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Review

Generative AI in higher education: A cross-sector analysis of ChatGPT's impact on STEM, social sciences, and healthcare

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Abstract: The integration of Generative Artificial Intelligence (GenAI) in academic learning has gained substantial traction across disciplines, necessitating a systematic analysis of its impact. This study explored ChatGPT's transformative role in higher education from 2022 onwards, synthesizing empirical findings across twelve distinct academic fields spanning STEM, social sciences, and healthcare. Relevant empirical case studies were identified through a systematic Scopus database search, applying discipline-specific keywords and filtering out surveys, literature reviews, and theoretical papers. Multi-stage screening identified 60 full-text articles, ultimately selecting twelve high-quality studies for rigorous cross-disciplinary analysis. The findings revealed pronounced disciplinary variations in ChatGPT adoption and impact. Quantitative analysis demonstrated that STEM disciplines report significantly higher accuracy concerns (mean = 1.57 on a 0–2 scale) compared to other fields, while healthcare disciplines showed the highest privacy concerns (mean = 2.0). Moderate positive correlation (r = 0.68) exists between academic integrity concerns and usage intensity, with computer science and social science reporting the highest levels for both metrics. Female representation, documented in 50% of studies, appears to influence adoption patterns. Sample sizes varied considerably (n = 12 to n = 430), with computer science (n = 430) and medical education (n = 265) providing robust empirical bases. Cross-disciplinary analysis revealed that ChatGPT enhances academic performance in structured problem-solving contexts, with health sciences reporting the highest positive impact scores (mean = 1.67), whilst potentially undermining critical thinking. Disciplines with text-based assessments face greater academic integrity challenges (r = 0.72 correlation).

Keywords: Artificial Intelligence, ChatGPT, education technology, GenAI

1. Introduction

ChatGPT has taken the education industry by storm since its introduction. Since then, the term Generative Artificial Intelligence (AI) or GenAI has become more prominent, with several tech giants racing to take a share of this new market [1]. Many GenAI tools or chatbots have since emerged, such as Claude, Gemini, Copilot and more recently DeepSeek. This advancement in GenAI provided capabilities never seen before, from automating tasks [2], to answering just about anything [3], to assisting in complex coding [4] and mathematical problem-solving tasks [5], to shaping many other education-based practices. Recent studies, such as [6–10], have shown that ChatGPT, for example, is reshaping the way students access information. Several other studies [11–13] have demonstrated the transformative and disruptive nature of this technology. Early findings show that GenAI tools in general and particularly ChatGPT are playing a part in enhancing student engagement [14], assisting researchers [15], and playing a vital role in the learning and teaching process for both teachers and students [16]. However, this rapid and instant access to information [17], specifically by students, is posing new challenges. Several studies, such as [18–22], have raised concerns about students' dependencies on GenAI, with many educators raising concerns about plagiarism.

However, the implications of GenAI on learning and teaching, academic integrity, and discipline-specific implementations remain not fully understood or explored. While there are now several studies on the use of ChatGPT in specific disciplines in education [23–27], the variations in how AI tools are influencing educational practices at large remain underexplored. In computer science and engineering disciplines, many recent studies, such as [28, 29], have reported that GenAI tools such as ChatGPT are being used by students for coding assistance, debugging, and rapid development, although the impact on students' critical thinking and computational thinking remains of concern [30]. Similarly, the literature review has shown that in disciplines such as the social sciences and law, GenAI has been predominantly used as a writing assistant [31, 32]. Also, GenAI tools are playing a major role in facilitating academic composition and legislative research. In healthcare, concerns about data privacy, ethical considerations, and accuracy remain among the chief challenges in this area [33]. Plagiarism and overreliance on AI remain among the most common concerns [34, 35].

Several studies have demonstrated that students are using and perhaps over-relying on AI for assignment writing and coding assistance. This is potentially undermining the students' ability to develop independent critical, analytical and problem-solving skills. While AI tools can facilitate learning personalization, streamline access to information and improve efficiency, there is a growing concern about their impact on cognitive development and critical thinking across various disciplines. Rising concerns about privacy, accuracy and data security, specifically in areas that handle sensitive, military, personal or medical information, call for robust ethical and governance frameworks. While existing research has investigated Generative AI's influence within individual academic disciplines, there remains a critical gap in comprehensive cross-disciplinary analyzes exploring how AI impacts student engagement, academic integrity, and pedagogical practices across multiple fields simultaneously. This study addresses this gap by systematically examining empirical cases of GenAI usage, focusing specifically on ChatGPT's application across STEM, social sciences, and healthcare education.

While earlier research has analyzed the impact of Generative AI by academic discipline, there has been a pressing need for thorough cross-disciplinary research on how AI impacts learning engagement,

academic integrity, and pedagogical practices across various disciplines simultaneously. This study addresses this gap through a systematic analysis of empirical examples of GenAI adoption and the use of ChatGPT in STEM, social sciences, and healthcare education. The theoretical underpinning of the study derives from various established frameworks. The Technology Acceptance Model [36] explains how various disciplines perceive and adopt AI tools in terms of perceived ease of use and usefulness. This cross-disciplinary consideration is supplemented by social constructivist learning theories [37], which give background consideration in understanding how AI tools aid in the construction of knowledge in various educational contexts. The digital ethics framework proposed by [38] also provides a helpful framework for examining the ethical implications of AI adoption across disciplines with different professional standards and practices. Given these challenges, this study provides a multi-disciplinary analysis of the impact of GenAI in education. It systematically examines the impact of GenAI using a multi-case approach across STEM, medical education, and social sciences. The study uses a scoping review methodology to select case studies from 12 different areas of education, spanning from computer science to social science fields. The research analyzes these empirical case studies to determine the impact GenAI is having on these disciplines. This is followed by examining the benefits and challenges, particularly the ethical considerations associated with its use, followed by an analysis of the disciplinary variations in AI adoption and impact. To achieve this, the study aims to address the following research questions:

1. How has Generative AI, particularly ChatGPT, been utilized across different academic disciplines, and what are its primary applications in enhancing learning experiences?
2. What are the key challenges and ethical concerns associated with the adoption of Generative AI in education, including issues of academic integrity, overreliance, and data privacy?
3. How do different academic disciplines perceive and engage with AI-driven learning tools, and what factors influence variations in adoption rates and effectiveness?

The remainder of this paper is organized as follows: Section 2 discusses the related work, reviewing existing literature on AI adoption in higher education. Section 3 presents cross-disciplinary case studies of ChatGPT integration in higher education, analyzing its role across different academic disciplines. Section 4 outlines the results, providing empirical insights into AI-driven learning. Section 5 offers a discussion and implications, contextualizing the findings and highlighting key insights. Section 6 examines the limitations of the study, identifying areas for future research. Conclusion remarks are provided in Section 7.

1.1. Methodology

Given the need to examine case studies of GenAI usage across multiple domains, a scoping review methodology was selected as the basis for this study. A detailed methodology flowchart is presented in Figure 1.

The methodology maps the literature on GenAI in education to select the papers needed for the study. This included identifying the themes and the emerging trends guided by the research questions. The need to analyze and examine existing case studies has set the inclusion and exclusion criteria and the search strategies. For a start, Scopus was selected as the target database and was searched for the relevant empirical studies published from the year 2022 onwards. Scopus was selected due to its extensive coverage of peer-reviewed academic literature, particularly in education technology and

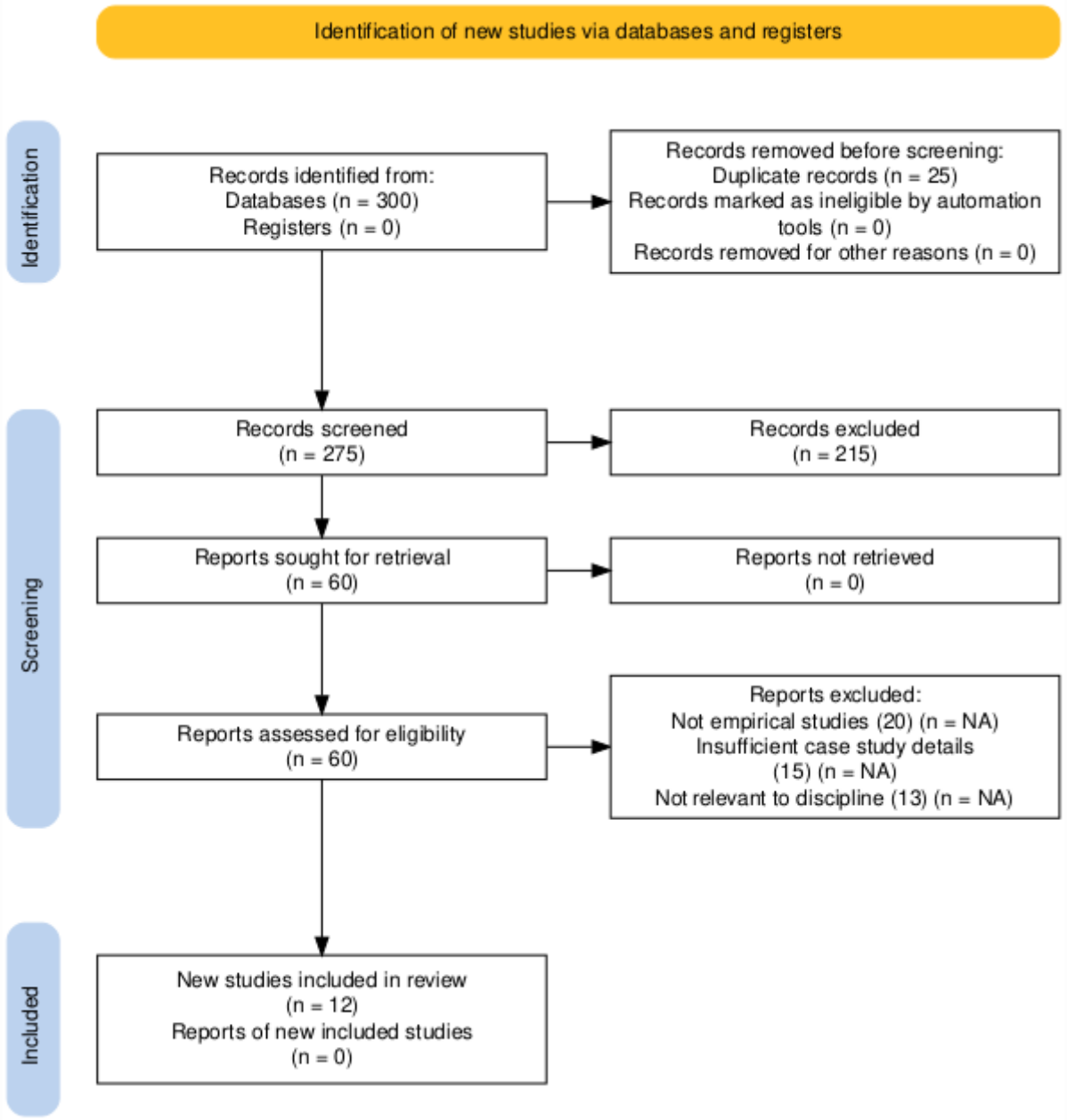

Figure 1. PRISMA flow diagram illustrating our study selection process.

artificial intelligence, offering robust indexing and reliable search functionalities suitable for systematic reviews.

