature review, aiming to explore the existing evidence on the impact of generative AI in education, examining both opportunities and challenges.

Thus, this research aims not only to review the current state of the literature on generative AI in teaching but also to identify gaps and suggest directions for future investigations. We hope that our findings will provide valuable insights for improving pedagogical practices and contribute to a more inclusive and effective educational future.

This article is divided into 6 sections. Following this brief introduction, Section 2 discusses the context and relevance of the research, based on previous studies. Section 3 presents the methodology adopted for the tertiary review, detailing the selection and analysis criteria for the studies. Section 4 explores the review results, addressing the impact of generative AI on teaching and learning, as well as the identified challenges and opportunities. Section 5 (Key Points Overview) synthesizes the main points discussed, providing an overview of the findings. Finally, Section 6 presents the conclusions and future directions, highlighting emerging research areas and recommendations for the sustainable integration of these technologies in education.

2   Previous Studies

Recent literature has extensively explored the impact of generative AI, particularly ChatGPT and similar models, in the educational context. Studies have addressed the transformative potential of these tools in various aspects of higher education and learning, including personalized learning, content creation support, and pedagogical insights.

Several systematic reviews have investigated the impact of these technologies on teaching. A study by Bozkurt (2023) highlighted predominant themes related to interaction and communication with educational chatbots, as well as the impact of language models on teaching and learning practices [03]. Another study by Peláez-Sánchez et al. (2024) focused on the potential of language models to support the concept of Education 4.0, promoting more autonomous and collaborative learning [06].

However, ethical and pedagogical challenges have also emerged as key issues. Kumar et al. (2024) raised concerns about academic integrity and the potential negative impact on students' critical thinking abilities, raising questions about the responsible use of these technologies [07]. Zhai et al. (2024) conducted a systematic review on the effect of over-reliance on AI-based dialogue systems, indicating that excessive use can impair cognitive skills such as critical thinking and decision-making [08].

In terms of research trends, Yusuf et al. (2024) mapped 407 publications, highlighting that generative AI applications are primarily centered around four categories: pedagogical enhancement, specialized training, writing assistance, and professional development. Research gaps include the lack of studies on the impact of these tools in K-12 education and the cultural dimensions of AI adoption [05].

These findings underscore the need for balanced approaches that integrate the transformative capabilities of AI while mitigating emerging ethical and pedagogical challenges. Addressing these concerns is essential to ensuring that AI serves as an enabler of meaningful learning rather than a hindrance to critical thinking and academic integrity. By fostering responsible AI adoption, educators and policymakers can harness its potential to enhance education while preserving the fundamental principles of pedagogical development [02] [11].

3   RESEARCH METHOD

3.1. Tertiary Systematic Review (SLR) Methodology

This study was conducted following Kitchenham's guidelines for the creation of this tertiary systematic review , which is a type of literature review that synthesizes evidence from multiple secondary reviews to provide a higher-level overview of a research domain. Kitchenham's method employs rigorous activities to collect and identify studies that are truly relevant to the context of the systematic review. Therefore, this method is of crucial importance for gathering evidence that can help address the impact of generative AI on teaching and learning.
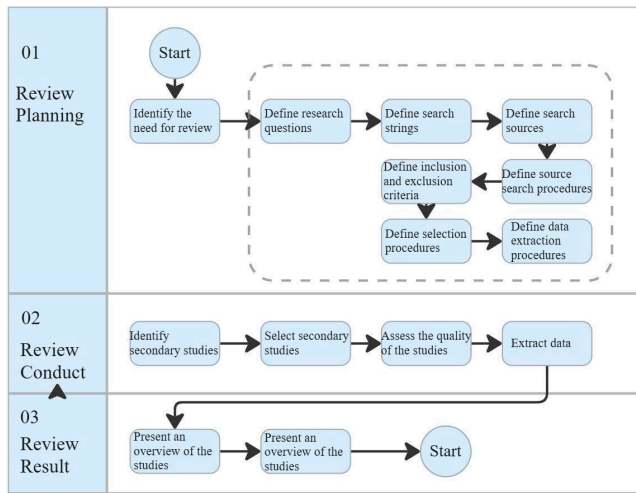

FIGURE I: REVIEW PROTOCOL FLOW. SOURCE: ADAPTED FROM KITCHENHAM (2004)

3.2   Review Planning

In the early phase of this study, the review planning establishes the groundwork for our tertiary investigation. This phase is essential for crafting a well-defined and structured methodological approach, ensuring the research remains focused and aligned with the study's objectives. During the planning stage, we formulated the core research questions that will guide our synthesis of existing systematic reviews, along with the inclusion and exclusion criteria to guarantee a thorough and relevant selection of literature. This careful planning process seeks to minimize potential biases and broaden the scope of the review, laying a strong foundation for systematically gathering and analyzing the data. The primary research question of this tertiary review is: "How does Generative AI impact education from a learning and teaching perspective?"

Supporting questions involve:

SQ1: *What is the panorama of use of generative AI in educational contexts?*

SQ2: *How does generative AI affect the way students learn?*

SQ3: *How does generative AI affect teaching?*

SQ4: *What are the challenges caused by artificial intelligence in the educational context?*

SQ5: *How can generative AI contribute to opportunities in the educational context?*

3.3   Identification

The initial phase of the tertiary systematic review process involves identifying relevant keywords to perform comprehensive searches. These keywords are then used to develop tailored search strings based on the specific search functionalities of digital libraries. This study selected the Web of Science, Scopus, IEEE Xplore, ERIC and Emerald as the primary search databases.

Search term selection was guided by an initial review of the literature related to generative AI solutions in academic settings. These searches revealed a high concentration of studies applying generative AI in educational contexts. After refining the keywords, a general search formula was established. The final search strategy, customized for the databases used, was then formulated as follows:

> ("Systematic review" OR "Systematic literature review" OR Meta-analysis OR SLR) AND (Education OR "Student Learning" OR Teaching) AND ("Generative AI" OR "Machine Learning Generation" OR LLM) AND (Impact OR Effect OR Influence OR Consequence)

When defining our keywords, we examined their distribution patterns in educational and AI-related environments, ensuring that terms such as "Generative AI" "Machine Learning" and "Education" effectively encompassed explicit and implicit concepts relevant to the focus of our study.

3.4 Conducting

All articles retrieved from the WoS, Scopus, IEEE Xplore, ERIC, and Emerald databases during the identification phase proceed to the next stage of the process. The screening phase is crucial, where publications are assessed for inclusion or exclusion based on predetermined criteria. During this stage, specific inclusion and exclusion criteria are applied to select relevant publications for tertiary review. In this study, the first exclusion criterion is articles published between 2018 and 2024, reflecting the increase in GenAI studies, especially after the public launch of ChatGPT in late 2022. The second criterion focuses on the type of document, prioritizing secondary articles. Other types, such as experimental studies, case studies, and surveys, are excluded as they are not considered secondary sources. The third criterion is related to duplicate articles, and the fourth is for articles unavailable for download or viewing. After completion of the screening process, a total of 15 systematic reviews were identified.

In the screening stage, 13 systematic review studies were conducted that met the quality criteria established for this tertiary review. These criteria are described below:

QC01 - Well-defined Methodology: The selected studies have a clear and structured methodology, allowing the reproduction and selection of the procedures adopted.

QC02 - Clear Application: The application of the proposed methods and approaches was clearly detailed, demonstrating how the results were obtained and the validity of the techniques employed.

QC03 - Well-defined Model or Proposal: The studies were concise and well-founded models or proposals, essential for understanding the results and contributions to the research area.

QC04 - Relevant and Consistent Discussions: The discussions were in-depth, relating the findings of the studies to the existing literature, ensuring consistency and relevance to the field of study.

QC05 - Research Limitations and Threats: The detailed studies also comment critically on the limitations and threats to the validity of the research, promoting a reflective and balanced view of the results presented.

This analysis of quality criteria ensured the inclusion of robust systemic studies, aligned with the objective of this review.

TABLE I: SELECTION PROCESS

Database	Collection	Exclusion	Quality
IEEE Xplore	4	0	0
Scopus	30	8	7
Emerald	58	0	0
ERIC	4	1	1
Web of Science	23	5	5
Total	119	15	**13**

The analysis of systematic literature reviews requires a clear understanding of the authors and methodological approaches employed in the selected studies. To facilitate comparison and identification of trends, Table II has been structured into four main columns: Article, Title, Authors, and Year of Publication. This organization provides an overview of the studies, highlighting the diversity of authors who have investigated the impact of generative AI in education.

TABLE II: SELECTED SECONDARIES STUDIES

Article	Title	Authors	Year of Publication
SS01	Emerging Research and Policy Themes on Academic Integrity in the Age of Chat GPT and Generative AI	Sterling Plata , Maria Ana De Guzman and Arthea Quesada	2023
SS02	Unleashing the Potential of Generative AI, Conversational Agents and Chatbots in Educational Praxis: A Systematic Review and Bibliometric Analysis of GenAI in Education	Aras Bozkurt	2023
SS03	Global insights and the impact of generative AI-ChatGPT on multidisciplinary: a systematic review and bibliometric analysis	Nauman Khan, Zahid Khan, Anis Koubaa, Muhammad Khurram Khan and Rosli bin Salleh	2024
SS04	Generative AI in education and research: A systematic mapping review	Abdullahi Yusuf,	Nasrin Pervin, Marcos Román-González and Norah Md Noor	2024
SS05	The impact of large language models on higher education: exploring the connection	Iris Cristina Peláez-Sánchez, Davis	2024

	between AI and Education 4.0	Velarde-Camaqui and Leonardo David Glasserman-Morales	
SS06	Will artificial intelligence drive the advancements in higher education? A tri-phased exploration	Satish Kumar, Purnima Rao, Shubham Singhania, Shubhangi Verma and Myra Kheterpal	2024
SS07	The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review	Chunpeng Zhai1 , Santoso Wibowo and Lily D. Li	2024
SS08	Artificial intelligence in applied (linguistics): a content analysis and future prospects	Obied Alaqlobi, Ahmed Alduais, Fawaz Qasem and Muhammad Alasmari	2024
SS09	Decision-Making Framework for the Utilization of Generative Artificial Intelligence in Education: A Case Study of ChatGPT	Umar Ali Bukar, MD. Shohel Sayeed, Siti Fatimah Abdul Razak, Sumendra Yogarayan and Radhwan Sneesl	2024
SS10	Generative AI Solutions for Faculty and Students: A Review of Literature and Roadmap for Future Research.	Giulio F. Marchena Sekli, Amy Godo and José Carlos Véliz	2024
SS11	Factors Affecting the Effectiveness of Generative Artificial Intelligence Apps on University Students' Programming Language Learning in Sri Lanka: A Systematic Literature Review	K. G. D. K. Perera, J. Wijayanayake and J. Prasadika	2024
SS12	A systematic review of large language models and their implications in medical education	Harrison C. Lucas, Jeffrey S. Upperman and Jamie R. Robinson	2024
SS13	Empowering Learners with ChatGPT: Insights from a Systematic Literature Exploration	Laila Mohebi.	2024

The concentration in Table II of studies in 2024 demonstrates the growing relevance of the topic and the widespread use of the systematic literature review method. By organizing the studies in this way, the table not only facilitates the identification of key researchers and their contributions but also serves as a reference for future investigations seeking to build on the established foundations.