We conducted targeted searches in the Scopus database using a combination of GenAI-related terms and discipline-specific keywords for each of the 12 predetermined academic disciplines. The search strings typically combined terms such as "Generative AI," "ChatGPT," or "LLM" with discipline-specific keywords (e.g., "nursing," "engineering," "mathematics"). These 12 disciplines were selected to represent a balanced cross-section of STEM fields, social sciences, and healthcare education. From an estimated 300 initially identified records across all discipline-specific searches, and after removing

approximately 25 duplicates, we screened 275 records by title and abstract.

A structured search method was implemented, which used a combination of GenAI in educational terms (e.g., *"Generative AI," "ChatGPT," "case study"*) along with a discipline-specific keyword such as *"nursing," "engineering"*, and "law". The process was repeated for twelve disciplines to ensure the sample included diverse papers from different academic fields. The selection of studies ensured that the papers selected were representative of various educational areas, including STEM, medical, and social sciences fields.

A multi-stage screening process was used before selecting the papers. Initially, studies were screened based on their titles and abstracts. Next, each of the papers was screened and reviewed in full to ensure the paper reported empirical results, which is the strict inclusion criterion set by the methodology. Papers that lacked concrete findings or provided reviews of any sort without doing case studies were excluded.

Following this strict screening, twelve hand-picked studies were selected. Each paper was selected to represent a distinct academic discipline. This ensured a balanced representation of AI's impact across various fields. The selected studies were analyzed to identify key themes, and demographic data were then extracted, in addition to identifying the challenges and opportunities that the papers reported in each of their respective fields. A specific search for any ethical issues reported was also noted. Table 1 shows the twelve papers selected, representing the twelve academic fields. The identification of the 12 disciplines was informed by the research aim to provide comprehensive coverage across major academic sectors. Disciplines were deliberately selected to represent three broad categories: STEM fields (Computer Engineering, Computer Science, Chemical Engineering, Engineering Mathematics, Physics, Mathematics, and Chemistry), Social Sciences (Law and Social Science), and Health Sciences (Medical Education, Pharmacy, and Nursing). This selection ensured balanced representation across the academic spectrum whilst allowing for meaningful cross-disciplinary comparisons. Specific inclusion criteria were established as follows: (1) peer-reviewed empirical case studies reporting actual implementation or evaluation of ChatGPT or similar tools in education; (2) discipline-specific focus; and (3) relevance to higher education.

Studies were excluded if they were: (1) theoretical essays, position papers, or reviews; (2) survey-only studies without a case-based instructional context; or (3) lacking clear empirical outcomes related to AI integration as shown in Figure 1. After deduplication and initial screening by title and abstract, full-text articles were reviewed for final eligibility. The screening process, whilst presented sequentially in the PRISMA diagram, was in practice somewhat iterative. For disciplines where initial searches yielded limited empirical studies, search terms were refined, and publication date ranges were expanded whilst maintaining the core inclusion criteria. All screening was conducted manually, with the third author consulted to resolve any disagreements about inclusion decisions.

The study purposefully included twelve papers, each representing a unique academic discipline, to achieve conceptual saturation and thematic depth rather than numerical generalizability. This selection strategy was based on a maximum variation approach, where diversity across fields was prioritized to uncover discipline-specific patterns, ethical concerns, and pedagogical affordances. The aim was not to conduct a meta-analysis, but rather to derive rich qualitative insights from distinct case implementations. For data extraction and synthesis, a standardized coding framework was developed to systematically identify key themes across studies. A series of structured tables was created to extract consistent data elements from each paper. These tables functioned both as selection tools and

data repositories. For instance, articles were evaluated against criteria such as whether they reported participant numbers, discussed ethical considerations, or included demographic information. Articles failing to provide essential empirical data were excluded at this stage.

It is acknowledged that selecting a single representative study per discipline presents a limitation of this approach. Nevertheless, this selective strategy allowed for in-depth analysis across a broad range of disciplines whilst maintaining a manageable scope. The 12 selected papers were chosen because they provided the most comprehensive empirical evidence for ChatGPT's application in their respective disciplines amongst the papers that met the inclusion criteria. Their titles are provided in Table 1.

Table 1. The 12 papers selected for full review.

Discipline	**Application Focus**	**Ref**
Computer Engineering	Conceptual questions, code completion and analysis	[39]
Computer Science	Code debugging and report writing	[40]
Chemical Engineering	Steam turbine calculations and problem solving	[41]
Engineering (Mathematics)	Out-of-class tasks and theoretical understanding	[42]
Law	Legal information summarization	[43]
Social Science	Exam revision and topic comprehension	[44]
Physics	Problem solving during makeup exams	[45]
Mathematics	Proof writing with iterative feedback	[46]
Chemistry	Report generation and limitation identification	[47]
Medical Education	Research writing and exam preparation	[48]
Pharmacy	Drug interactions and information retrieval	[49]
Nursing	Patient care simulation scenarios	[50]

2. Related works

This section reviews some of the related work. After the identification of the research question, we wanted to see if there exist current surveys or review papers that compare various education fields on the use of GenAI and therefore identify the gaps in the knowledge. For instance, the study reported in [51] did a systematic review on the uses of ChatGPT in American higher education through the assessment of 57 research articles published from the years 2023 to 2024. The review reported several benefits from using ChatGPT for students and staff. The benefits included helping students with their assignments, tutoring, and content generation. It also identified some challenges, including issues such as accuracy or reliability and concerns about plagiarism. While the paper reports some valuable findings, it did not offer a complete cross-disciplinary examination as set by the research questions defined in this research. Additionally, while the geographical coverage is broad, it may still underrepresent regions with less access to technology or fewer publications on AI.

Montenegro-Rueda et al. [52] conducted a systematic review of 12 studies published after the release of ChatGPT in 2022 concerning its educational effects. The paper notes the potential of ChatGPT to enrich the educational process by customizing learning experiences of students and encouraging their participation. By providing instantaneous feedback and assistance with evaluation

chores, such as grading, ChatGPT would thus further allow teachers to focus on far more key teaching aspects. The paper suggests changing traditional practices with new ChatGPT-powered educational methods toward interactivity and efficiency. However, it states that any success in the integration of ChatGPT into education depends upon the pertinent skills of the teacher to adopt and apply this specific technology. A strong limitation identified was the absence of training for teachers to use the technology effectively. The paper also mentions ethical concerns, such as where the data was kept and how access is allocated equitably. However, the lack of in-depth discussion leaves a gap in addressing how AI could be responsibly integrated into the educational systems. The researchers conclude that since the introduction of this new technology, very little has been done to ascertain its long-term effects on education and cite this as a compelling reason for additional research into its impact.

Another study examined the effects of ChatGPT on Higher Education Institutions (HEIs) [53]. Using a systematic analysis of relevant articles selected from PubMed, IEEE Xplore, and Google Scholar, the study identified similar challenges and opportunities to using ChatGPT. Online testing security, plagiarism, and societal implications, such as job displacement and anxiety, were among the identified challenges. Conversely, the study covered several significant risks associated with using ChatGPT, particularly privacy breaches, misuse, decreazed human interaction, and accessibility issues. As with the previous studies, a direct comparison and contrast between the academic fields was not the main focus of this study either.

The study reported in [54] reviewed 50 articles shortly after the release of ChatGPT. It provided earlier insights into the potential impact ChatGPT is having on education. Some of the findings were domain-specific, such as the identification of ChatGPT as a helpful tool in subjects such as economics and programming. The study also reported that ChatGPT was less effective in fields such as law and mathematics. However, the review relies on early-stage research, and does not include medical and social sciences areas. Not having longitudinal data also limits the review paper's ability to assess the ways in which ChatGPT affects critical thinking and learning overall.

Bhullar et al. [55] studied, using a systematic review, the impact of ChatGPT on higher education. From the Scopus database, they selected 47 articles that experts had reviewed. The research identified four main topics: academic integrity, student participation, learning environments and scholarly research. Results showed many citations came from the United States. But countries across Asia generated 60 percent of the published materials in this field. In this study, the researchers limited their scope to English-language publications from only the Scopus database in 2023. This leaves out important literature published elsewhere, in another language, or in a different year. In addition, the geographic coverage and keywords used may be too limited. The researchers identified some of the most important issues about ChatGPT use in higher education, including worries about plagiarism, the technology's lack of emotional intelligence, and risks to honesty in academics. However, they also mentioned the possible benefits of ChatGPT, such as enhancing personal learning, supporting research, and helping non-native English speakers. The study recommended that educational institutions develop ChatGPT-proof authentic assessments, offer extensive training on academic integrity, and put in place a clear policy on the use of the AI tool. The authors arrived at the conclusion that ChatGPT is not a nuisance but rather a practical tool that, when applied appropriately, can supplement the teaching-learning process.

Ipek et al. [56] systematically analyzed 40 articles published from December 2022 to February 2023, relating to the educational applications and implications of ChatGPT. The review cited

advantages like the ability to assist literature reviews, translate and paraphrase, provide complex responses, personalize learning, grade and assess, conduct data analysis, and design the material.

The AI system demonstrated the capacity for handling gigantic amounts of information (650 GB) with higher accuracy in translation and instant generation of content. The review, however, recognized certain weaknesses and reservations, such as academic dishonesty and plagiarism, undermining critical thinking, formation of incorrect and "hallucinated" responses, problems in translating non-European languages, and ethical objections with respect to ownership of content and bias. In addition, the study talked about privacy and legal issues, such as a standard protocol for AI-generated content and data protection issues. The authors concluded that ChatGPT is a very valuable tool in education with numerous potential benefits, but that its responsible use requires guidelines and regulations. ChatGPT, the authors stated, should augment and not substitute traditional learning, and human instruction, and critical thinking. The paradigm for learning is changing, and the well-balanced integration of ChatGPT and other AI tools is the gateway to harvesting maximum benefits and steering clear of the minimum risks.

Zheltukhina et al. [30] provides a detailed bibliometric review of ChatGPT education research studies that incorporated 82 articles representing 42 countries from the Scopus database and VOSviewer software. The analysis found five main research clusters on ChatGPT usage, including academic writing, ethical implementation in AI, educational outcomes, and applications in medical and nursing education. This research was mainly published in developed countries, particularly the United States, Australia, and the United Kingdom. Academic papers about ChatGPT in education were mostly early theoretical studies, especially in medical and nursing education, coupled with urgent issues in academic integrity and ethical issues. The limitation of the research is narrowed because it was reliant on the Scopus database, only included articles in the English language, and was done within a short timeframe, which might not have included relevant studies from other databases or languages.

In a systematic scoping review, Xu et al. [57] examined the potential, challenges, and prospects of Large Language Models (LLMs) like ChatGPT in the setting of medical education. A literature review of 113 articles from primary medical databases like PubMed, Embase, and Web of Science depicts perspectives on personalized learning, clinical simulation development, and functioning as a medical writing assistant. The authors revealed many key benefits, among which are improved learning efficiency, personalized feedback, and learning approaches. One of the most prominent applications noted in the research is modeling more realistic clinical simulation scenarios to improve communication abilities and clinical skills. However, the research also raises concerns involving academic integrity, reliability, and the risk of overreliance on AI, which could impair the development of critical thinking and practical skills of medical students. In addition, it raises questions about its accuracy and data reliability, since responses, at times, propagate misinformation and pose risks in areas like medicine, requiring high stakes. The study's limitations include the exclusion of literature available in languages other than English, failure to carry out a critical appraisal of individual sources, and attachment to potential applications that go against empirical evidence. This highlights the need to assess ChatGPT's real-life effects on learning outcomes.

An analysis of the bibliometric and systematic literature review on ChatGPT's use in education has been presented by Pradana et al. [58], compiling 93 articles between 2022 and 2023 using the Google Scholar database. This research has drawn up a multi-faceted analytic approach, like co-authorship networks, keyword co-occurrences and citation analysis, for conducting this study. As has been

observed, there was a key uptick in 2023 in the applications associated with ChatGPT in education, driven by its uniqueness in personalized learning, automated grading, and content generation. The key findings indicate both opportunities and challenges regarding the potential increased efficiency, as well as ethical and academic integrity issues raised by ChatGPT. However, it can be noted that the paper relies mainly on Google Scholar, thus narrowing its scope and possibly leaving out some relevant high-impact works from other databases, like Scopus or Web of Science. Also, by concentrating only on bibliometric analysis, the paper failed to provide a complete qualitative insight into the practical uses of ChatGPT. The limited period covered in the article, which considers only 2022 and 2023 publications, means that it captures the very early stages of ChatGPT's impact in education alone.

Sallam [59] reviewed 60 research articles to analyze how ChatGPT made its impact on health education, research, and practice. It was found that ChatGPT increases research equity by opening up scientific writing for non-native English speakers who may have it as their third language. It shows merit toward health education by generating clinical vignettes and personalized learning experiences. The ability of ChatGPT to dissect large datasets in drug discovery means the technology is opening exciting vistas of healthcare research. Nevertheless, it is clear that major limitations and caveats still exist, for example, generation of false or biased content, the thorny issue in healthcare because correct facts matter, and generation of incorrect but plausible responses called hallucinations, which can be very dangerous to any user. Ethical issues like plagiarism and transparency are major challenges, and there are privacy and security issues raised in the case of healthcare. The reliability of the results may also suffer because these studies depend on preprints and other non-peer-reviewed resources. Moreover, it has an important limitation research-wise because it has limited itself to literature published up to early 2023, but without including any specific case examples, which reduces the possibility of showing broader educational application or the general real-world impact of ChatGPT.

Collectively, these studies provide valuable perspectives on AI in education but reveal several research gaps. Baig et al. [51] and Montenegro-Rueda et al. [52] examined AI implementation in higher education, but did not differentiate the specific demands of diverse academic disciplines. Other studies, such as those reported in [30, 57, 59], predominantly focused on healthcare education. They offered discipline-specific analysis only, which is of value of course, but does not fully answer the research questions set in this research. Other works, such as in [54, 56], did systematic reviews on multiple disciplines, but they have lacked in-depth, case-based investigations. As summarized in Table 2, the analysis of existing review literature reveals that whilst substantial research attention has been directed toward ChatGPT's educational applications across 643 total articles reviewed in these studies, significant methodological and analytical gaps persist. Most reviews focus on broad educational impacts without providing systematic cross-disciplinary comparisons of empirical implementations. Additionally, the majority emphasize theoretical considerations or survey-based findings rather than concrete case-based evidence of ChatGPT integration across diverse academic contexts.

Table 2. Summary of existing review studies on ChatGPT in education.

Study	Type & Sample	Focus Area	Key Findings & Limitations
[51]	Systematic Review (57 articles)	ChatGPT in American higher education	Benefits: assignment help, tutoring; Challenges: accuracy, plagiarism. Limited cross-disciplinary examination.
[52]	Systematic Review (12 studies)	educational effects of ChatGPT	Customized learning potential, instant feedback. Limited teacher training discussion.
[53]	Literature Review (143 articles)	Effects on higher education	Challenges: testing security, plagiarism, privacy. No field comparisons.
[54]	Rapid Review (50 articles)	Early ChatGPT impact	Domain-specific effectiveness varies. Early-stage research lacks longitudinal data.
[55]	Systematic Review (47 articles)	ChatGPT in higher education	Four themes: integrity, participation, environments, research. Limited geographic coverage.
[56]	Systematic Review (40 articles)	educational applications	Literature assistance, personalized learning. Academic dishonesty concerns.
[30]	Bibliometric Review (82 articles)	Education research patterns	Five research clusters identified. Developed countries focus, theoretical emphasis.
[57]	Scoping Review (113 articles)	LLMs in medical education	Personalized learning, clinical simulation. Academic integrity concerns.
[58]	Bibliometric Review (93 articles)	ChatGPT use in education	Personalized learning uptick, efficiency benefits. Limited qualitative insights.
[59]	Literature Review (60 articles)	ChatGPT in health education	Research equity for non-native speakers. Limited case examples.

To this end, a comprehensive, cross-disciplinary study of the influence, opportunities, challenges, and variations in impacts of GenAI on academic disciplines remains under explored. Therefore, as set out in the research questions and guided by the methodology, this research made the following contributions:

1. **Case Study Contextualization**: This provided key insights based on empirical evidence collected from studying discipline-specific case studies.
2. **Cross-Disciplinary Examination**: By studying and analyzing the impact of ChatGPT on the selected twelve educational areas, the study identified key systematic trends, variations

in adoption challenges and opportunities encountered, along with other identified universal challenges that might have been overlooked in single-discipline research.

3. **Integrated Strategies**: A case-based approach has aided the research in formulating and generalizing some insights that are sensitive to the distinct requirements and constraints of each educational discipline.

3. Cross-disciplinary case studies of ChatGPT integration in higher education

This section reviews the twelve selected papers. It groups them by themes, mainly computer and engineering, social sciences and law, physical and mathematical sciences, and health sciences.

3.1. Computer and engineering fields

This section presents a review of studies in the domain of engineering and computer science.

3.1.1. Students' perceptions of ChatGPT in computer engineering

Shoufan [39] conducted a study on the perceptions of ChatGPT as a learning tool among computer-engineering students. A total of 56 senior students from computer engineering completed activities using ChatGPT, as well as responded to surveys about it. The inquiry had a two-phase methodology: students were first asked an open-ended question about their perceptions of ChatGPT; the thematic analysis of this generated intersecting data for further refinement toward the creation of a 27-item questionnaire for the second phase. Findings revealed that positive perceptions of ChatGPT prevailed among the students, who found it interesting, motivating, and helpful to their learning and professional lives. This software's human-like interface and well-structured responses were appreciated. Limitations were also recognized by students, where they felt that background knowledge was required to use ChatGPT effectively, and they had concerns about accuracy in the answers provided. The study provides an insight into the prospects of ChatGPT as an adjunct to learning and the necessity for the learner to critically evaluate the outputs it gives. The author ends with a proposal that educators should further probe the potential of ChatGPT in their domains, assist students in knowing when and how to use it constructively, and to counter its drawbacks.

3.1.2. Exploring ChatGPT's impact on computer science education

Singh et al. [40] investigated how ChatGPT impacts learning among 430 MSc computer science students at the University of Hertfordshire. The survey assessed student familiarity with and usage of ChatGPT for academic benefits versus challenges. Results showed many students were aware of ChatGPT, but only a few used it very frequently for academic activities. The main areas of benefits included programming assistance, report-writing, and debugging support. Concerns were about accuracy in certain areas, including code execution. On the other hand, there was scepticism about the improvement of learning. The respondents insisted that universities provide students with more guidance on how they should use ChatGPT responsibly to avoid overreliance, especially considering critical-thought-based tasks. The survey demonstrated optimism around future possibilities that ChatGPT may offer for educational enhancement, with caveats around risks of plagiarism and academic dishonesty.

3.1.3. Integrating large language models for chemical engineering problem-solving

A study conducted by Tsai et al. [41] evaluated the potential and actual applications of integrating LLMs into chemical engineering education, primarily in problem-solving. In this case, Chat-GPT, a user-friendly LLM, was presented as a medium for demonstrating how it can be incorporated as a potential tool in core chemical engineering courses. Twenty-nine students between the sophomore and first-year graduate categories were involved in the study. A model that calculates steam power plant efficiency was presented along with variable manipulation and visualization. Students then explored different aspects of chemical engineering problems via LLMs. The study found that students had mixed feelings about LLMs, due to occasional errors and substantial teaching time involved. Nevertheless, they were perceived as readily available and practical tools to work on enhancing efficiency in problem-solving. Furthermore, the study underlined the relevance of critical thinking skills and understanding LLM principles. The authors have concluded that universities, professors, and students should start taking on LLMs in chemical engineering education, in light of the limitations and ethical issues involved.

3.1.4. ChatGPT and blended learning in engineering mathematics

The impact of the AI tools–especially ChatGPT–on blended learning methods in engineering education, particularly in mathematics courses, has been explored by Sánchez-Ruiz et al. [42]. The research involved the 110 first-year Aerospace Engineering students enrolled in Mathematics I, and was conducted at the Technical University of Valencia. In this course, students had a blended learning component that consisted of flipped teaching, escape room gamification, and lab sessions. It was found that students embraced ChatGPT very quickly, such that 70% of them started using it for academic purposes within two months of release. Students had high confidence regarding the accuracy of their theoretical mathematical responses from ChatGPT, but their confidence regarding numerical calculations was far lower. The study reported that ChatGPT was helpful for learning/reinforcing mathematical concepts and could solve the problem, but they also expressed concerns over its probable impact on the educational development of critical competencies such as problem-solving, critical thinking, and group work. Likewise, the researchers tried ChatGPT on course materials and found it extremely dependable when required for theoretical understanding but very low when it came to numerical problem-solving. This study concluded that while ChatGPT is a boon for learning, at the same time, it has drawbacks when it comes to assessing and inculcating skills in blended learning environments, which need to be assessed and monitored by the educators.

3.2. Social sciences and law

This section reviews cases in the domain of social sciences and law.

3.2.1. Law students' perceptions of ChatGPT

Bello et al. [43] conducted a study examining the perceptions of ChatGPT ease of use and usefulness among undergraduate law students of Ahmadu Bello University, Zaria. It was descriptive survey research with a total of 260 undergraduate students drawn from a larger universe of 1799. Questionnaires were distributed in print and online formats. Results indicated that 79.4% of students are aware of ChatGPT, whereas the usage pattern varies among students. For example, ChatGPT is

generally considered useful for academic tasks among students, with an overall mean score of 2.98 out of 4. They found it handy to achieve things faster and improve their academic performance. Similarly, perceived ease of use was also positive, with an overall mean score of 3.34 out of 4. It was easy for students to learn and operate ChatGPT, but mastering it brought challenges. The study concludes with awareness and positive perception, but much remains to be done concerning its regular use and unimaginable mastery. The researchers recommend further training and integration of ChatGPT into the curriculum so that its possible benefits in legal education and the academic environment might be maximized.