Table III provides an overview of the number of primary studies utilized by each secondary study analyzed in this tertiary review. The table is organized into two main columns: Study ID, which identifies each secondary study, and Number of Primary Studies,

which indicates the quantity of primary sources reviewed in each study.

TABLE III: PURPOSE OF USING TECHNOLOGIES BY ANALYZED

Article	Primary Studies
SS01	37
SS02	513
SS03	1161
SS04	407
SS05	83
SS06	89
SS07	14
SS08	73
SS09	41
SS10	44
SS11	47
SS12	40
SS13	32

This structure allows for a quantitative analysis of the scope and breadth of the included systematic reviews, highlighting the depth and extent of the investigations conducted. By mapping this relationship, the table offers insights into the methodological robustness of the secondary studies and their contribution to understanding the impact of generative AI in education.

To ensure transparency and allow for the verification of the data used in this study, we provide access to the spreadsheet containing the results of the analyzed studies. The file can be accessed at the following link: [Tabulation of results]. This spreadsheet includes detailed references to the studies considered, as well as the metrics used in the analysis.

3.5 Limitations, Opportunities and Challenges

The emergence of Generative Artificial Intelligence (GenAI) has garnered significant attention from researchers, educational institutions, policymakers, and the general public. However, despite the growing volume of research since the rise of GenAI in educational contexts, the number of available systematic reviews remains limited, primarily due to the rigorous review protocols required. This gap represents a valuable opportunity for new review studies to be conducted, aiming to identify future trends and deepen the understanding of GenAI's impact on education.

The review identified a significant gap: only 15% of the studies (SS04, SS05) address the impact of AI on primary education. Future research should investigate how tools like ChatGPT can be

adapted for younger age groups, considering cognitive development and adult supervision. Studies such as SS07 and SS09 reveal that unequal access to AI may widen educational disparities, especially in regions with poor digital infrastructure. The implementation of digital inclusion policies (e.g., subsidies for devices) is crucial to prevent AI from deepening existing inequalities.

Among the research opportunities, investigating cultural influences on the adoption of GenAI and analyzing its impacts to inform public policies and funding decisions stand out. Most of the reviewed articles highlighted ethical concerns related to the use of these technologies, such as privacy issues, algorithmic bias, and academic integrity. Therefore, it is crucial for educational institutions to establish clear ethical guidelines to promote the responsible use of GenAI, ensuring that its applications benefit both students and educators.

In addition to traditional methodologies, Artificial Intelligence (AI) tools were employed to assist in data analysis and result organization, aiming to optimize the precision and comprehensiveness of the research. NotebookLM was used to facilitate the contextual analysis of secondary studies, ensuring that specific excerpts addressed the proposed research questions. For instance, to verify whether a particular study answered a specific research question, a document called "Data Collection X" was created, and the following prompt was used:

> *According to the collection of studies by ID, provide context on why this collection answers research question X.*

DeepSeek was instrumental in contextualizing key points from the studies, while ChatGPT was utilized for creating graphs and data visualizations. For example, to create a chart showing the usage rate of generative AI technologies across secondary studies, the information was collected and organized, and the following prompt was used:

> *Technology 'N' was exposed in Y% of studies, technology M was exposed in Z% of studies... generate a pie chart.*

These tools not only streamlined the analysis process but also contributed to a clearer and more visual interpretation of the data, reinforcing the methodological robustness of this tertiary review.

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4 Results

4.1. What is the panorama of use of generative AI in educational contexts?

The examined studies reveal a diverse array of generative AI technologies employed across different educational

contexts, showcasing a range of applications from personalized learning platforms to intelligent tutoring systems. Notably, studies such as SS04, SS10, and SS12 demonstrate effective integration of AI tools in enhancing student engagement and adaptive learning experiences. However, a critical review of studies SS06 and SS07 exposes significant gaps in the documentation of specific technologies, their implementation strategies, and measurable outcomes. This lack of clarity complicates efforts to assess the overall impact of generative AI in education and hinders the potential for these methodologies to be replicated or scaled in other settings.

4.1.1. AI Technologies

For this analysis, we identified a notable prevalence of studies that expose the use of generative AI technologies in education, as illustrated in Figure III. For example, study SS02 emphasized the use of ChatGPT, Bard, Bing Chat, and Ernie, which can serve as valuable tools for higher education courses. In addition, studies SS05 and SS11 explored the use of ChatGPT, Open Assistant, DALL-E, Midjourney, and Github Copilot in interactive learning environments, demonstrating their effectiveness in promoting engagement and deep learning across a variety of educational disciplines. All technologies used in the analyzed studies are demonstrated in Figure II.
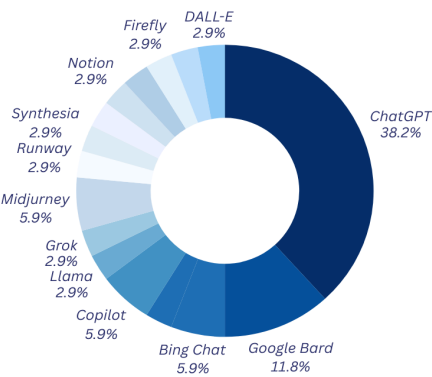

FIGURE II: TECHNOLOGIES USED

4.1.2. Educational Levels

The studies analyzed reveal a predominance of research in education as a whole, representing the majority of the levels evaluated, as shown in Figure II. This level is often the focus of investigations on the use of generative AI technologies for student development. In contrast, undergraduate and graduate studies (SS01, SS06, SS07, SS08, SS11 and SS12) emphasize the use of 4 specific technologies: ChatGPT, Google Bard, Bing and Firely, highlighting their relevance in higher education. Technical education (SS11) was less explored, with a focus on the integration of technologies such as: ChatGPT, Google Bard, Microsoft Bing and Github Copilot for professional education environments.
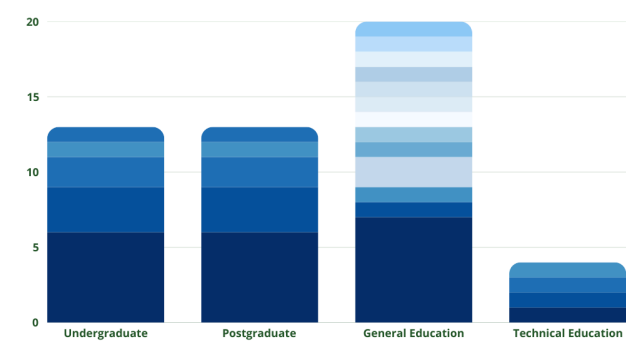

FIGURE IV: CORRELATION BETWEEN COURSES AND TECHNOLOGIES

FIGURE III: CORRELATION BETWEEN EDUCATIONAL LEVELS AND TECHNOLOGIES

4.1.3 Courses

The following chart provides a visual representation of the various courses associated with different generative AI technologies employed in educational settings. For this analysis, most of the studies do not specify a specific subject area, as shown in the chart, with emphasis on studies SS01, SS02, SS03, SS05, SS09, SS10, and SS13. Additionally, it illustrates how these technologies are integrated into medical, business, technology, and engineering courses by highlighting the prevalence of specific technologies in specific fields of study. By examining this data, we can gain valuable insights into the educational contexts where generative AI is making a significant impact, as well as identify trends and opportunities for future research and applications.
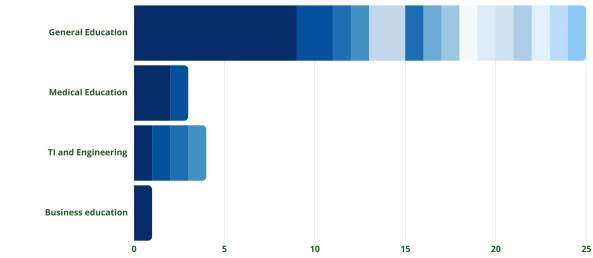
4.1.4. Purpose of AI use

The analyzed studies highlighted a range of purposes for utilizing generative AI technologies in educational contexts. These purposes encompass various applications, including smart chatbots, custom content generators, education virtual assistants, adaptive learning platforms, learning style analysis, language learning support, and automated tutoring. Table IV summarizes the studies that are associated with each of these purposes, providing insights into how these technologies are being implemented to enhance educational experiences and outcomes.

TABLE IV: PURPOSE OF USING TECHNOLOGIES BY ANALYZED

PURPOSE OF USE	STUDY
Smart Chatbots	SS02, SS08, SS09
Custom Content Generators	SS01, SS10, SS12
Education Virtual Assistants	SS02, SS03, SS05, SS06, SS07, SS08, SS10, SS11, SS13
Adaptive Learning Platforms	SS05, SS11
Learning Style Analysis	SS05
Language Learning Support	SS08
Automated Tutoring	SS01, SS11

Smart chatbots are advanced digital tools designed to simulate human-like interactions, offering solutions, information, and support through automated conversations. Examples include ChatGPT, Google Bard, and Microsoft Copilot. In education, these systems are highly versatile,

serving as virtual tutors, assisting in personalized learning, and providing instant feedback to students. Examples include SS02, SS08 and SS09. They can adapt to different teaching methodologies, such as problem-based learning (PBL), by facilitating research, critical thinking, and collaboration. Their ability to learn and improve over time ensures a broad range of possibilities, making them valuable tools for enhancing engagement and accessibility in educational environments.

In study SS02, Rudolph, Tan, and Tan conducted a comparative analysis of chatbots Bard, Bing Chat, ChatGPT, and Ernie, exploring the impact of the so-called "AI gold rush" on higher education. The authors highlight how the rapid evolution of these technologies is transforming education, offering new possibilities for personalized learning, research support, and the automation of administrative tasks. However, they also warn of ethical and pedagogical challenges, such as the need to ensure the accuracy of information, prevent misuse by students, and rethink the role of educators in an increasingly AI-driven landscape. The research emphasizes that while these chatbots have the potential to enhance efficiency and accessibility in higher education, it is crucial to develop clear guidelines for their responsible integration, ensuring that technology complements, rather than replaces, critical thinking and human creativity.

The studies SS01, SS10, and SS12 explore the use of personalized **content generators in education**, highlighting their transformative potential in creating tailored learning materials. These tools leverage artificial intelligence to adapt content to individual student needs, enhancing engagement and comprehension. Applications include the creation of presentation slides, the formulation of essays and multiple-choice questions, and the development of customized content based on students' understanding levels, as evidenced in SS10. For instance, AI-driven platforms can analyze a student's learning pace and style, generating resources that align with their specific strengths and weaknesses. This personalization not only supports differentiated instruction but also empowers educators to focus on higher-order teaching tasks, such as mentoring and fostering critical thinking. However, the studies also emphasize the importance of balancing automation with human oversight to ensure the quality and relevance of the generated content, ultimately creating a more dynamic and inclusive educational environment.