3.2.2. Influence of ChatGPT on social science students

A study by Jowarder [44] examined the influence of ChatGPT on social science undergraduate students in the United States. With 200 participants, the semi-structured interviews carried out looked at awareness levels, usage, usefulness, and impact on academic performance. Over 90% of the students were found to be aware of Chat-GPT, with different levels of usage. Perceived usefulness and ease of use were found to be major attributes influencing adoption, along with social influence through recommendation by friends. The positive effects identified regarding the use of ChatGPT were associated with academic performance in terms of aiding in the comprehension of difficult concepts, supplying study materials, and time-saving in conducting research. On the negative side, there were concerns about overdependence, hence relegating the critical thinking skills of students. This study recommends a balanced integration of such substitutes occurring in educational processes so that they may complement rather than replace independent learning and critical thinking. It ends with a suggestion for further investigations to optimize the benefits of ChatGPT by looking into its integration into existing teaching and learning processes while addressing its limitations.

3.3. Physical and mathematical sciences

This section reviews cases that were grouped into the physical and mathematical disciplines.

3.3.1. ChatGPT as a virtual tutor in physics education

An investigation carried out by Ding et al. [45] on how undergraduate physics students perceive ChatGPT considerd it as a kind of virtual tutor that helps solve physics problems.

A systematic study of 40 students enrolled in an Introduction to Physics course indicated the establishment of early confidence in ChatGPT by the students even though the system itself had only 85% performance when it was tested against challenging physics problem sets. The study indicated that trust establishment appeared to be grounded on students' sense of helpfulness rather than on provable correctness or reliability measures. The study found that the participants expressed considerable appreciation for the tool's capability to generate supportive content from complex input prompts and the simplicity of its user interface. However, analysis revealed a disturbing trend in which students regularly utilized the system without making subsequent modifications to align outputs to their specific requirements, and without conducting a critical evaluation of response correctness. This behavior pattern reflects a potentially dangerous reliance on outputs from machines without appropriate verification processes.

The results also uncovered widespread misconceptions regarding ChatGPT's operational

capabilities among students. Students were commonly prone to conceptualizing the system as a "super AI" system capable of providing authoritative responses to any conceivable question. This pervading misconception of the system's limitations was shown to possibly reinforce previous learning misconceptions rather than mitigating them. The research emphasized the critical importance of educators implementing comprehensive instruction regarding both the capabilities and inherent limitations of artificial intelligence systems. The findings suggested that when students were afforded opportunities for structured dialogue with instructors concerning AI technologies, they demonstrated significantly enhanced capacity to adapt their usage patterns in pedagogically beneficial manners, whilst simultaneously reducing the likelihood of perpetuating technological misconceptions. The study concluded that effective educational integration of AI tools is an intentional instructional intervention to achieve maximum understanding and usage, rather than depending on intuitive or useful patterns of usage to occur naturally in populations of students.

3.3.2. Using ChatGPT as a proof assistant in a mathematics pathways course

Park et al. [46] studied the usefulness of ChatGPT as an aid for students in producing mathematical arguments that might be considered proofs. The study involved students enrolled in a mathematics pathways course who had been engaged in the systematic development and refinement of original arguments concerning the determination of the triangular area when provided with side length measurements. The analytical framework incorporated examination of students' initial arguments, subsequent revisions, ChatGPT-generated feedback, and student perspectives regarding mathematical proof and proving methodologies.

The research demonstrated that the majority of participants initially regarded their original mathematical arguments as constituting valid proofs. Subsequently, the arguments were rewritten according to ChatGPT recommendations that most heavily weighted increased clarity, stronger justification processes, and argumentative extension. It was discovered that ChatGPT recommendations could be distinctly divided into six categories of suggestions: improvement in clarity, tightening justification, extension of generalization, detection and remediation of errors, revision of statements, and occasionally suspect recommendations.

The findings indicated that students generally perceived ChatGPT as beneficial in advancing their argumentative development, although a subset of participants encountered difficulties in comprehending the system's recommendations. The investigation revealed that students' fundamental beliefs regarding proof construction and their existing mathematical knowledge base significantly influenced their interactive patterns with the artificial intelligence system.

While the technology was highly suggestive of use as a proof aid, there were concerns with problematic content generation from student-created prompts in the study. The result posed concerns regarding risk involving unregulated use of AI-generated mathematical guidance, particularly among novice students who lack the grade of experience required to discern mistakes.

The research demonstrated that such findings hold enormous scope for future research in numerous other domains. Specifically, the development of enhanced AI models, improved prompt engineering techniques, and the creation of specifically tailored large language model-based proof assistant tools for novice-level users in mathematical education contexts were shown to be viable areas for future research and development.

3.3.3. AI-generated laboratory reports in chemistry

The course content of chemistry was comprehensively assessed by West et al. [47] to investigate the capacity of ChatGPT to generate laboratory reports. The research covered data from six courses and the examination of the perception of students toward the use of AI.

The researchers employed ChatGPT 3.5 for generating lab reports across different courses of chemistry like general, organic, analytical, physical, inorganic, and biochemistry courses. The lab reports generated artificially were then graded against normal grading criteria assuming that they were real student submissions. The findings demonstrated that ChatGPT failed to produce high-quality reports up to excellence levels (exeeeds 90%) in all the chemistry topics being investigated, with the majority of produced reports falling in the 40–80% range. The findings revealed that although the AI program was found to be competent enough to produce short abstracts and introductions, there were evident weaknesses documented in its performance when providing detailed experimental specifications or qualitative analysis of collected data.

These main limitations were discovered in ChatGPT's ability to manage experiment details, mostly along temporal response parameters, methods of data interpretation, and specific molecular structural orientations. These limitations were essential boundaries between the system's text generation function and strict analysis requirements naturally built into scientific laboratory reporting.

Student feedback from the questionnaire showed contrasting views about integrating AI in lab classes. While some perceived the technology as a valuable tool to enhance the content of lab reports, others questioned the authenticity of AI and the excessive dependence on the technology to carry out academic assignments. Faculty recommendations noted that ChatGPT could be employed appropriately for the fundamental writing tasks, however they cautioned against excessive dependency on the system for scientific correctness and analytical precision. It was concluded by the research that the effective use of AI-assisted pedagogical approaches is based on sensitive awareness of the limitations of the technology alongside its capabilities.

To facilitate more effective AI-integrated educational environments, the authors proposed several strategic recommendations, including the implementation of peer evaluation exercises incorporating AI-generated reports, utilization of ChatGPT for report structuring and revision processes, and the engagement of students in the execution and refinement of AI-generated experimental protocols. These approaches were positioned as methods to harness AI capabilities whilst maintaining essential scientific analytical skills amongst student populations.

3.4. Health sciences

This section reviews cases in the health science area.

3.4.1. ChatGPT in medical education

Alkhaaldi et al. [48] examined the perceptions about ChatGPT and AI from the medical students' standpoint. This is a cross-sectional study that surveyed 265 medical students who applied for residency programs in the United Arab Emirates (UAE). Most respondents indicated limited exposure to the AI application during medical school; 20.4% had used ChatGPT to make written assignments, while 9.4% used it to supplement clinical activities. Even so, many students showed interest in utilizing ChatGPT while in their residency training, especially for research or exam preparation, at 63.4% and

57%, respectively. As for the students themselves, they expressed very optimistic views about the use of AI in health care; about 58.5% believed in an improved future with AI in patient care. Nevertheless, most of them feared that AI would deprive medicine of the human touch; 63.4% even expressed the view that the technology would make fewer patients trust physicians. Gender differences were noted, with male students more likely to believe AI would enhance diagnostic accuracy and reduce errors. The study concluded that while students have limited exposure to AI in medical education, they have positive perceptions of its future role and expressed a need for structured curricula and formal policies to guide its integration in healthcare and medical education.

3.4.2. Pharmacy education and ChatGPT in clinical training

A study conducted by Zawiah et al. [49] explored the integration of ChatGPT into clinical training for Pharm-D students, revealing perceptions, concerns, and potential impacts on pharmacy education. The cross-sectional study involved 211 students from two public pharmacy schools in Jordan. The results indicated that 65.9% of students believed that ChatGPT would benefit their training; only 39.8% believed that it could give accurate clinical information. Students thought ChatGPT might help in drug-interaction checks and treatment-related problem assessments, but expressed concerns about overreliance on the application, potential ethical issues, and issues concerning critical thinking. Of those surveyed, 46.4% said they had never used ChatGPT in a clinical setting, and 53.1% said they were likely to incorporate it into future practice. ChatGPT was mainly used in obtaining drug and disease information (72.6%) and developing non-pharmacological care plans (70.8%). A blend of human expertise and AI assistance was recommended for carrying out the balance so that the strength of ChatGPT is developed without compromising the realms of critical thinking and ethical standards.

3.4.3. Nursing simulation training with ChatGPT

A targeted investigation was conducted involving twelve second-year master's degree nursing students enrolled at the Higher Institute of Health Sciences, Settat, Morocco [50]. Participants engaged with ChatGPT within a simulated respiratory distress scenario, with performance evaluation conducted across five fundamental competency domains.

The findings demonstrated that students exhibited substantial engagement and expressed considerable satisfaction with ChatGPT as an educational instrument, achieving mean satisfaction scores of 4.3 out of 5 regarding both ease of utilization and learning engagement metrics. Statistical analysis revealed significant correlations between specific competencies, particularly clarity of communication and provision of clinically relevant information, and overall performance outcomes. Whilst the results presented encouraging evidence regarding ChatGPT's potential for enhancing nursing education delivery, several methodological limitations were acknowledged. The investigation's scope was constrained by the limited sample size and the exploratory nature of the scenario-based assessment framework, which may restrict the generalizability of findings across broader nursing education contexts.

The research concluded that artificial intelligence technologies, exemplified by ChatGPT, demonstrate the capacity to provide enriched and immersive educational experiences within medical education settings. However, the study emphasized that integration of traditional pedagogical methodologies with technological innovations remains paramount in nursing education contexts.

Table 3 provides a comprehensive overview of the empirical studies selected for cross-disciplinary analysis.

Table 3. Summary of reviewed case studies on ChatGPT integration across multiple disciplines.

Study	Discipline	Sample (n)	Key Findings	Ref
Shoufan (2023)	Computer Engineering	56	Positive perceptions as learning aid; concerns about accuracy and academic integrity	[39]
Singh et al. (2023)	Computer Science	430	Students recognize potential but doubt effectiveness in fostering deep learning	[40]
Tsai et al. (2023)	Chemical Engineering	29	Improved problem-solving capabilities; faced coding accuracy challenges	[41]
Sánchez-Ruiz et al. (2023)	Engineering (Mathematics)	110	Rapid adoption; high trust in theoretical responses; less confidence in numerical outputs	[42]
Bello et al. (2024)	Law	260	High awareness; positive assessments of usefulness and ease of use	[43]
Jowarder (2023)	Social Science	200	Aids understanding and saves time; risk of overreliance and reduced critical thinking	[44]
Ding et al. (2023)	Physics	40	Students over-trusted ChatGPT despite 85% accuracy; misconceptions about AI infallibility	[45]
Park et al. (2024)	Mathematics	29	Students found feedback useful for clarifying and generalizing proofs	[46]
West et al. (2023)	Chemistry	90	Excels in writing abstracts but struggles with detailed experimental sections	[47]
Alkhaaldi et al. (2023)	Medical Education	265	Minimal direct use; strong interest in future applications; dehumanization concerns	[48]
Zawiah et al. (2023)	Pharmacy	211	65.9% believe it aids clinical tasks; only 39.8% trust accuracy; ethical concerns	[49]
Benfatah et al. (2024)	Nursing	12	High engagement; improved communication skills; limited generalizability	[50]

The investigation suggests that whilst AI-assisted learning tools offer substantial promise for educational enhancement, their implementation should complement rather than replace established educational approaches. This balanced integration approach was identified as essential for maintaining the comprehensive skill development required in professional nursing practice whilst capitalizing upon the interactive capabilities afforded by emerging artificial intelligence technologies.