The studies SS02, SS03, SS05, SS06, SS07, SS08, SS10, SS11, and SS13 focus on the role of **virtual education assistants** in transforming the educational landscape. In SS10, the study highlights the development of EduChat, a GenAI-powered chatbot designed to handle university-related inquiries, particularly benefiting administrative tasks. EduChat was created by analyzing 625 text messages from student interactions, involving academic advisors and staff from two Vietnamese universities. By combining rule-based methods with an enhanced machine learning approach, using an advanced random forest algorithm integrated with ChatGPT, the chatbot effectively addresses common questions about academic programs, admission processes, student life, and more. This innovation streamlines administrative efficiency and improves student support.

Additionally, SS05 emphasizes the potential of Large Language Models (LLMs) to enhance interactive, collaborative, and autonomous learning, aligning with the principles of cyber pedagogy and the framework of Education 4.0. These models foster personalized and adaptive learning experiences, preparing students for a technology-driven future while promoting critical thinking and self-directed learning.

The studies SS05 and SS11 explore the significance of **Adaptive Learning Platforms** in education, emphasizing their role in personalizing learning experiences to meet individual student needs. These platforms leverage artificial intelligence to adjust content, pace, and teaching methods based on real-time data, enhancing engagement and improving learning outcomes. By catering to diverse learning styles and abilities, adaptive learning fosters inclusivity and supports self-directed learning, making it a cornerstone of modern educational strategies.

In SS11, the study highlighted that while most research focuses on a single type of learning, one investigation specifically examined how students used three different platforms for teaching introductory programming courses: e-learning, m-learning, and game-based learning. The results showed that students were more likely to use these platforms when they perceived them as easy to use and useful. Additionally, the study found that students' actual use of the platforms was strongly influenced by their positive intentions toward them. Ease of use and utility positively impacted students' behavioral intentions to engage with all three platforms.

The study also underscored motivation as a central factor in work-based learning (WBL), revealing that attitude, anxiety, and motivation significantly influence student performance. Motivation, in particular, plays a crucial role. The research further described the range of skills required for learning programming, including the ability to follow, trace, and tinker with code, as well as problem-solving skills. These findings align with the Technology Acceptance Model (TAM), which suggests that user motivation is influenced by perceived ease of use, perceived usefulness, and other factors such as social interaction and attitudes toward using a system. This highlights the importance of designing adaptive learning platforms that are not only functional but also intuitive and engaging to maximize student adoption and success.

The study SS05 discusses **Learning Style Analysis**, emphasizing its importance in education as a tool to identify and cater to the diverse ways students process and retain information. By understanding individual learning preferences—such as visual, auditory, or kinesthetic—educators can tailor teaching methods and materials to better align with students' needs. This personalized approach enhances engagement, improves comprehension, and fosters a more inclusive and effective learning environment, ultimately supporting better academic outcomes.

In SS08, the study addresses **Language Learning Support**, highlighting the integration of technology and AI in applied linguistics, including education, as a significant advancement in English language teaching and learning. The use of AI tools, such as ChatGPT, in language education has been widely recognized and recently emphasized. The study underscores ChatGPT's role in providing authentic texts and personalizing content for language learners, enhancing their engagement and metalinguistic awareness by reflecting the complexities of 'meta' language aspects. However, while ChatGPT is a valuable tool for language teaching, it cannot replace human qualities like humor and empathy. The study also identifies gaps in learning optimization and knowledge understanding, emphasizing the need for a balanced approach that combines AI support with human interaction to maximize language learning outcomes.

Automated tutoring plays a crucial role in modern education, especially with the advancement of technology and the diversification of teaching methods. It allows for a personalized learning experience, supports a larger number of students simultaneously, and provides instant feedback—something that would be unfeasible with traditional tutoring.

The SS11 study highlights that many previous studies focused on only one type of learning. However, the analysis of students using three different platforms—e-learning, m-learning, and game-based learning—demonstrates the importance of automated tutoring in adapting to different learning styles and needs. This diversified approach enables a more dynamic and effective learning experience, leveraging the specific advantages of each platform.

4.2 How does generative AI affect how students learn?

The integration of generative Artificial Intelligence (AI) into the educational landscape has brought about a significant transformation in the way students learn. Recent studies have shown that AI not only offers new tools and pedagogical approaches, but also challenges traditional teaching and learning methodologies. AI's ability to generate texts, personalize learning, and provide immediate feedback brings as many benefits as concerns about its impact on education.

The research reviewed reveals a wide range of impacts of generative AI on learning practices, demonstrating how AI is being used in a variety of educational contexts and impacting the way students acquire knowledge. Studies such as SS04, SS10, and SS12 indicate effective integration of AI tools to promote student engagement and adaptive learning experiences. However, a critical analysis of studies such as SS06 and SS07 reveals significant gaps in the documentation of how these technologies are implemented and their measurable outcomes. This lack of clarity makes it difficult to assess the overall impact of generative AI in education and limits the potential for replication or expansion of these methodologies to other settings.

4.2.1 Applications of Generative AI in Learning: Focus on Perceived Benefits

The secondary studies reviewed point to several benefits of generative AI for student learning, as shown in figure V. It is important to note that some studies emphasize multiple benefits. Personalized learning is one of the most cited benefits, appearing in several of the studies reviewed, such as SS06, SS09, and SS13. Generative AI has the ability to tailor instruction to the pace, needs, and interests of each student, offering additional support in specific areas and making the educational experience more welcoming to a wider range of students (SS06, SS09, SS13). AI can also provide personalized, real-time feedback on student performance, helping students identify their weaknesses. This is especially useful in programming, where AI can provide instant feedback on code (SS01, SS11).
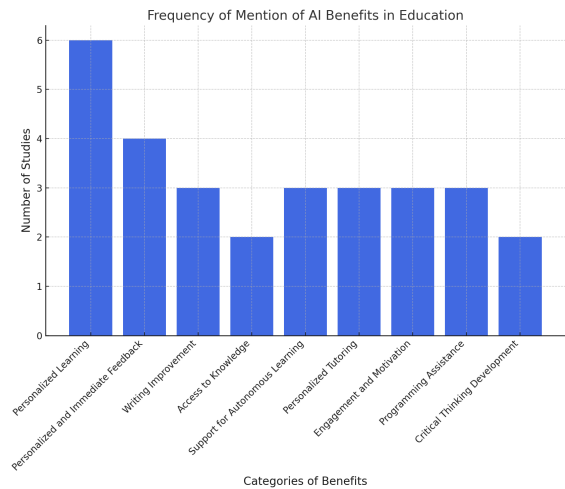

FIGURE V: FREQUENCY OF MENTION OF AI BENEFITS IN EDUCATION

Figure V illustrates the frequency with which different benefits of AI are mentioned in the studies analyzed (SS01-SS13). This allows us to identify which aspects of generative AI are most valued in education, such as personalizing teaching and supporting autonomous learning. The graph also allows us to compare the different impacts of AI on learning. It is important to note that, although AI has several benefits, some are explored more in the literature than others, which may indicate gaps for future research (SS01-SS13).

One important benefit noted is improved academic writing, with AI helping with accuracy, style, and formatting of texts, as well as contributing to students' self-confidence in their writing skills (SS07, SS10, SS12). AI tools can assist students in writing, assessing their quality, and identifying areas for improvement. In one study, AI was shown to be able to complement teacher assessments of academic writing (SS07, SS10, SS12).

Another important aspect is the immediate access to a vast amount of information and scholarship, allowing students to explore content quickly and efficiently (SS05, SS12). It can enhance critical thinking, especially when used to refine AI-generated outputs. For example, college students can use AI to create a business plan and then refine that plan, improving their writing skills (SS06, SS10). Additionally, by generating complex scenarios, AI allows students to engage in brainstorming sessions, which contributes to the development of cognitive skills (SS06, SS10). The use of AI can also enhance students' ability to formulate questions, evaluate information, and understand complex subjects.

Generative AI also plays a key role in supporting autonomous learning, encouraging self-study and allowing students to progress at their own pace, according to their individual needs (SS03, SS05, SS13). AI-based tools can also pose questions that encourage independent learning. Furthermore, the personalized tutoring offered by these systems stands out, providing detailed explanations, clarifying doubts, and guidance on complex topics, acting as virtual tutors (SS03, SS06). Students can use AI to conduct research, including information gathering, literature synthesis, and text editing. AI can also help in the development of concepts and data interpretation, which facilitates the research process (SS03, SS05, SS13).

Student engagement and motivation are also favored by the use of AI, mainly through gamification resources and the creation of interactive narratives, which make learning more dynamic and engaging (SS04, SS06). In the field of programming, AI proves to be an important ally, helping students with little or no experience to solve problems, debug errors, and obtain support in various programming languages (SS04, SS11, SS13). In studies, students who used AI to learn programming demonstrated greater computational thinking skills, self-efficacy, and motivation (SS04, SS11, SS13).

4.2.2 Student Perspective

Students see generative AI, such as ChatGPT, as a useful tool for independent learning. AI supports self-study, allowing students to explore topics at their own pace and clarify doubts without relying solely on teachers (SS03, SS09, SS13). Generative AI is seen as a digital tutor, capable of providing personalized assistance.

The ability to get quick and accurate answers to questions and the reduction in time spent on research are perceived as significant advantages (SS03, SS09, SS13). Studies have highlighted that language models such as ChatGPT can be very beneficial from the perspective of medical students, demonstrating competence in standardized clinical exams (SS04, SS12). These models provide immediate access to medical knowledge, research studies, and clinical guidelines, helping students manage complex clinical projects. AI can assist medical students and educators with writing accuracy, improving the style and format of texts, and ensuring the appropriate use of language and terminology (SS04, SS12).

Mechanical engineering students have used GPT-3 to write lab reports and Codex to automate control systems labs, exploring predictions from tasks completed with AI tools (SS10). Additionally, master's and doctoral students have used ChatGPT in research projects for personalized tutoring, language editing, brainstorming, and concept development (SS10).

Student attitudes toward generative AI vary. Some are open-minded, viewing the technology as a learning opportunity, while others are more cautious, seeing the benefits but also the potential risks (SS06, SS09). Most students demonstrate cautious rational optimism toward generative AI (SS02, SS06, SS09).

While many students view AI as a useful tool, there are also concerns about the inappropriate use of the technology. The possibility of plagiarism and over-reliance on AI to the detriment of developing critical thinking are some of the issues raised by students (SS01, SS02, SS03, SS09). Students have also expressed concerns about the accuracy of data and the reliability of AI-generated content. Additionally, some students may experience anxiety about the accessibility and use of the technology (SS02). It is important to note that students' perspectives on generative AI are complex and multifaceted, involving both recognition of the benefits and concern about potential risks (SS01, SS02, SS03, SS09).

4.3 How artificial intelligence affect the teaching?

The integration of Artificial Intelligence (AI) into education has significantly transformed not only the way students learn but also the way educators teach. AI offers a diverse range of tools and pedagogical approaches that can enhance teachers' work, from creating teaching materials to monitoring individualized student progress. Studies such as SS08 and SS10 illustrate how AI can assist in the creation of quizzes, lesson plans, content, and hands-on activities for a variety of subjects (SS08, SS10). This section will explore the various facets of this impact, analyzing how AI is reshaping the role of the educator by personalizing teaching, and the challenges and ethical considerations that emerge with this transformation.

The following analysis is structured into topics that detail the impact of AI on the role of the teacher, the use of AI for personalizing teaching and student support, and the challenges and ethical considerations in the use of AI in teaching. Studies such as SS12 and SS06 will also be referenced in relation to reducing the administrative and teaching burden on educators (SS12, SS06). Studies such as SS04, SS10, and SS12 illustrate the use of AI tools to promote engagement and adaptive learning (SS04, SS10, SS12). Finally, studies such as SS07 raise questions about originality, critical thinking, and ethical standards in the use of AI (SS07).

4.3.1 Impact of Generative AI on the Role of the Teacher

Generative artificial intelligence (AI) is transforming the traditional role of the teacher, who is now more of a facilitator of learning than a mere transmitter of knowledge. AI provides tools that can automate administrative and teaching tasks, allowing educators to focus on more complex and personalized activities. This shift does not mean that teachers are being replaced by technology, but rather that their roles and responsibilities are being redefined.

One of the main changes is the reduction of the administrative burden on teachers. AI tools can help with the creation of teaching materials such as lesson plans, presentations, quizzes, and exercises. Studies such as SS08 and SS10 demonstrate how ChatGPT can be used to generate these resources, freeing up time for teachers to focus on other activities (SS08, SS10).

AI can also help assess student work by providing early feedback. This not only reduces the time spent grading papers but also allows teachers to provide faster and more personalized feedback to students. According to SS03, Large Language Models (LLMs) have the potential to provide preliminary feedback before supervisor review, supporting students' psychological needs and improving the quality of feedback (SS03). With AI managing routine tasks, teachers can focus on one-on-one mentoring, developing new teaching techniques, and creating more meaningful learning experiences for students.

AI can help alleviate the shortage of educators, especially in resource-constrained settings. By automating tasks and providing support, AI allows teachers to spend more time mentoring students one-on-one. The teacher becomes a facilitator and guide, guiding students through the use of technology and developing critical thinking skills. SS12 discusses how LLMs can help reduce the shortage of educators, particularly in resource-limited environments, and provide more time for educators to focus on individual student mentoring (SS12).

Educators need to become digitally literate to use AI tools ethically and effectively. This includes the ability to use prompts appropriately and assess the quality of AI-generated content. SS06 emphasizes the need for ethical and effective use of AI tools by digitally competent teachers and students (SS06). AI can help teachers develop curricula and objectively assess students. Interaction between teachers and students becomes more personalized and focused on individual needs, as AI provides detailed information about each student's progress.

4.3.2 AI Tools and Technologies for Educators

In addition to transforming the role of the teacher, Artificial Intelligence (AI) offers a diverse range of tools and technologies that can optimize the work of educators. This subtopic explores the main AI technologies available, detailing their functionalities and practical applications in the educational context. The goal is to provide educators with a comprehensive overview of the tools that can assist in lesson planning, creating teaching materials, assessing students, and personalizing teaching, complementing the previous discussion on the impact of AI on the role of the teacher. Among these tools, intelligent chatbots such as ChatGPT, Bard, Bing Chat, and Ernie stand out, which play a fundamental role in modernizing teaching and supporting learning.

OpenAI's ChatGPT is widely used in education due to its ability to understand and generate cohesive and contextualized texts. It can assist teachers in creating teaching materials such as detailed lesson plans, presentations, and interactive exercises. SS08 highlights that ChatGPT can help teachers develop quizzes, exams, lesson plans, presentations, and other resources (SS08). Additionally, it can answer student questions in a clear and adaptive way, providing explanations at different levels of complexity, depending on the needs of each student.

Bard, developed by Google, is an AI designed to provide answers based on up-to-date research and integrated with the web, which makes it a valuable tool to help develop educational content based on recent information. Although no specific study highlights Bard, its utility aligns with the need for maintaining updated content in educational settings.

Microsoft's Bing Chat combines the power of generative AI with real-time search capabilities, allowing students and teachers to access verified and contextualized information during their educational activities. Its distinguishing feature is its ability to respond with direct references, helping to validate content and develop students' analytical skills.

Baidu's Ernie is an AI that excels in supporting language teaching and understanding more in-depth content, being an excellent tool for language classes and interdisciplinary studies. SS10 explores the use of GenAI to explain grammatical concepts and enhance writing skills, which aligns with Ernie's capabilities (SS10). It can be used for translation practices, vocabulary learning, and dialogue simulations, helping students improve their language skills in an interactive way.

In addition to these applications, chatbots can act as virtual tutors, offering personalized support to students and helping with research and development of complex concepts. In language teaching, for example, they can be used to simulate dialogues and role-playing, creating immersive experiences that promote practice and fluency. In this way, these AIs not only complement the teacher's work but also contribute to making teaching more dynamic, accessible, and efficient.

In addition to intelligent chatbots, other AI technologies play a crucial role in personalizing education and creating interactive learning materials. Tools such as DALL-E and Midjourney enable the generation of custom visual content, allowing educators to create images tailored to the pedagogical needs of each subject. SS10 mentions the use of GenAI to create diverse materials, such as presentation slides and personalized content (SS10). These images can be incorporated into presentations, teaching materials, interactive activities, and even visual simulations to help illustrate abstract concepts, such as scientific phenomena, anatomical structures, or historical settings. The use of these technologies makes learning more dynamic and accessible, especially for students who struggle with traditional text-based materials.

In the field of adaptive learning, platforms using intelligent tutoring systems are revolutionizing education by providing real-time, individualized support. These platforms analyze student performance and automatically adjust content and learning pace based on individual needs. SS01 indicates that GenAI technologies can capture student learning data and enable interactions for more adaptable digital environments (SS01). Such

tools are widely used in programming education, enabling students to receive instant feedback on their code, suggestions for improvement, and best practice recommendations in various programming languages. A practical example is GitHub Copilot, which acts as an AI-powered coding assistant, helping students and professionals write more efficient code, debug errors, and understand complex programming concepts.

AI is also a powerful ally in educational assessment and automated feedback. Intelligent tools can grade essays, analyze text coherence, and offer detailed suggestions to improve students' writing. SS03 highlights the potential of LLMs to provide preliminary feedback, and SS10 mentions the use of GPT-3 to categorize responses to open-ended questions and examine the role of ChatGPT in supporting teacher feedback (SS03, SS10). Additionally, automated analysis of student performance helps identify learning patterns and recurring difficulties, allowing teachers to intervene more effectively. This not only saves time on grading but also promotes personalized learning, addressing each student's specific needs.

In language learning, AI technologies serve a dual role: conversation simulations and linguistic development support. Advanced chatbots can conduct realistic dialogues, allowing students to practice conversations in a safe and adaptive environment. SS10 explores the use of GenAI to enhance writing skills and practice communication through role-playing with ChatGPT support (SS10). Additionally, AI-powered tools can correct grammar, analyze texts, and generate customized content to aid comprehension and writing. These applications make language learning more immersive and effective, reducing barriers for those seeking fluency.

Despite the advancements and benefits of AI in education, challenges remain. Studies indicate gaps in the documentation of some of these technologies, including details about their implementation strategies and measurable impact on learning. This makes it difficult to successfully replicate these methodologies in different educational contexts, highlighting the need for further research and the development of clear guidelines for integrating these tools.

Despite the advancements and benefits of AI in education, challenges remain. Studies indicate gaps in the documentation of some of these technologies, including details about their implementation strategies and measurable impact on learning. SS03 calls for more research on the effectiveness of prompt engineering and the need to address potential flaws, biases, and ethical concerns of LLM AI in education (SS03). SS04 points to opportunities for further review studies to uncover future trends (SS04). This makes it difficult to successfully replicate these methodologies in different educational contexts, highlighting the

need for further research and the development of clear guidelines for integrating these tools.

AI technologies are already widely used at all levels of education, from primary education to higher and technical education. Some tools, such as ChatGPT, Google Bard, Bing Chat, and Firefly, have been particularly popular in higher education, where they are employed for academic research, content generation, and knowledge development. However, their potential extends to various fields, making AI a valuable ally for the future of education.

As these technologies continue to evolve, it is essential for educators, institutions, and researchers to explore innovative ways to integrate them into the educational process. AI does not replace teachers but enhances their capabilities, enabling a more personalized, interactive, and efficient approach. The combination of human expertise and artificial intelligence has the potential to transform education, making it more accessible, inclusive, and tailored to the needs of the 21st century.

4.3.3 Classroom Teaching Mediation Strategies with Generative AI

The integration of generative AI in education requires a redefinition of the teacher's role, shifting them to a critical mediator between technology and learning. Systematic studies reviewed in this research highlight practical strategies adopted by educators to ensure the effective pedagogical use of these tools. Table V lists some of the cited strategies.

TABLE V: TEACHER MEDIATION STRATEGIES WITH GENERATIVE AI

Strategy	Study	Teacher's Action	Student Skills Developed
Supervised role-play	SS10	Prompt modeling + response analysis	Contextual communication and critical thinking
Two-stage assessment	SS05	Debate on AI biases and accuracy	Comparative analysis and autonomy
Rubrics for AI-generated text analysis	SS08	Criteria creation for content evaluation	Linguistic metacognition and curation
Explicit prompt modeling	SS13	Structured command design for AI interaction	Self-efficacy and strategic tool use

The supervised role-play strategy, documented in SS10, shows how language teachers used ChatGPT to create realistic dialogue simulations (e.g., medical consultations, business negotiations). Educators modeled specific prompts (e.g., "Act as a dissatisfied customer in a store") and guided students in critically analyzing AI outputs, identifying errors or areas for improvement. This approach not only enhanced communicative practice but also strengthened students' ability to interact with technology as collaborative learning partners (SS10).

In SS05, instructors implemented a two-phase evaluation model to counter passive AI reliance. Students first used ChatGPT to generate answers to complex questions, then engaged in group discussions to assess the accuracy, sources, and potential biases of AI outputs. This "generate-validate-debate" approach fostered critical thinking and reduced uncritical acceptance of automated content (SS05).

Applied linguistics educators (SS08) developed detailed rubrics to evaluate AI-produced texts, including criteria like logical coherence, cultural bias, and pedagogical appropriateness. Students applied these rubrics in exercises, learning to discern between reliable and superficial content. This practice cultivated linguistic metacognition—the ability to analyze automated texts' nuances—while training students as information curators in an AI-driven content landscape (SS08).

The explicit prompt modeling strategy (SS13) involved creating structured commands to guide AI interactions (e.g., "Ask ChatGPT to explain evolutionary theory to 10-year-olds and evaluate its clarity"). Teachers demonstrated how iterative prompt refinement could yield more targeted outputs. This approach boosted student self-efficacy, encouraging intentional rather than superficial AI use (SS13).

The strategies from SS05, SS08, SS10, and SS13 demonstrate that generative AI does not replace teachers but requires their expert mediation to become an effective pedagogical tool. Whether through prompt modeling, peer critique of AI outputs, or evaluative rubrics, educators emerge as facilitators, curators, and learning designers. These practices mitigate risks like plagiarism and overreliance while cultivating 21st-century skills—critical thinking, information literacy, and autonomy. Successful implementation, however, hinges on teacher training and curriculum adaptation, themes explored in the following section.