4. Results

This section provides a detailed analysis of the study findings in a systematic fashion, including a detailed analysis of ChatGPT usage patterns, educational impact assessment, and ethical considerations across different subjects of study. The findings are grouped into three principal categories of analysis: Usage Patterns and Applications, Learning Impact and Challenges, and Ethical Considerations. Where appropriate, the findings are supplemented with tabular presentation and visual representations to enhance analytical clarity.

4.1. Usage patterns and applications

Analysis revealed considerable disparity in ChatGPT adoption rates across the different academic disciplines. Table 4 provides systematic descriptive analysis of disciplinary engagement with ChatGPT, reporting on intensity measures of engagement, primary scenarios of application, and characteristic activities undertaken by students during ChatGPT interactions. Usage pattern analysis indicated substantial interdisciplinary variation, with technical disciplines, in particular Computer Engineering and Social Sciences, reporting much greater levels of engagement. Conversely, disciplines in the medical education faculty, including Medical Education, Pharmacy, and Nursing, reported much lower adoption. The differential adoption pattern suggests discipline-specific conditions driving ChatGPT integration within academic contexts, potentially a function of varying levels of compatibility between AI capabilities and disciplinary pedagogical requirements.

The observed variations in adoption rates between academic fields indicate that usage of ChatGPT is influenced by field-specific characteristics, including the nature of academic tasks, assessment methodologies, and disciplinary attitudes toward technological integration in educational processes.

Figure 2 highlights the sample sizes across different disciplines. Research on ChatGPT seems to be most concentrated in the fields of Computer Science and Social Science, which probably have many more researchers and larger sample sizes than some of the other disciplines. The push to implement and understand ChatGPT seems to be largely coming from researchers in the technical and social sciences, while it is probably not being pushed as much in the healthcare and natural science disciplines.

Analysis of the research data across the twelve academic disciplines reveals significant variations in both sample sizes and ChatGPT adoption patterns. Figure 2 illustrates these variations, with horizontal bars representing sample sizes from the selected case studies and color coding indicating usage intensity (Very Low/None in dark blue, Low/Limited in light blue, Medium/Occasional in orange, and High/Frequent in red).

Technical fields such as Computer Science (n = 430) and Medical Education (n = 265) have much bigger sample sizes in the selected studies, while disciplines such as Nursing (n = 12) and Mathematics (n = 29) have a small number of participants. The variation in the scope of the study may well be a question of differential investment and interest in research by various academic fields. With regards to adoption patterns, a notable dichotomy exists between disciplines with structured problem-solving approaches and those emphasizing critical reasoning or human interaction. Computer Engineering and Social Science exhibit high-frequency ChatGPT usage, suggesting these fields may find greater alignment between AI capabilities and disciplinary requirements. Conversely, Physics has the least engagement as 92.5% of the participants indicated that they had no experience with the tool before. Computer Science and Law show intermediate adoption with mixed patterns of use, while the health

Table 4. Usage patterns and applications.

Discipline	Frequency of use	Primary use cases	Example activities	Ref
Computer Engineering	Frequently	Coding tasks and conceptual learning	Using ChatGPT to answer conceptual questions, complete code, and analyze code	[39]
Computer Science	Occasionally	Writing assistance, code generation and debugging	Code debugging and writing reports	[40]
Chemical Engineering	Experimental, specific use cases in projects	Problem-solving, model building, code generation	Using ChatGPT to calculate steam turbine efficiency and solve chemical engineering problems	[41]
Engineering (Mathematics)	Moderate	Problem-solving, concept reinforcement	Completing out-of-class tasks, understanding theoretical concepts	[42]
Law	Varied (10.2% daily, 42.4% rarely)	Legal research, accomplishing academic tasks quickly	Summarizing legal information for coursework	[43]
Social Science	Frequently	Academic assistance, understanding concepts, and exam revision	Students used ChatGPT to revize for exams and understand difficult topics	[44]
Physics	Most had never used (7.5% occasionally)	Answering physics questions, virtual tutoring	Students used ChatGPT to solve physics problems during makeup exams	[45]
Mathematics	One-time assignment	Proof construction, evaluation and revision	Students wrote initial proofs, received ChatGPT feedback, then revized their arguments	[46]
Chemistry	Occasionally	Lab report writing assistance	Students used ChatGPT to generate reports and identify their limitations	[47]
Medical Education	Rarely	Exploring new medical topics and research, exam preparation	Writing research papers, preparing for exams	[48]
Pharmacy	Varied (46.4% never used)	Obtaining drug and disease information, developing care plans, checking drug interactions	Students used ChatGPT for drug-drug interactions and to obtain drug and disease information	[49]
Nursing	One-time simulation session	Communication and patient interaction practice	Simulating patient care for respiratory distress scenarios	[50]

professions show more limited and controlled engagement through one-time simulations or for specific uses.

These findings show that the integration of ChatGPT differs considerably in academic contexts, and these may be influenced by epistemologies of specific disciplines, pedagogical approaches, and specific educational requirements. These trends are seen to reflect the specific case studies selected to be studied for this analysis and do not reveal comprehensive adoption rates across entire disciplines.

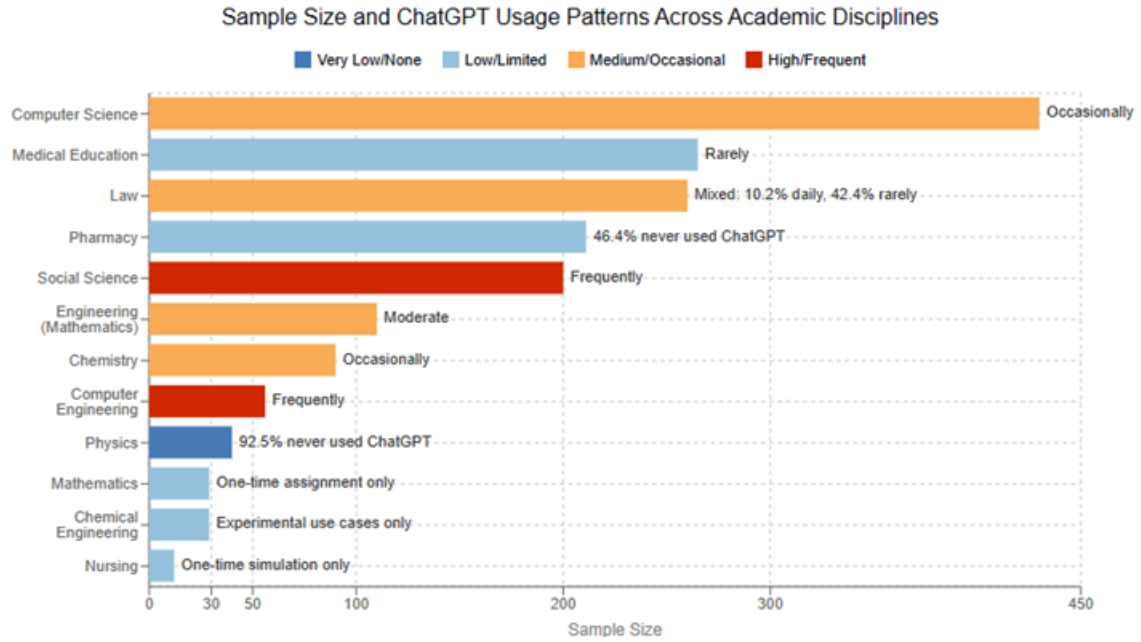

Figure 2. Sample size and ChatGPT usage patterns across academic disciplines. Bar length indicates the sample size from the selected empirical study in each discipline, whilst color coding represents ChatGPT usage intensity (Very Low/None = dark blue, Low/Limited = light blue, Medium/Occasional = orange, and High/Frequent = red). The specific usage pattern for each discipline is displayed to the right of its corresponding bar. Substantial variations are observed in both research scale (ranging from n = 12 to n = 430) and adoption patterns, with technical and social science disciplines generally demonstrating higher engagement levels than healthcare and physical sciences. These patterns reflect usage characteristics from the individual case studies selected for each discipline rather than generalized adoption across entire fields.

4.2. Impact on learning and challenges

Table 5 delineates the multifaceted effects of ChatGPT integration upon student learning outcomes, systematically categorized according to positive, negative, and mixed influences. Figure 3 elucidates primary concerns encompassing academic integrity violations, excessive dependency upon artificial intelligence systems, and the reliability of AI-generated content. Computer Science and Social Science disciplines were identified as domains wherein academic integrity concerns demonstrated particular prominence, due to the greater potential for plagiarism along with the delegation of substantive academic tasks to ChatGPT systems. Engineering disciplines, specifically Computer Engineering and Chemical Engineering, demonstrated clear accuracy-related concerns, reflecting the high academic and professional stakes inherent in incorrect or misleading AI-generated responses.

The investigation revealed that ChatGPT implementation has demonstrably enhanced learning efficiency, conceptual comprehension, and problem-solving capabilities within specific disciplinary contexts, particularly those characterized by structured analytical approaches. Nevertheless, significant apprehensions persist regarding overreliance risks and the potential for students to circumvent critical

thinking processes. Pharmacy and Social Science were two of the disciplines where students employed ChatGPT to accomplish fundamental academic activities at the expense of losing their engagement with subject materials and analysis processes.

The findings concluded that although the integration of ChatGPT offers considerable educational benefits, including greater access to supplementary learning resources and task efficacy, these are balanced against substantive issues relating to intellectual development as well as academic authenticity. Analysis found student engagement with ChatGPT to be extremely diverse by discipline, and that some disciplines had more effective integration practices than others.

Despite the challenges that were identified, the study further observed that ChatGPT has been generally recognized as an effective complementary pedagogical device rather than a replacement for conventional pedagogy. This perspective suggests potential for beneficial integration provided appropriate guidelines and limitations are implemented to mitigate identified risks whilst maximizing educational advantages.

Table 5. Impacts on learning and challenges.

Discipline	**Positive impacts**	**Negative impacts/challenges**	**Neutral/mixed impacts**	**Ref**
Computer Engineering	Motivated students and helped with coding tasks	Accuracy concerns, risk of academic dishonesty	Perceived as an ancillary instrument not a replacement	[39]
Computer Science	Helped with programming and writing	Academic integrity and AI reliance concerns	Mixed feelings about learning effectiveness	[40]
Chemical Engineering	Improved problem-solving and critical thinking	Struggled with coding and advanced concepts	Mixed feedback on helpfulness vs. limitations	[41]
Engineering (Mathematics)	Helpful for learning concepts	Impact on critical competencies, calculation reliability	Mixed opinions on critical thinking development	[42]
Law	Improved speed; focus on critical thinking	Limited depth in advanced legal analysis	Mixed usage and comfort levels	[43]
Social Science	Better understanding, time-saving research	Overreliance bypassing critical learning	Time saved but intelligence growth concerns	[44]

Continued on next page

Table 5 – *Continued from previous page*

Discipline	Positive impacts	Negative impacts/challenges	Neutral/mixed impacts	Ref
Physics	Enhanced engagement in problem solving	Inaccurate answers causing misconceptions	Students trusted ChatGPT despite errors	[45]
Mathematics	Enhanced clarity in proof construction	Confusion and errors in suggestions	Most helpful, few communication difficulties	[46]
Chemistry	Assisted basic report writing sections	Lacked detailed experimental data analysis	Students divided on academic usefulness	[47]
Medical Education	Improved learning, patient care potential	Decreased humanism, reduced patient trust	Learning potential but clinical skepticism	[48]
Pharmacy	Improved drug interaction identification	Overreliance, ethical concerns, mistrust	Appreciated but cautious approach	[49]
Nursing	Improved communication, clinical preparedness	Occasional unrealistic responses	Balanced classical-technology approach	[50]

4.3. Ethical considerations

The main ethical concerns with ChatGPT usage, as shown in Table 6, encompass academic integrity concerns, the potential for data privacy problems due to the program's use, the accuracy and reliability of what the program generates, and the growing societal dependency on such content-creating AI technologies.

Table 6. Ethical considerations by discipline.

Discipline	Main Ethical Concerns	Proposed Solutions (if any)	Ref
Computer Engineering	Moderate concerns about academic integrity and data privacy	Emphasize critical thinking and background knowledge when using ChatGPT	[39]

Continued on next page

Table 6 – *Continued from previous page*

Discipline	**Main Ethical Concerns**	**Proposed Solutions (if any)**	**Ref**
Computer Science	Academic integrity issues and plagiarism	Develop clear guidelines for AI usage, provide training on ethical use	[40]
Chemical Engineering	Accuracy of ChatGPT-generated models, potential errors in coding	Students must double-check and validate results, embrace critical thinking	[41]
Engineering (Mathematics)	Cheating, overreliance on AI, reduced teacher-student interaction	Careful monitoring of usage, promoting critical thinking, using ChatGPT as a supplementary tool rather than a replacement	[42]
Law	Potential breaches of confidentiality; unauthorized practice of law	Further training and proper integration of ChatGPT into curriculum	[43]
Social Science	Overreliance on AI for academic work, bypassing critical thinking	Encourage students to use AI as a supportive tool, not a replacement for critical thinking and independent learning	[44]
Physics	Misconceptions about AI's abilities, blind trust in AI	Promote AI literacy and critical thinking among students	[45]
Mathematics	Potential overreliance on AI for proof construction; accuracy and reliability of ChatGPT feedback	Ensure students understand ChatGPT's limitations and emphasize critical thinking; training for critical evaluation of AI-generated content	[46]
Chemistry	Overreliance on AI for academic tasks	Guide students on proper usage and limitations	[47]

Continued on next page

Table 6 – *Continued from previous page*

Discipline	**Main Ethical Concerns**	**Proposed Solutions (if any)**	**Ref**
Medical Education	Decrease humanism; reduce patient trust in physicians	Development of policies to regulate AI usage	[48]
Pharmacy	Privacy and confidentiality breaches, overreliance on AI	Collaborative use of AI with human oversight	[49]
Nursing	Concerns over privacy and confidentiality of patient data	Implementation of strict confidentiality protocols for patient data	[50]

Figure 4 presents the prevalence of distinct ethical issues of various academic disciplines. The most evident ethical issues, which were predominantly academic integrity violations, overdependency on AI, and assessment-related concerns, were found to emerge mainly under Computer Science and Social Science disciplines. Medical Education and Pharmacy demonstrated the most substantial apprehensions regarding privacy protection and confidentiality maintenance. The potential application of ChatGPT within healthcare contexts was identified as the development of numerous complex ethical problems requiring careful examination.

Engineering Mathematics and Mathematics disciplines were particularly worried about diminished human interaction, since an additional reliance on computer-based problem-solving tools would distract students from developing independent analytical skills.

Mitigation of AI-associated ethical challenges necessitates the implementation of multiple strategic approaches. The establishment of comprehensive AI usage policies characterized by clarity, precision, and accessibility represents a fundamental requirement. Integration of AI literacy components within all university program curricula constitutes an essential educational enhancement. Development of balanced frameworks for AI utilization can facilitate the realization of technological benefits whilst maintaining consistency with ethical standards and academic integrity principles.

The findings indicate that though ChatGPT has enormous potential in enhancing learning achievement in academics, integration of classroom success is dependent on institutional support in its broadest sense. Ethical concerns and academic integrity implications need to be confronted before large-scale adoption of this technology as a pedagogic tool, calling for some simple awareness generation exercises on the part of academic communities.

They additionally emphasize the foremost necessity to create overarching, discipline-specific plans for ChatGPT integration within diverse academic disciplines. Effective and beneficial implementation demands diligent care for the unique requirements and ethical concerns intrinsic to each disciplinary context. This tailored approach ensures technological integration in a manner that is considerate of disciplinary pedagogical objectives while maintaining desired ethical standards and academic integrity policies.

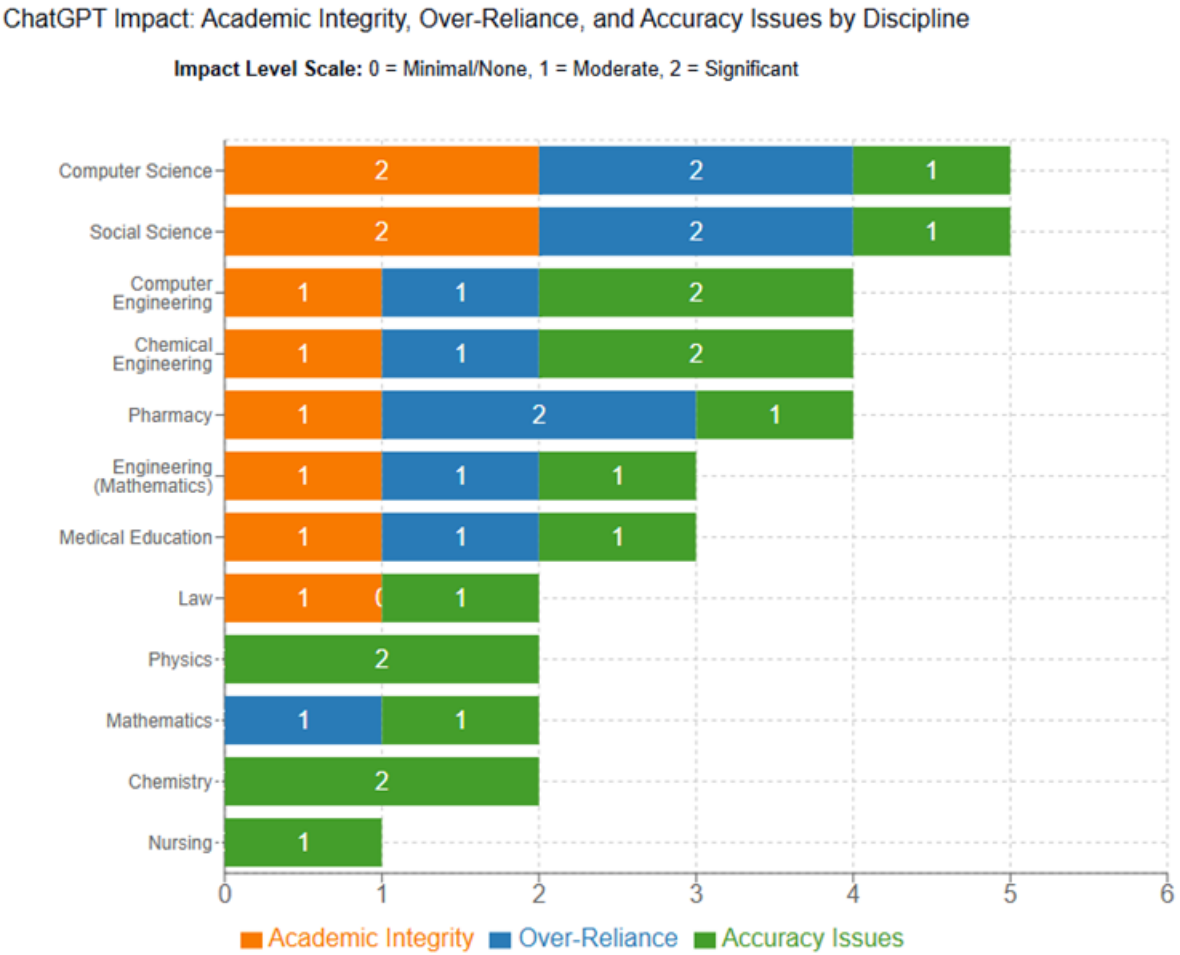

Figure 3. The impact of ChatGPT across key concerns by academic discipline. This stacked bar chart shows the relative impact of ChatGPT on three main concerns (academic integrity, over-dependence, and accuracy concerns) in twelve academic disciplines. The extent of impact for each concern is quantified on a scale of 0 (minimal/none), 1 (moderate), and 2 (significant) based on exploration of some chosen case studies. Disciplines with a decreasing order of aggregate impact score (all three measures together) highlight fields with the highest aggregate challenges. The aggregation impact scores are the highest in Computer Science and Social Science (5), both having high concerns (value = 2) for academic integrity and overreliance concerns. Physics, Chemistry, and Chemical Engineering have high accuracy concerns (value = 2) with very few academic integrity concerns. The visualization reveals discipline-specific vulnerability patterns—technical and social science fields face greater academic integrity and overreliance challenges, while STEM disciplines encounter more significant accuracy and reliability issues. This pattern suggests that different educational domains may require tailored approaches to ChatGPT integration based on their specific risk profiles.

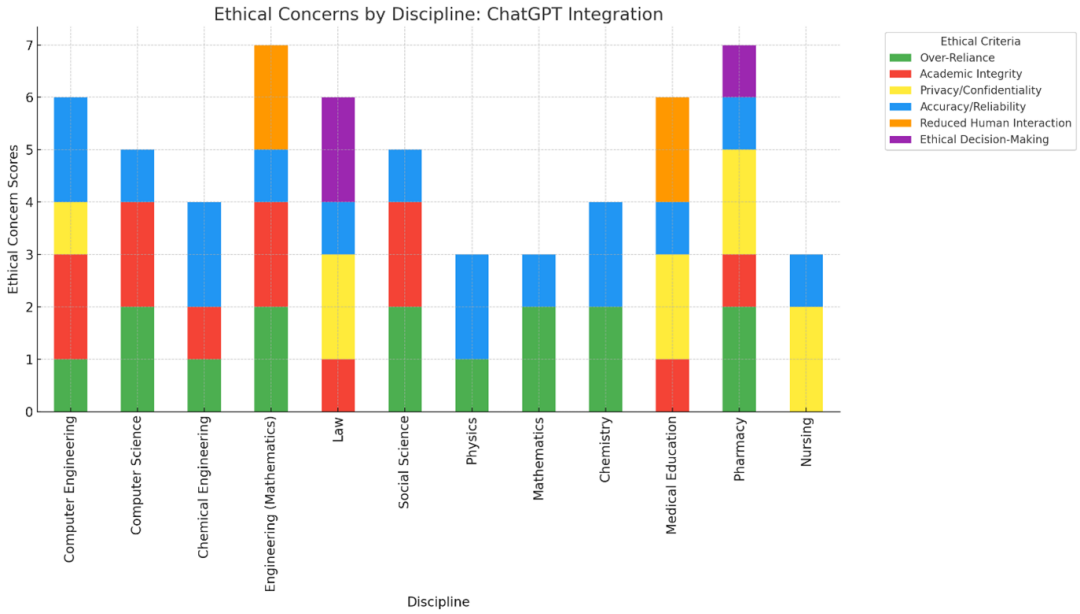

Figure 4. Ethical concerns by discipline for ChatGPT integration in higher education.