4.4 What are the challenges caused by artificial intelligence in the educational context?

The integration of generative artificial intelligence (AI) in education has the potential to significantly transform teaching and learning by offering opportunities to personalize educational experiences and expand access to knowledge. However, this evolution also brings complex challenges that require careful analysis. The secondary studies reviewed in this research highlight a series of concerns that must be addressed to ensure that AI is implemented ethically, effectively, and equitably in the educational context (SS01, SS04, SS05, SS06, SS07, SS09, SS10, SS12).

In addition to its benefits, such as personalized content generation and learning support, the identified challenges include academic integrity, the reliability of AI-generated content, social and equity implications, and difficulties in implementing and integrating these technologies into educational environments. Among the main obstacles are the risks of plagiarism and excessive reliance on AI (SS04, SS06, SS07, SS09, SS10), the dissemination of inaccurate or biased information (SS03, SS04, SS06, SS07, SS09, SS10, SS13), the need to ensure data privacy and security (SS03, SS04, SS06, SS07, SS09, SS12, SS13), and the importance of training educators and students to use these tools responsibly (SS01, SS04, SS11, SS13).

The studies also emphasize the urgency of establishing clear regulations and guidelines for the use of AI in education (SS01, SS05, SS06, SS09), the importance of developing critical thinking skills to address the challenges posed by these technologies (SS01, SS04, SS06, SS07, SS09, SS10, SS11, SS12), and the necessity of promoting equity in access to these resources (SS07, SS09). Given this context, the following analysis explores in detail the key challenges of generative AI in education, highlighting its implications and potential approaches for mitigation.

4.4.1 Challenges Implementing IA in Academic Contexts

For this question, we identified a total of 11 studies that discussed any challenge caused by AI in academic context and 15 relevant themes were found in common to other studies, plus a number of miscellaneous themes that were mentioned once in any article, totalling 16 challenges investigated that can be found in Table V.

TABLE VI: CHALLENGES IMPLEMENTING GENERATIVE AI IN ACADEMIC CONTEXTS

Challenges Implementing Generative AI in Academic Contexts	Total (%)	Studies
Accuracy and Reliability	69,2%	SS01, SS04, SS05, SS06, SS07, SS09, SS10, SS11, SS12
Over Dependence and Skill Erosion	61,5%	SS01, SS04, SS06, SS07, SS09, SS10, SS11, SS12
Biases	53,8%	SS03, SS04, SS06, SS07, SS09, SS10, SS13
Privacy and Security	53,8%	SS03, SS04, SS06, SS07, SS09, SS12, SS13
Academic Integrity	38,4%	SS04, SS05, SS09, SS10, SS12
Plagiarism	38,4%	SS04, SS06, SS07, SS09, SS10
Educator Preparedness and Training	30,7%	SS01, SS04, SS11, SS13
Institutional Readiness and Policy Development	30,7%	SS01, SS05, SS06, SS09
Legal Implications	30,7%	SS05, SS06, SS09, SS12
Student Preparedness and Training	23%	SS04, SS05, SS11
Transparency	23%	SS04, SS06, SS07
Educational Equity	15,3%	SS07, SS09

Integration to Pedagogical Frameworks	15,3%	SS05, SS13
Technological Infrastructure	15,3%	SS06, SS13
Disruption of Collaboration	15,3%	SS11, SS13

With a significant 69,2% of mentions, "Accuracy and Reliability" emerges as a major challenge. While AI can generate vast amounts of information quickly, it is not always accurate or reliable. This issue, commonly referred to as "AI hallucination," underscores the need for students and educators to critically assess AI-generated content in order to maintain academic rigor and trust in the educational process (SS01, SS04, SS05, SS06, SS07, SS09, SS10, SS11, SS12).

With 61,5% of the studies identifying it as a concern, overdependence on AI tools can lead to skill erosion. Students may become overly reliant on AI to generate content, solve problems, or even think critically, resulting in a decline in essential academic skills such as critical thinking, problem-solving, and creativity (SS01, SS04, SS06, SS07, SS09, SS10, SS11, SS12).

53,8% of the studies identified "Biases" as a significant challenge. AI systems, including generative models like ChatGPT, are trained on vast datasets that may contain biased or unbalanced information. When used in educational settings, these biases can perpetuate stereotypes or present distorted perspectives (SS03, SS04, SS06, SS07, SS09, SS10, SS13).

The concern of privacy and security, mentioned in 53,8% of the studies, revolves around the handling of personal data by AI systems. Educational institutions collect and process large amounts of sensitive student information, which can be exposed to risks such as unauthorized access or data breaches when using AI technologies (SS03, SS04, SS06, SS07, SS09, SS12, SS13).

The integrity of content created by academia is another significant concern, highlighted by 38,4% of the studies. The ease with which students can access AI-generated content raises the question of whether a paper is authentically authored if AI was used in its production (SS04, SS05, SS09, SS10, SS12).

Plagiarism is an ethical concern that can become an issue created by the introduction of AI in educational contexts, as mentioned by 38,4% of studies. Without critical thinking or moral etiquette, this becomes an issue that educational institutions will need to invest in advanced detection methods and educate students about the ethical use of AI to prevent misuse (SS04, SS06, SS07, SS09, SS10).

A total of 36.4% of the studies pointed out that many teachers are unprepared to incorporate AI tools into their teaching practices, as they lack the necessary training and understanding of how these technologies function (SS01, SS04, SS11, SS13).

The challenge of institutional readiness and policy development was identified in 30,7% of the studies, mentioning that institutions must establish comprehensive policies and frameworks for AI implementation that address ethical considerations, proper usage guidelines, and the development of digital literacy skills (SS01, SS05, SS06, SS09).

Legal implications, discussed in 30,7% of the studies, relate to issues such as intellectual property, copyright, and accountability. When AI is used to generate content, it raises questions about ownership and the legal responsibilities of educators and institutions. Establishing clear legal frameworks to address these concerns is critical to prevent potential disputes and ensure compliance with existing laws (SS05, SS06, SS09, SS12).

Similar to educator preparedness, 23% of papers mention the concern of preparing students to better utilize AI in an academic context. This discussion includes considering adding AI literacy and prompt writing to academic curricula (SS04, SS05, SS11).

Transparency is a critical concern in the implementation of generative AI tools in educational settings. The lack of clarity regarding AI's decision-making processes was highlighted in 23% of the studies reviewed. As generative AI tools are integrated into learning environments, it becomes a concern as to which tools can be safely used (SS04, SS06, SS07).

Mentioned in 15,3% of the studies, the introduction of generative AI tools in education raises significant concerns about educational equity. While these tools have the potential to enhance learning experiences, there is a risk that disparities in access to technology and digital literacy may exacerbate existing inequalities among students. For instance, students from underprivileged backgrounds may lack access to the necessary devices or high-speed internet, limiting their ability to engage with generative AI applications effectively. Additionally, if educators are not adequately trained to utilize these tools, some students may benefit disproportionately from AI-assisted learning, leading to further gaps in achievement (SS07, SS09).

Integrating generative AI tools into existing pedagogical frameworks presents both opportunities and challenges. The effectiveness of these tools is contingent upon their seamless incorporation into teaching methodologies and curricula. However, as noted in the research, challenges arise regarding

pedagogical integration, with 15,3% of studies emphasizing difficulties in embedding ChatGPT and similar technologies into current educational practices (SS05, SS13).

While access to basic technology has improved in many institutions, the need for reliable internet connectivity, sufficient hardware, and adequate support systems remains critical. The studies reviewed indicated that technological infrastructure is a lower concern in terms of access (only 15,3%), suggesting that many institutions have the necessary tools in place (SS06, SS13).

Studied by 15,3% of papers, the introduction of generative AI tools into academic settings can disrupt traditional collaborative learning practices. While these technologies can facilitate collaboration by providing instant access to information and resources, they also risk diminishing interpersonal interactions and group dynamics (SS11, SS13).
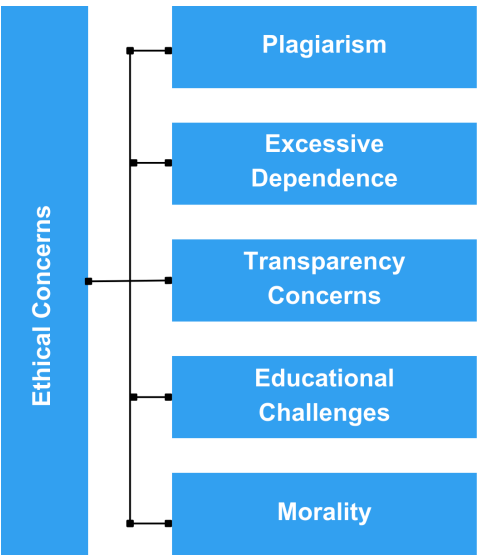
4.4.2 Challenges and Ethical Concerns

FIGURE VI: FIVE ETHICAL ISSUES OF AI IDENTIFIED

The integration of generative AI in education raises significant concerns regarding ethics and academic integrity. The ease with which AI can generate texts, essays, and other academic content from simple prompts challenges traditional notions of authorship and originality. This automation opens space for discussions on plagiarism, attribution, and information accuracy, as well as the risk of undermining students' critical thinking skills (SS01, SS04, SS05, SS06, SS07, SS09, SS10, SS12).

The ease of generating content with AI (SS04, SS09) clashes with concerns about plagiarism and authenticity (SS07). The 'low

detectability' of AI-generated texts (SS04) necessitates a revision of academic integrity policies, as suggested by SS01, including teacher training for assessments that value originality. Studies indicate that traditional plagiarism detection systems, such as Turnitin, struggle to identify AI-generated content. The SS04 study suggests that the traditional rational choice theory, which is based on evaluating the perceived costs and benefits of cheating, is undermined by the use of generative AI, such as ChatGPT. This happens because the low detectability of plagiarism reduces the perceived costs for students, making academic misconduct a more viable option. Furthermore, the study highlights that moral disengagement is a significant factor in this behavior, as it allows students to rationalize plagiarism as acceptable, minimizing its ethical implications (SS04, SS06, SS07, SS09, SS10).

Moreover, excessive dependence on these technologies represents a critical challenge. The automation of writing may lead students to rely too heavily on AI for producing essays and academic work, hindering the development of essential skills such as writing, critical thinking, and creativity. There is a concern that this dependence will reduce students' ability to analyze and reason independently, jeopardizing their academic and professional success (SS01, SS04, SS06, SS07, SS09, SS10, SS11, SS12).

Given this scenario, higher education institutions (HEIs) must redefine the concept of cheating and establish clear criteria for identifying and addressing AI-mediated plagiarism. It is essential for HEIs to implement academic integrity policies that address the ethical and responsible use of these technologies. These guidelines should emphasize the importance of originality and critical thinking, providing concrete instructions on the appropriate use of AI in academic activities (SS01, SS04, SS05, SS09).

To tackle these challenges, educators must be trained to understand the impact of AI tools on academic integrity and to develop assessment methods that foster authentic learning. This includes designing evaluations that require more than merely reproducing AI-generated content, encouraging analysis and critical reflection (SS01, SS04, SS11).