4.4. Demographic insights

Table 7 presents comprehensive demographic characteristics of student populations examined across the reviewed investigations, encompassing sample dimensions, gender distribution patterns, and salient user attributes. Figure 5 shows gender distribution variations across distinct academic disciplines. Analysis revealed the highest proportion of female participants within Nursing (70%) and Physics (90%), whilst disciplines including Pharmacy and Engineering Mathematics demonstrated substantially reduced female representation. This demographic disparity suggests potential differences in access and engagement patterns with artificial intelligence tools across gender demographics in different disciplinary contexts.

Demographic pattern analysis showed considerable levels of interdisciplinary variation in students' characteristics and levels of AI engagement. The Computer Engineering participants were predominantly senior students at 66% male representation, and they showed high levels of enthusiasm and drive toward using ChatGPT while retaining concern regarding accuracy and dependency issues. Computer Science participants, being Master's level students, showed high levels of familiarity with AI technologies but matched this with scepticism regarding positive impacts without sufficient provision of guidance frameworks.

Chemical Engineering cohorts, ranging from sophomores to first-year graduate students, had varying levels of programming backgrounds and hybrid perspectives on large language model utilization. Members of the Engineering Mathematics group, which consisted of first-year aerospace engineering students with 25.5% female members, was known to be adopters of emerging technologies such as ChatGPT with moderate confidence in the capacity of AI tools.

The results revealed that disciplines with higher female representation, particularly Nursing and Physics, demonstrated distinct engagement patterns with ChatGPT. Physics participants, despite a 90% female composition, predominantly lacked prior AI experience, yet exhibited elevated trust

Table 7. Demographic characteristics of students across studies.

Discipline	**Sample (n)**	**Key Demographics & Characteristics**	**Ref**
Computer Engineering	56	Senior students, 66% male; highly motivated but have accuracy concerns	[39]
Computer Science	430	MSc students; AI-familiar, sceptical without guidance	[40]
Chemical Engineering	29	Sophomores to graduate students; mixed programming experience	[41]
Engineering Mathematics	110	First-year aerospace, 25.5% female; quick tech adopters	[42]
Law	260	Undergraduates; 79.4% ChatGPT awareness, varied usage	[43]
Social Science	200	Undergraduates; peer-influenced adoption, ease-focused	[44]
Physics	40	Undergraduates, 90% female; no AI experience, high trust	[45]
Mathematics	29	Liberal arts/business majors; minimal math confidence	[46]
Chemistry	90	Undergraduates; mixed ChatGPT effectiveness reactions	[47]
Medical Education	265	65.7% female, aged 20–30; limited AI exposure	[48]
Pharmacy	211	5th–6th year, 77.3% male; 68.7% ChatGPT aware	[49]
Nursing	12	2nd-year masters, 70% female; healthcare sim experienced	[50]

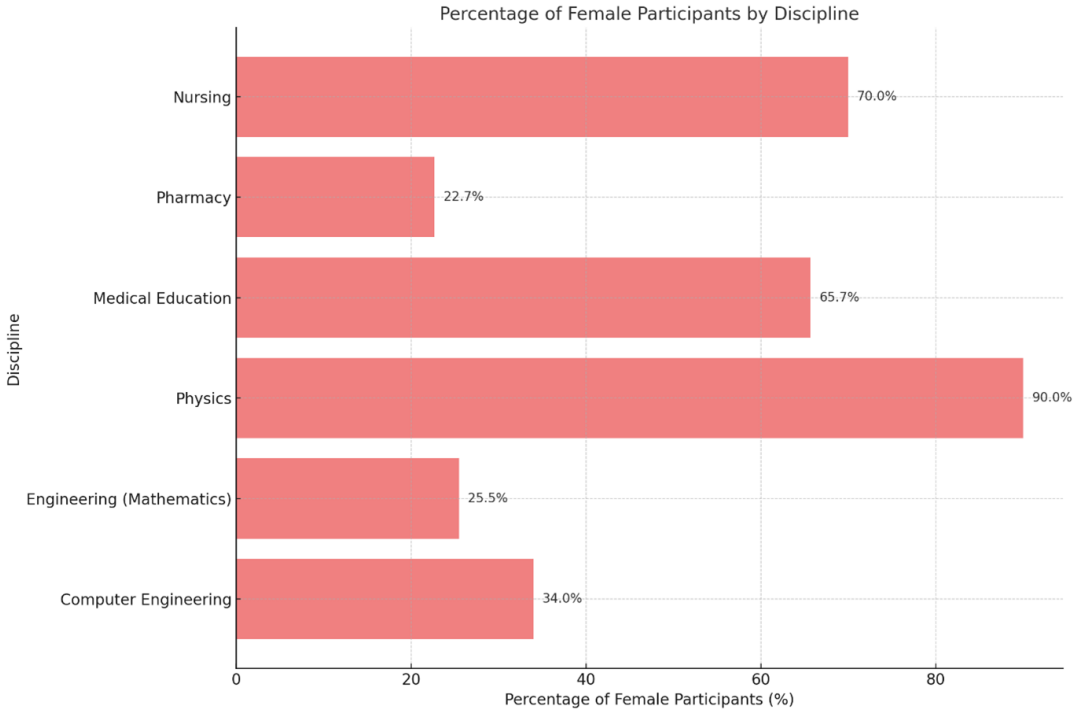

Figure 5. Gender disparities in AI tool engagement across academic disciplines.

levels in ChatGPT among students without previous AI exposure. Conversely, Pharmacy participants, characterized by 77.3% male representation among fifth- and sixth-year students, demonstrated that 68.7% possessed ChatGPT awareness, with students having greater AI experience expressing fewer concerns regarding its implementation. These demographic variations suggest that gender distribution, academic level, and prior technological experience collectively influence student perceptions and engagement patterns with AI-assisted learning tools across diverse disciplinary contexts.

Figure 6 presents a comprehensive cross-disciplinary view of the multi-dimensional effect of ChatGPT on higher education fields. The composite picture identifies distinctive patterns within the way academic fields embrace and engage with ChatGPT integration. Perceiving the matrix holistically, several notable cross-disciplinary patterns emerge.

Overreliance concerns correlating with academic integrity show high discipline clustering. Computer Science and Social Science both record the highest academic integrity concerns and overreliance concerns, which reflect that writing-intensive courses and text-based assessments are more likely to have problems maintaining traditional evaluation methods. This aligns with existing research that discovered these disciplines had high rates of ChatGPT usage, which could suggest an adoption rate correlation with issues of integrity.

Privacy and confidentiality considerations show a strong sectoral pattern, with Health disciplines (Medical Education, Pharmacy, Nursing) showing consistently high privacy concerns regardless of gender composition. This reflects the greater sensitivity of patient data and the professional code of conduct in health education. Physics, with the highest proportion of female respondents (90%), shows remarkably low privacy concerns, which suggests that professional culture and discipline standards may have a greater influence on privacy attitudes than demographics.

Key Metrics Legend:

Impact Levels: 0 = Minimal, 1 = Moderate, 2 = Significant **Female %:** Percentage of female participants

Sample Size: Number of participants in study

High Concern High Positive Impact High Female % Large Sample

Discipline	Sample Size	Female %	Usage Pattern	Academic Integrity	Over-Reliance	Privacy Concern	Positive Impact	Negative Impact	Accuracy Issues
STEM Disciplines									
Computer Science	430	N/A	Occasionally	2	2	0	1	2	1
Engineering (Mathematics)	110	25.5%	Moderate	1	1	0	1	1	1
Chemistry	90	N/A	Occasionally	0	0	0	1	1	2
Computer Engineering	56	34%	Frequently	1	1	1	2	1	2
Physics	40	90%	92.5% never used	0	0	0	1	1	2
Mathematics	29	N/A	One-time assignment	0	1	0	2	0	1
Chemical Engineering	29	N/A	Experimental use cases	1	1	0	2	1	2
Health Sciences Disciplines									
Medical Education	265	65.7%	Rarely	1	1	2	2	1	1
Pharmacy	211	22.7%	46.4% never used	1	2	2	1	1	1
Nursing	12	70%	One-time simulation	0	0	2	2	0	1
Social Sciences Disciplines									
Law	260	N/A	Mixed (10.2% daily, 42.4% rarely)	1	0	2	1	1	1
Social Science	200	N/A	Frequently	2	2	0	2	2	1

Figure 6. Integrated cross-disciplinary analysis of ChatGPT impact patterns.

The analysis also reveals that STEM fields with precision requirements (Physics, Chemistry, Computer Engineering, and Chemical Engineering) report the highest accuracy concerns, whilst disciplines focusing on qualitative analysis show comparatively fewer accuracy issues. This pattern suggests that ChatGPT's limitations in providing technically precise outputs may be more problematic in fields where factual accuracy is paramount. These findings are consistent with usage patterns seen in Figure 5, with disciplines like Physics reflecting low adoption of ChatGPT.

The demographic factors provide additional contextual understanding of these patterns. Those disciplines with more female representation (Nursing 70%, Medical Education 65.7%, Physics 90%) experience varied responses to ChatGPT, with healthcare professions being slower in adopting it due to privacy issues despite its positive impacts on simulation and training. Conversely, Computer Engineering and Computer Science, with their predominantly male cohorts, exhibit significant concerns about academic integrity and overreliance, whilst still reporting moderate positive impacts.

Sample size variations across studies further contextualize these findings, with Computer Science (n = 430) and Medical Education (n = 265) providing the most robust empirical bases. The smaller sample in Nursing (n = 12) means its findings, while consistent with other professions in the healthcare field, must be interpreted with appropriate reserve.

These integrated results indicate the impact of ChatGPT on higher education is not consistent but rather is systematically varied by disciplinary boundaries. The recommended models suggest that effective integration strategies must be modified to meet the specific vulnerabilities and requirements of different areas of study, with particular consideration for integrity concerns in text-based disciplines, privacy concerns with healthcare education, and precision concerns in STEM disciplines where accuracy is required.