Some studies propose guidelines for the responsible use of AI, such as excluding AI as an author in scientific manuscripts, valuing human discernment when AI is used in academic writing, and ensuring transparent documentation of AI usage in academic work. Additionally, research highlights the importance of cultivating fundamental human skills such as empathy, critical thinking, and problem-solving, which AI cannot replace (SS04, SS06, SS07).

The research by Zhang, Amos, and Pentina (2024) reveals that the low detectability of ChatGPT-based plagiarism undermines rational choice theory, which considers the perceived costs and

benefits of cheating. The study identified moral disengagement as a significant predictor of AI-mediated plagiarism, along with perceived benefits, the severity of punishment, and informal sanctions (SS04).

Implementing AI in education requires a proactive and reflective approach to ensure that ethics and academic integrity are upheld. This necessitates not only new policies and guidelines but also a shift in how educators and students approach learning and assessment in the AI era.

4.4.3 Challenges Related to Content Quality and Skills Development

The rapid integration of generative AI in education raises concerns about the quality of produced content and its impact on the development of students' essential skills. Although studies such as SS04 and SS10 highlight personalized learning and efficiency in content creation, others (SS06, SS07) warn about the erosion of cognitive skills due to excessive reliance on AI. This conflict underscores the need for a balance between innovation and the preservation of essential competencies, such as critical thinking.

Studies indicate that tools like ChatGPT can generate inaccurate, outdated, or even false information, leading to misinformation and negatively affecting the learning process. AI's tendency to "simulate and produce false information" requires students and educators to carefully verify AI-generated content. The lack of reliable references and the potential for AI "hallucinations"—convincingly generating incorrect information—are also significant concerns (SS04, SS06, SS07, SS09, SS10).

AI models are trained on vast datasets that may contain biases, potentially leading to the perpetuation of stereotypes and the presentation of skewed perspectives. This bias can impact educational equity, distorting information and offering unbalanced viewpoints. Additionally, some studies show that AI struggles with evaluating open-ended responses, especially in fields like mathematics, where precision is crucial. This highlights AI's limitations in replacing human assessment, particularly in evaluating students' reasoning and deep understanding (SS03, SS04, SS06, SS07, SS09, SS10, SS13).

Another issue is the lack of originality and critical thinking in AI-generated content, which often results in excessive text with vague language. Overreliance on these tools can reduce analytical capacity, critical thinking, and problem-solving skills. The convenience of quick answers may discourage students from conducting in-depth research and forming their own opinions (SS04, SS06, SS07, SS09, SS12, SS13).

Although AI can assist in idea generation, it may also limit students' creativity by making them dependent on ready-made solutions. Excessive use of tools like ChatGPT can hinder students' analytical and cognitive abilities, negatively impacting their long-term growth and development (SS04, SS06, SS07, SS09, SS10).

Another significant concern is the ethical implications of AI use in education, particularly regarding plagiarism. While AI can improve writing proficiency, it may also decrease creativity and foster excessive dependence. The lack of detailed explanations behind AI-generated paraphrases can make it harder for students to understand the context and verify content accuracy. Beyond these challenges, AI can provide unstructured learning, require additional tools, and face limitations in data structures and algorithms. Research suggests that students using AI for programming education may develop weaker problem-solving skills and retain less knowledge (SS11).

It is crucial to remember that AI is an algorithmic tool and lacks interpersonal skills, empathy, and emotional intelligence—essential elements for the development of soft skills that are highly valued in the job market (SS06). Given these challenges, educators and academic institutions must adopt a balanced approach that integrates AI use while promoting essential skills. To achieve this, it is important to teach students to use AI responsibly and critically, understanding its limitations and risks. This includes incorporating digital literacy training to help students assess the quality and reliability of AI-generated content, ensuring they can distinguish between accurate and misleading information.

Additionally, assessments should be designed to go beyond mere content reproduction, fostering critical thinking, creativity, and problem-solving skills. Educators should encourage students to use AI as a supportive tool rather than a replacement for deep research, critical analysis, and independent reflection. At the same time, it is vital to reinforce the development of interpersonal skills, empathy, and emotional intelligence, as these remain irreplaceable by AI and are essential for academic, professional, and personal success. By adopting this balanced approach, institutions can ensure that AI serves as a complement to education rather than a substitute for the development of fundamental human skills.

4.4.4 Social and Equity Challenges

The integration of generative AI in education not only transforms teaching and learning methods but also raises significant challenges related to equity and social justice. Unequal access to these technologies can deepen educational disparities, particularly for underserved communities that struggle with access to devices,

high-quality internet, and adequate digital infrastructure. The lack of proper training for educators further exacerbates these inequalities, as the improper application of AI tools may disproportionately benefit certain students, widening performance gaps. Without effective educational policies, minority groups and students with special needs may encounter additional barriers, reinforcing patterns of exclusion (SS07, SS09, SS13).

Beyond unequal access, AI has the potential to reinforce existing social biases, as its algorithms are trained on datasets that may contain stereotypes and distorted perspectives. This directly impacts how knowledge is transmitted, potentially shaping students' perceptions of diversity and inclusion in a negative way. The improper application of AI in education could thus compromise the fairness of learning, disadvantage historically marginalized groups, and limit opportunities for those already struggling within the education system (SS03, SS04, SS06, SS07, SS09, SS10, SS13).

The impact of AI on society and the future of work also raises concerns. The uncertainty regarding which skills will be valued in an increasingly automated job market creates anxiety among students. Moreover, the lack of proper regulation complicates the establishment of clear guidelines on the intellectual property of AI-generated content, raising questions about transparency and accountability. Modernizing legal frameworks and defining clear rules for AI usage are essential to ensure that its application in education remains ethical and beneficial for all (SS06, SS13).

To mitigate these challenges, a set of measures must be implemented to promote a more equitable and responsible use of AI in education. Developing inclusive policies that guarantee access to these technologies for all students, regardless of their socioeconomic background, is crucial. Investing in educator training is also essential, equipping them to use AI ethically and effectively while enabling them to identify and mitigate algorithmic biases. At the same time, digital literacy should be encouraged among students, teaching them to use AI critically and responsibly (SS07, SS09, SS13).

Promoting diversity in AI development is another key measure to prevent systems from reinforcing social inequalities. Additionally, ensuring transparency in how AI algorithms operate and continuously monitoring their impacts should be prioritized, ensuring that AI contributes to a more just and accessible educational environment. With well-defined regulations and responsible practices, AI has the potential to positively transform education, fostering innovation without compromising equity and social justice (SS03, SS04, SS06, SS07, SS09, SS10, SS13).

4.4.5 Implementation and Integration Challenges

The implementation of generative AI in education faces challenges that go beyond mere technological adoption. For effective integration, it is essential to carefully analyze pedagogical needs, available infrastructure, educator preparedness, and institutional policies. Technological infrastructure remains an obstacle for many institutions, as reliable connectivity, adequate hardware, and technical support are fundamental to ensuring efficient AI use. The lack of these resources not only limits implementation but may also exacerbate educational inequalities (SS06, SS13).

Educator preparation is another significant challenge. Many teachers lack sufficient training to incorporate AI tools into their teaching practices. Beyond understanding how the technology works, they need to develop digital competencies that enable ethical and effective use, such as creating appropriate prompts and evaluating AI-generated content. Without proper training, AI tools may be used inconsistently and inefficiently, highlighting the need for targeted professional development programs (SS01, SS04, SS11, SS13).

Integrating AI with existing pedagogical structures also requires careful consideration. To be truly effective, AI applications must align with teaching methodologies and educational curricula. Studies have already identified difficulties in incorporating tools like ChatGPT into current educational models, demonstrating the need for pedagogical adjustments to ensure these technologies contribute to learning outcomes (SS05, SS13).

Institutional readiness and the development of clear policies are crucial for the responsible implementation of AI in education. Institutions must establish guidelines that address ethical AI use, academic integrity, and plagiarism while also developing mechanisms to assist students and educators in applying these policies. The creation of detailed regulations on AI-generated content use and production is one of the main needs in this context (SS01, SS05, SS06, SS09).

Student engagement and motivation must also be considered. While AI tools can make learning more dynamic, a lack of understanding of their proper use may hinder effectiveness. It is necessary to develop incentives and pedagogical approaches to ensure that students utilize these technologies productively (SS11, SS13).

Other challenges involve legal and academic issues. Defining the boundaries of academic integrity becomes more complex with AI use, raising concerns about plagiarism and excessive dependence on these tools. Additionally, intellectual property laws need modernization to address authorship and ownership of AI-generated content. The limited number of studies on the

impact of different generative AI tools further complicates their proper implementation (SS05, SS06, SS09, SS10, SS13).

To overcome these challenges, several strategies are essential. Investment in technological infrastructure should ensure equitable access to the internet and necessary devices. Training programs must be developed to equip educators with the skills needed to use AI ethically and effectively. Educational institutions should create clear policies guiding AI use, covering ethical considerations, privacy, and academic integrity. Adopting flexible pedagogical methodologies will facilitate the integration of AI, fostering critical thinking and problem-solving skills. Additionally, promoting digital literacy among students will encourage responsible AI use while highlighting its risks and limitations. Collaboration among educators, researchers, and AI developers can enhance AI's implementation in education, while continuous research will help assess its impact and refine strategies as needed (SS01, SS04, SS05, SS06, SS09, SS11, SS13).

4.5 How can generative AI contribute to opportunities in the educational context?

The integration of generative artificial intelligence (AI) into the educational landscape opens up a diverse range of opportunities, transforming the way knowledge is accessed, assimilated, and transmitted. The studies analyzed in this tertiary review highlight that generative AI not only expands the reach of education by personalizing learning and adapting content to individual needs but also redefines pedagogical practices and drives professional and institutional development. For instance, SS03 emphasizes how generative AI, such as ChatGPT, can increase the accessibility and reach of scientific communication by translating complex concepts into more understandable language and offering multimodal communication options. Similarly, SS08 highlights the diverse applications of AI tools in applied linguistics, providing new opportunities for personalized learning experiences and pedagogical innovation. AI-based tools are increasingly being employed to automate administrative tasks, generate personalized teaching materials, provide individualized student support, and assist educators in designing and refining teaching methodologies.

Moreover, generative AI plays a fundamental role in democratizing access to education, breaking down linguistic, cultural, and cognitive barriers through automatic translations, intelligent summaries, and accessible content for diverse audiences. SS13 indicates that the creation and delivery of efficient content, enhanced personalized learning, and support for diverse learning needs are key possibilities in the implementation of generative AI in academic environments. In the pedagogical sphere, its application enables a more dynamic and interactive approach, from creating innovative educational resources to personalizing student progress tracking. At the same time, the incorporation of this technology into educational processes fosters

academic research and institutional innovation, promoting new approaches to teacher training, continuous education, and the enhancement of teaching structures. Thus, generative AI not only optimizes learning but also contributes to building a more inclusive, efficient educational ecosystem aligned with the transformations of the digital era.

4.5.1 Opportunities for Professional and Institutional Development

Opportunities for Generative AI in Education	Number of studies	Total studies (%)
Expanding Access and Personalizing Learning	3	21,4%
Transformation of Teaching and Learning Practices	4	28,6%
Enhancing Computational Thinking	1	7,1%
Increased Self-Efficacy and Motivation	1	7,1%
Writing Skills Development	2	14,3%
Optimization of Administrative Processes	1	7,1%
Acceleration of the Research Process	1	7,1%
Knowledge Creation and Dissemination	1	7,1%
Innovation in the Educational Field	2	14,3%
Supporting Diverse Learning Needs	1	7,1%
Student Engagement and Motivation	1	7,1%
Developing Critical Thinking Skills	1	7,1%

FIGURE VII: OPPORTUNITIES OF GENERATIVE AI IN EDUCATION BY STUDY

Generative AI offers a wide range of opportunities for **professional and institutional development** within the educational context. These opportunities span from improving essential skills to transforming administrative and research practices, as well as fostering innovation and the development of more effective educational policies. SS01 underscores the need to explore how generative AI can enhance teaching and how professional development programs can be expanded to help leaders and the workforce harness the power of this evolving technology.

Generative AI has the potential to enhance various **crucial skills** for academic and professional success. Studies such as that of Yilmaz and Yilmaz (2023), as cited in SS04, have shown that integrating AI tools like ChatGPT into programming education enhances computational thinking, self-efficacy, and student motivation. These skills are increasingly valued in the job market and can be developed through adaptive tools and platforms that provide instant feedback and personalized support.

Computational thinking, for instance, is not limited to learning programming languages but involves the ability to break down complex problems into smaller parts, recognize patterns, and develop solutions. AI-based tools, such as coding assistants (e.g., GitHub Copilot), allow students to practice coding with contextual suggestions, detailed explanations, and real-time error correction. This type of support accelerates learning and lowers

barriers for beginners, making programming more accessible. Furthermore, the development of self-efficacy—the belief in one's ability to learn and solve problems—is strengthened by interacting with these tools, as students gain confidence by seeing their mistakes corrected instantly and receiving suggestions that help them progress. Motivation is also boosted by the interactive and responsive nature of AI-based technologies, which provide personalized challenges and instant rewards throughout the learning process, creating a dynamic and engaging environment.

Additionally, AI can aid in **developing writing, critical thinking, and problem-solving skills.** By offering support in text revision, idea generation, and data analysis, AI enables students and professionals to refine their abilities more efficiently and effectively. Tools such as ChatGPT can assist in content creation and research, allowing users to focus on more complex and personalized tasks. SS08 supports this by highlighting the role of AI in scientific writing and linguistic analysis, where it can suggest stylistic improvements, structure arguments, and identify gaps in textual coherence, promoting continuous refinement of writing skills.

The impact of AI on academic and **professional writing** goes beyond simple grammar correction. Advanced models can suggest stylistic improvements, structure arguments, and even identify gaps in textual coherence, promoting continuous refinement of writing skills. AI-powered tools that provide linguistic insights and clarity suggestions help writers enhance their style and objectivity. In the educational context, this capability can benefit students by providing detailed reviews tailored to their proficiency level. Furthermore, AI can encourage critical thinking by generating counterpoints, offering comparative analyses, and suggesting sources to support arguments. Regarding problem-solving, AI algorithms can provide simulations, interactive case studies, and predictive analysis, allowing students and professionals to test different scenarios and make more informed decisions.

Generative AI can also **optimize administrative processes in educational institutions**. A study by Dinh and Tran (2023), cited in SS10, highlighted the potential of chatbots like EduChat to answer questions about academic programs, procedures, and admissions processes. Automating these tasks frees up time for administrative staff to focus on more strategic activities and student support. The impacts of automation go beyond mere time savings. The adoption of chatbots and virtual assistants improves accessibility and efficiency in communication between students and institutions. Unlike traditional student support methods—which are often bureaucratic and time-consuming—AI-based assistants can provide instant, detailed, and personalized responses, operating 24/7. Additionally, these technologies can be integrated into academic systems, allowing students to check their grades, enrollments, and financial

dues quickly and intuitively. Another advantage lies in large-scale data analysis: by processing thousands of interactions, AI can identify patterns, predict demands, and suggest improvements to administrative services. This enables institutions to make more informed decisions and adopt proactive strategies to enhance the student experience.

Generative AI is also revolutionizing research methodologies across various fields of knowledge. As highlighted in SS03, AI can **accelerate the research process**, provide quick access to vast amounts of information, and facilitate knowledge creation and dissemination. AI tools can assist in literature reviews, complex data analysis, and the generation of new hypotheses. In the context of literature reviews, AI plays a crucial role by automating the search, extraction, and synthesis of relevant information. Some platforms use AI models to identify patterns in large volumes of scientific publications, enabling researchers to find the most relevant articles efficiently. Moreover, advanced algorithms can summarize texts, highlight key points, and provide an overview of the state of the art in a given field of study. This significantly reduces the time required for information gathering and allows for a more comprehensive and in-depth analysis.

AI also opens new opportunities for **innovation in the educational field.** Studies have demonstrated AI's potential to create personalized learning experiences, develop innovative teaching resources, and provide individualized student support. AI can be used to simulate scenarios, generate interactive content, and tailor teaching to the specific needs of each student. SS13 highlights "Enhanced Personalized Learning" as one of the main benefits perceived from the implementation of ChatGPT in the academic environment.

Personalized learning, one of the most promising aspects of AI in education, allows each student to receive content tailored to their pace and learning style. Educational platforms already use AI to automatically adjust challenges and exercise suggestions based on individual student performance. Additionally, technologies like Adaptive Learning Systems apply predictive algorithms to anticipate difficulties and offer targeted support, improving engagement and knowledge retention.

In developing **innovative teaching resources**, AI can be used to generate interactive multimedia content, such as personalized explanatory videos, scientific experiment simulations, and immersive learning environments with augmented and virtual reality. These tools enrich the educational process by making learning more dynamic and accessible, providing students with more practical and engaging experiences.

Individualized student support also benefits from AI. Intelligent virtual assistants, such as educational chatbots, can answer questions, recommend study materials, and monitor students'

academic progress in real time. This reduces teacher workload and allows for more effective student development tracking. Furthermore, AI can identify performance patterns and suggest personalized pedagogical interventions to prevent learning difficulties.

To fully leverage the opportunities offered by generative AI, institutions must invest in **professional development programs for educators and staff**. As highlighted in SS01, it is crucial to educate both students and teachers on the benefits and limitations of AI tools. Training should address ethical and responsible AI use, the development of digital skills, and the implementation of innovative teaching methodologies. Educator training should include mastering available AI tools, ensuring they can integrate them effectively into their teaching practices. This involves using teaching assistants and creating AI-generated personalized content. Additionally, teachers must understand AI's impact on learning assessment, exploring new ways to measure student progress through automated analyses and instant feedback.

In addition to developing digital skills, it is essential to encourage the implementation of innovative methodologies that take advantage of AI capabilities to enhance learning. Hybrid pedagogical models, project-based learning, and gamification strategies can be enriched with the use of AI, making teaching more dynamic and student-centered.

In this way, generative AI not only transforms educational research and innovation but also requires a structural adaptation in teaching, with continuous training and renewed pedagogical practices to ensure its efficient and responsible use.

4.5.2 Educational Inclusion in the Age of AI: How Technology Transforms Learning

Generative AI has a significant impact on expanding access to education and personalizing learning by offering innovative solutions that meet students' individual needs and overcome geographic and socioeconomic barriers. AI tools can adapt content and learning pace to accommodate each student's needs, making education more inclusive, effective, and accessible. SS03 emphasizes how generative AI can increase the accessibility and reach of scientific communication by translating complex concepts into more understandable language and offering multimodal communication options.

Generative AI can translate complex content into more accessible language and offer multimodal communication options. This facilitates the understanding of complex scientific information, for example, and enables a broader audience to participate in academic discussions. Adapting scientific content into accessible

language is essential for democratizing knowledge. AI models can simplify academic papers, highlighting key concepts and presenting clear explanations for a lay audience. Tools like ExplainPaper and ChatGPT can rewrite dense sections of scientific research in a more didactic manner, allowing students and professionals from different fields to understand academic advancements without requiring deep technical knowledge. Additionally, AI can support visually and hearing-impaired individuals by converting text into audio and generating automatic captions for educational videos.

Generative AI can be adapted to meet a wide range of learning needs. Tools like ChatGPT have demonstrated the ability to provide personalized educational experiences, taking into account students' individual needs. SS13 highlights the "Enhanced Personalized Learning" as one of the main benefits perceived from the implementation of ChatGPT in the academic environment.

Personalized learning allows students with different styles and learning paces to access more effective education. AI models can identify knowledge gaps and suggest specific materials for reinforcement. For example, platforms like Squirrel AI use adaptive algorithms to adjust the difficulty level of exercises based on the student's progress. This enables more dynamic learning, preventing advanced students from becoming demotivated by overly easy content and ensuring that struggling students are not left behind.

Generative AI can analyze student performance and automatically adjust content and learning pace based on individual needs. This allows students to progress at their own pace, focusing on their difficulties and enhancing their skills. AI-based performance analysis utilizes historical data and real-time interactions to create personalized learning profiles. Machine learning algorithms identify patterns in student behavior, such as frequent mistakes and areas of difficulty, to suggest specific corrective exercises. On platforms like Smart Sparrow and DreamBox, this type of continuous monitoring enables a more efficient teaching approach, ensuring that each student receives exactly the support needed to progress effectively.

AI can act as a digital tutor, providing personalized and individualized support to students. These virtual tutors can give detailed explanations, clarify doubts, and offer guidance on complex topics. This approach ensures that students receive the necessary attention for effective learning. AI-powered digital tutors, such as Khan Academy's Khanmigo and Google's Socratic, function as intelligent assistants that support students in real-time. They can answer questions about math, science, history, and other subjects, providing step-by-step explanations. Additionally, these tutors can use conversation-based teaching techniques, where AI encourages students to think critically and formulate their own

answers before receiving a final solution. This type of interaction promotes active learning and improves knowledge retention.

AI provides instant feedback on student performance, helping them identify their weaknesses and focus on areas where they need more support. This is particularly useful in fields like programming, where immediate feedback on code can accelerate learning. AI-powered automated feedback is already widely used in platforms like CodeSignal and LeetCode, which analyze students' written code and provide real-time correction suggestions. This allows programming students to learn more quickly, fixing mistakes as they arise instead of waiting for human evaluations. Additionally, AI systems can identify recurring error patterns and suggest more effective learning strategies, making the teaching process more efficient.

Platforms that use intelligent tutoring systems adjust content and learning pace based on individual student needs. These platforms analyze student performance and provide personalized exercises and materials. Systems like Carnegie Learning and Century Tech utilize artificial intelligence to tailor teaching to each student's profile. Based on student interactions, AI suggests additional content, personalized reviews, and specific challenges to reinforce learning. This type of adaptation ensures that each student receives tailored education, increasing learning efficiency and reducing dropout rates.

The combination of expanding access and personalizing learning results in a more inclusive and effective educational environment, meeting the needs of diverse students. AI can help students from various backgrounds and skill levels learn at their own pace and in the way that best suits them. This inclusive approach is especially beneficial for students with learning difficulties, such as dyslexia or ADHD, as AI can provide support tailored to their specific needs. Through engagement pattern analysis, AI systems can identify when a student is struggling and suggest alternative approaches, such as interactive videos or gamified exercises, to maintain motivation and focus on learning.

Generative AI, therefore, not only expands access to education but also significantly improves the quality and personalization of teaching. By integrating these technologies responsibly, educational institutions can create a more effective, inclusive, and innovative learning environment for all students.

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5 KEY POINTS OVERVIEW

These Key Points Overview in Figure VIII were developed to organize and synthesize the main dimensions related to the impact of Generative Artificial Intelligence (GenAI) in education, focusing on four key areas: **Learning**, **Teaching**, **Challenges**, and **Opportunities**. Each dimension is detailed in **keypoints** and

impacts, providing a clear and structured overview of the benefits, challenges, and potential transformations brought by GenAI in the educational context.

The importance of these key points overview lies in its ability to offer a comprehensive and balanced view of how GenAI is shaping education. It serves as a practical guide for educators, researchers, and policymakers, helping to identify strategies to maximize the benefits of GenAI while mitigating its challenges. Additionally, the key point overview highlights research and innovation opportunities, encouraging the exploration of new pedagogical approaches and the development of more inclusive and efficient educational policies.

By structuring the information into clear and interconnected dimensions, these key points overview informed decision-making and the implementation of educational practices that leverage the transformative potential of GenAI. It also promotes critical reflection on ethical and social issues, ensuring that the use of these technologies is responsible and aligned with the principles of inclusive and equitable education.

Key Points Overview for the Use of Generative AI in Educational Contexts

Learning Affected By GenAI

KEYPOINTS:

- Personalized learning through generative AI tools like ChatGPT and Bard.

- Support for autonomous learning, allowing students to progress at their own pace.

- Instant and adaptive feedback, especially in areas such as programming and academic writing.

IMPACT:

- Improved academic performance, with better retention and application of knowledge.

- Increased student engagement, as content is tailored to individual needs.

- Development of critical thinking and problem-solving skills through interactive tools.

Teaching Affected By GenAI

KEYPOINTS:

- Automation of repetitive tasks, such as creating teaching materials and grading assessments.

- Support for lesson planning and generation of personalized resources.

- Reduction of teachers' workload, allowing more focus on strategic activities like mentoring.

IMPACT:

- Greater efficiency in the teaching process, with faster and more accurate feedback for students.

- Improved teacher-student interaction, with more time dedicated to developing critical and creative skills.

- Adaptation of pedagogical methodologies to include AI tools, promoting more dynamic and inclusive teaching.

Challenges of GenAI in Education

KEYPOINTS:

- Concerns about academic integrity, such as plagiarism and over-reliance on AI tools.

- Algorithmic bias and lack of transparency in AI decision-making processes.

- Inequalities in access to technology and training for teachers and students.

IMPACT:

- Risk of erosion of essential skills, such as critical thinking and creativity, due to excessive use of AI.

- Need for clear policies and training to ensure ethical and responsible use of AI.

- Potential increase in educational inequalities, with students from disadvantaged contexts falling behind.

Opportunities of GenAI in Education

KEYPOINTS:

- Democratization of access to education, with AI tools overcoming geographic and socioeconomic barriers.

- Innovation in teaching methodologies, such as adaptive learning and gamification.

- Development of 21st-century skills, such as computational thinking and digital literacy.

IMPACT:

- Creation of a more inclusive and efficient educational environment, with personalized support for all students.

- Preparation of students for a job market increasingly reliant on advanced technologies.

- Potential to transform education into a more dynamic, interactive system aligned with the demands of the digital age.

FIGURE VIII: KEY POINTS OVERVIEW

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6 CONCLUSIONS

Generative artificial intelligence has established itself as a powerful tool in education, offering innovative opportunities while also presenting challenges that require a careful and thoughtful approach. Technologies such as ChatGPT, Bard, Bing Chat, and Ernie are widely used to personalize learning, generate customized content, and provide virtual support to students. The ability of these tools to adapt teaching to individual student needs has proven essential in fostering more dynamic and effective learning experiences.

The integration of generative AI in education presents significant opportunities for developing innovative models of student

engagement and motivation indicators, as evidenced by the studies analyzed in this review. The reviewed works demonstrate that while tools such as ChatGPT and GitHub Copilot can enhance student engagement through personalized activities and adaptive feedback (SS04, SS13), there is still a lack of robust metrics to qualitatively assess this impact. This gap opens space for future research to develop hybrid assessment models, combining quantitative interaction data (such as frequency and diversity of use recorded in platform logs) with qualitative indicators that measure the cognitive depth of interactions, such as the complexity of prompts used and students' ability to identify and correct biases in AI-generated content (SS05, SS08).

The analyzed studies particularly suggest the need for validation of these indicators in real educational settings through longitudinal research comparing classrooms with different levels of teacher mediation in the use of generative AI tools. For example, it would be valuable to investigate how the evolution in prompt complexity—from simple commands to requests requiring critical analysis and synthesis (SS13)—correlates with traditional academic performance measures and intrinsic motivation indicators. The research by SS10, which demonstrated the potential of supervised role-play with ChatGPT, and the findings of SS05, on the effectiveness of two-stage assessment, provide concrete foundations for developing frameworks to guide educators in designing engaging activities with generative AI.

As a practical illustration, in a programming course, engagement progression could be tracked by analyzing the increasing sophistication of commands used with tools like GitHub Copilot—from basic code generation prompts to complex requests that include optimization and justification of algorithmic choices. This approach would not only measure engagement but also develop rubrics to assess both AI-generated outputs and students' critical interaction processes with these tools (SS08). The implementation of these indicator models would represent a significant advancement in understanding the real impacts of generative AI in education, going beyond superficial usage measures to capture fundamental qualitative dimensions of technology-mediated learning.

In addition to transforming students' learning experiences, generative AI redefines the role of educators by assisting in the creation of teaching materials, evaluating student work, and personalizing instruction (SS08, SS10). Intelligent chatbot tools enable more efficient support, reducing teachers' workload and improving student-teacher interaction. However, this new reality also presents challenges, such as academic integrity, the reliability of AI-generated information, and ethical and equity concerns regarding access to technology (SS01, SS04, SS05, SS06, SS07, SS09, SS10, SS12).

Cultural and contextual factors also play a crucial role in the adoption of generative AI in education. The cultural expectations of students and teachers can influence the acceptance and effectiveness of these new methodologies, making it essential to tailor pedagogical approaches to the specific needs of each educational setting. Additionally, resistance to change represents a significant obstacle to implementing these innovations, posing challenges not only for teachers and administrators but also for students themselves (SS04, SS06, SS09).

This tertiary review revealed fundamental tensions: while AI enhances personalized learning (SS03, SS13), its indiscriminate use threatens academic integrity (SS04, SS07) and exacerbates inequalities (SS09). Gaps in research on K-12 education (SS04) and regulation (SS05) demand urgent action.

As the field of generative AI in education continues to evolve, future research should focus on addressing the identified gaps and exploring new opportunities. Key areas for investigation include the long-term impact of AI tools on critical thinking and creativity, the development of ethical guidelines for AI use in academic settings, and the integration of AI into diverse educational contexts, such as K-12 and vocational training. Additionally, more studies are needed to understand the cultural and socioeconomic factors influencing AI adoption and to evaluate the effectiveness of AI-driven personalized learning across different student populations. By pursuing these directions, researchers can contribute to a more inclusive, equitable, and effective educational ecosystem that leverages the transformative potential of generative AI while mitigating its challenges.

REFERENCES

[1] Plata, S., De Guzman, M. A., & Quesada, A. (2023). *Emerging Research and Policy Themes on Academic Integrity in the Age of ChatGPT and Generative AI.* Asian Journal of University Education, 19(4), 743-754. DOI: https://doi.org/10.24191/ajue.v19i4.24697

[2] Bozkurt, A. (2023). *Unleashing the Potential of Generative AI, Conversational Agents and Chatbots in Educational Praxis: A Systematic Review and Bibliometric Analysis of GenAI in Education.* Open Praxis, 15(4), 261–270. DOI: https://doi.org/10.55982/openpraxis.15.4.609

[3] Yusuf, A., Pervin, N., Román-González, M., & Noor, N. M. (2024). *Generative AI in education and research: A systematic mapping review.* Review of Education, 12(2), e3489. DOI: https://doi.org/10.1002/rev3.3489

[4] Yusuf, A., Pervin, N., Román-González, M., & Noor, N. M. (2024). *Generative AI in education and research: A systematic mapping review.* Review of Education, 12(2), e3489. DOI: https://doi.org/10.1002/rev3.3489

[5] Peláez-Sánchez, I. C., Velarde-Camaqui, D., & Glasserman-Morales, L. D. (2024). *The impact of large language models on higher education: exploring the connection between AI and Education 4.0*. Frontiers in Education, 9, Article 1392091. DOI: https://doi.org/10.3389/feduc.2024.1392091

[6] Kumar, S., Rao, P., Singhania, S., Verma, S., & Kheterpal, M. (2024). *Will artificial intelligence drive the advancements in higher education? A tri-phased exploration*. Technological Forecasting & Social Change, 201, Article 123258. DOI: https://doi.org/10.1016/j.techfore.2024.123258

[7] Zhai, C., Wibowo, S., & Li, L. D. (2024). *The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review*. Smart Learning Environments, 11(28). DOI: https://doi.org/10.1186/s40561-024-00316-7

[8] Bukar, U. A., Sayeed, M. S., Razak, S. F. A., & Yogarayan, S. (2024). *Decision-Making Framework for the Utilization of Generative Artificial Intelligence in Education: A Case Study of ChatGPT*. IEEE Access, 12, 95368-95384. DOI: https://doi.org/10.1109/ACCESS.2024.3425172

[9] Alaqlobi, O., Alduais, A., Qasem, F., & Alasmari, M. (2024). *Artificial intelligence in applied linguistics: A content analysis and future prospects*. Cogent Arts & Humanities, 11(1), 2382422. DOI: https://doi.org/10.1080/23311983.2024.2382422

[10] Sekli, G. F. M., Godo, A., & Véliz, J. C. (2024). *Generative AI solutions for faculty and students: A review of literature and roadmap for future research*. Journal of Information Technology Education: Research, 23, Article 14. DOI: https://doi.org/10.28945/5304

[11] Perera, K. G. D. K., Wijayanayake, J., & Prasadika, J. (2024). *Factors Affecting the Effectiveness of Generative Artificial Intelligence Apps on University Students' Programming Language Learning in Sri Lanka: A Systematic Literature Review*. IEEE Conference Proceedings.

[12] Lucas, H. C., Upperman, J. S., & Robinson, J. R. (2024). *A systematic review of large language models and their implications in medical education*. Medical Education. DOI: https://doi.org/10.1111/medu.15402

[13] Mohebi, L. (2024). *Empowering learners with ChatGPT: insights from a systematic literature exploration*. Discover Education, 3(36). DOI: https://doi.org/10.1007/s44217-024-00120-y