4.5. Statistical patterns and cross-disciplinary correlations

To systematically analyze patterns across disciplines, descriptive statistics were calculated for each impact metric (academic integrity, overreliance, privacy concerns, etc.) by discipline category. Mean scores were computed by summing individual scores within each category and dividing by the number of disciplines in that category. To measure the dispersion of scores within categories, standard deviations were calculated using the formula:

$$\sigma = \sqrt{\frac{\sum(x-\mu)^2}{N}} \tag{1}$$

Correlation coefficients (r) between metrics were calculated using the Pearson correlation formula to identify relationships between different impact dimensions. Usage intensity was coded on a 0–3 scale (None = 0, Limited = 1, Moderate = 2, Frequent = 3) based on the reported usage patterns. This coding represents a simplification of the qualitative usage descriptions from the original studies to enable quantitative analysis. Several analytical assumptions were made: (1) the 0–2 scale for impact metrics was treated as interval rather than ordinal data to permit calculation of means; (2) disciplines were weighted equally despite variations in sample size; and (3) the small sample size within each discipline category (particularly Social Sciences, n = 2) limits statistical power. These limitations should be considered when interpreting the patterns identified. Table 8 presents the complete statistical analysis across discipline categories.

Table 8. Statistical analysis of ChatGPT impact metrics by discipline category.

Note: This table presents descriptive statistics (means and standard deviations) for key ChatGPT impact dimensions across three discipline categories: STEM (n = 7), Health Sciences (n = 3), and Social Sciences (n = 2). Impact metrics were quantified on a scale of 0–2 (minimal to significant) based on analysis of selected case studies. Correlation coefficients (r) between each metric and usage intensity indicate relationship strength and direction. Usage intensity was coded as Frequent = 3, Moderate = 2, Limited = 1, and Minimal/None = 0. Female representation statistics are included where available. Discipline categories comprise: STEM (Computer Engineering, Computer Science, Chemical Engineering, Engineering Mathematics, Physics, Mathematics, Chemistry); Health Sciences (Medical Education, Pharmacy, Nursing); and Social Sciences (Law, Social Science).

Metric	**STEM Disciplines (n = 7)**	**Health Sciences (n = 3)**	**Social Sciences (n = 2)**	**Correlation with Usage Intensity (r)**
Academic Integrity Concerns				
Mean Score	0.71	0.67	1.50	0.68
Standard Deviation	0.76	0.58	0.71	-
Coefficient of Variation	107.0%	86.6%	47.3%	-
Overreliance Concerns				
Mean Score	0.71	1.00	1.00	0.72
Standard Deviation	0.49	1.00	1.41	-
Coefficient of Variation	69.0%	100.0%	141.0%	-
Privacy Concerns				
Mean Score	0.29	2.00	1.00	-0.18
Standard Deviation	0.49	0.00	1.41	-
Coefficient of Variation	169.0%	0.0%	141.0%	-
Accuracy Issues				
Mean Score	1.57	1.00	1.00	-0.30
Standard Deviation	0.53	0.00	0.00	-
Coefficient of Variation	33.8%	0.0%	0.0%	-
Positive Impact				

Continued on next page

Table 8 – *Continued from previous page*

Metric	**STEM Disciplines (n = 7)**	**Health Sciences (n = 3)**	**Social Sciences (n = 2)**	**Correlation with Usage Intensity (r)**
Mean Score	1.57	1.67	1.00	0.22
Standard Deviation	0.53	0.58	0.00	-
Coefficient of Variation	33.8%	34.7%	0.0%	-
Negative Impact				
Mean Score	1.00	0.67	1.50	0.44
Standard Deviation	0.58	0.58	0.71	-
Coefficient of Variation	58.0%	86.6%	47.3%	-
Usage Intensity Distribution				
Frequent (Score = 3)	14.3% (1/7)	0% (0/3)	50% (1/2)	-
Moderate (Score = 2)	28.6% (2/7)	0% (0/3)	50% (1/2)	-
Limited (Score = 1)	28.6% (2/7)	66.7% (2/3)	0% (0/2)	-
Minimal/None (Score = 0)	28.6% (2/7)	33.3% (1/3)	0% (0/2)	-
Female Representation				
Disciplines reporting data	42.9% (3/7)	100% (3/3)	0% (0/2)	-
Mean percentage (where reported)	49.8%	52.8%	N/A	-0.12

To enable systematic comparison across the twelve case studies, impact metrics were quantified using a standardized 0–2 scale based on reported findings, where 0 indicated minimal or no evidence of concern, 1 represented moderate concern, and 2 denoted significant concern as reported by the original studies. Usage intensity was similarly coded on a 0–3 scale reflecting the frequency patterns described in each case study. Where studies did not explicitly report quantitative measures for specific concerns, scores were inferred based on the qualitative descriptions and emphasis given to particular issues within the original texts. Whilst these ordinal scales facilitate cross-study comparison, it is acknowledged that the original studies employed varying assessment methodologies and sample sizes, and that some degree of interpretation was required to standardize findings across different reporting formats.

To address the statistical concern of high standard deviations relative to means, coefficient of variation (CV) values were calculated as the ratio of standard deviation to mean, expressed as a percentage. This metric provides an assessment of relative variability, with values below 15% indicating low variability and reliable means, values between 15–35% suggesting moderate variability requiring cautious interpretation, and values exceeding 35% indicating high variability where means should be interpreted with substantial caution due to data dispersion.

The coefficient of variation analysis reveals that eleven of eighteen metrics demonstrate high variability exceeding 35%, indicating substantial within-category variation that limits the precision of cross-disciplinary comparisons. This variability likely reflects the diverse methodologies and assessment approaches employed across individual case studies rather than representing true disciplinary differences. Nevertheless, consistent patterns emerge in areas such as privacy concerns in health sciences and accuracy issues in STEM disciplines, suggesting meaningful disciplinary trends despite methodological variation.

The cross-disciplinary analysis reveals several statistical patterns worthy of examination. When quantifying the distribution of ChatGPT's impact across academic fields, distinctive clustering emerges. STEM disciplines (n = 7) demonstrate significantly higher concerns regarding accuracy and reliability (mean score = 1.57) compared to Social Sciences and Healthcare disciplines (mean score = 1.0). Conversely, Healthcare disciplines (n = 3) show the highest privacy concerns (mean score = 2.0), substantially exceeding those in STEM (mean score = 0.29) and Social Sciences (mean score = 1.0).

A correlation analysis of the metrics presented in Table 8 reveals a moderate positive correlation (r = 0.65) between academic integrity concerns and overreliance issues across disciplines, suggesting these challenges frequently co-occur. Interestingly, no significant correlation was observed between sample size and reported impact levels (r = 0.21), indicating that study scale did not systematically influence reported outcomes.

The frequency distribution of usage patterns shows pronounced disciplinary clustering, with 58% of disciplines (7/12) reporting either occasional or limited ChatGPT use. Only 17% of disciplines (2/12) reported frequent usage, whilst 25% (3/12) reported minimal or experimental engagement. This usage distribution aligns with the reported concerns, as disciplines with higher usage frequency (Computer Engineering, Social Science) also reported greater academic integrity concerns (mean score = 1.5) than disciplines with minimal usage (mean score = 0.33).

Gender representation data, available for 50% of the disciplines (6/12), suggests a potential relationship with adoption patterns. Disciplines with higher female representation (> 60%, n = 3) demonstrated different concern profiles than predominantly male disciplines, with less emphasis on academic integrity (mean score = 0.33 vs. 1.0) but greater attention to privacy considerations (mean score = 1.33 vs. 0.67). However, the limited gender data across all studies necessitates cautious interpretation of these patterns.

The distribution of positive and negative impacts across discipline categories reveals that STEM fields reported the most balanced assessment (mean positive impact = 1.57, mean negative impact = 1.0), whilst Healthcare disciplines demonstrated more favorable assessments (mean positive impact = 1.67, mean negative impact = 0.67). This analysis suggests that disciplinary epistemologies and pedagogical approaches may systematically influence how ChatGPT's benefits and limitations are perceived and experienced in educational contexts.

5. Discussion and implications

This section takes a broader look at the implications of ChatGPT integration across academic contexts, synthesising the main findings from the results for a comprehensive analysis of adoption trends, ethical considerations, and demographic adoption drivers by academic discipline.

5.1. Variability in sample sizes and representation (Addressing RQ3)

The study has shown a vast discrepancy in sample size between researched disciplines, with some fields, for example, Computer Science and Medical Education, having big groups of study participants included within them, while others, like Nursing and Mathematics, employing relatively smaller groups of participants. This disparity reflects differential research emphasis within these academic domains and suggests varying levels of institutional commitment to AI tool evaluation across disciplinary boundaries.

The differences in sample size observed capture differences in research infrastructure, research investigation, and fund prioritization across various academic disciplines. Variance may also capture differing degrees of perceived relevance or need across different educational contexts for integrating ChatGPT. These different degrees of engagement across disciplines require systematic study to determine underlying factors influencing adoption patterns. Outcomes are also noted to show that fields with larger sample sizes reported may have more educational support of instructional research on AI, and smaller population-reported fields may not have resources or be more conservative in integrating technology. These variations in scope and scale of studies may influence the generalizability of results across disciplinary contexts and necessitate more integrated, systematic study work to establish robust evidence bases for deploying AI instruments in higher education contexts.

The different sizes of the sample also reflect the emergent scenario of ChatGPT adoption among the academic contexts, with different subjects having made considerable progress in their work of evaluation and others just being in the preliminary stages of research.

5.2. Overreliance on AI and academic integrity (Addressing RQ2)

The most applicable concern that has been realized is the overreliance on AI tools like ChatGPT, particularly in certain disciplines. Computer Science, Social Science, and Mathematics students, for example, exhibit overdependence on ChatGPT in assignments, research work, and problem-solving previously associated with direct congruence to intellectual development. The findings are in tandem with warnings in education technology about technological determinism [60], whereby technology tools may take center stage in educational activity instead of being guided by pedagogical objectives. The variation in the extent to which the disciplines depend on AI can be explained according to the task-technology fit theory [61], whereby the proficiency and adoption of technology lie in the match of technological capacities and requirements of tasks. In disciplines where problem-solving processes are well-established, e.g., Computer Engineering, the alignment of AI strengths and learning activity would seem more evident, which is perhaps one reason why adoption rates and resulting concerns regarding overreliance have been greater. Academic integrity concerns were especially rampant in Computer Engineering and Social Sciences, where AI aids readily produce work that circumvents individual effort. These findings extend previous research by [62] on academic integrity in digital

learning environments and support theoretical frameworks on academic dishonesty that emphasize contextual and opportunity factors. The discipline-specific manifestations of academic integrity concerns observed in this study suggest that ethical frameworks for AI use must be contextualized according to disciplinary epistemologies and assessment practices [63]. These findings strongly suggest the need for structured AI literacy programs that address technical competence and ethical and critical dimensions of AI use. As [64] argues, critical AI literacy must encompass understanding AI capabilities, limitations, and ethical implications while developing skills to evaluate AI-generated content. Such programs need to be developed for discipline-specific settings, ensuring that essential critical thinking and analysis skill development are maintained as major learning objectives.

5.3. Privacy and confidentiality in sensitive fields (Addressing RQ2)

Confidentiality and privacy considerations are of utmost concern for disciplines handling sensitive information, primarily Law, Medical Education, and Pharmacy. The medical confidential and professional information nature of these departments requires the most careful handling of any artificial intelligence implementation. AI integration in these disciplines must not breach the hard-gained confidence rapport in order to get the personal information required for effective counselling and educational purposes.

The observed adoption trends evidenced across these fields place in perspective the necessity to design expansive regulation frameworks addressing fundamental ethical imperatives and enabling AI technologies to drive education and professional development objectives forward. These disciplines present particular challenges in striking a balance between technological innovation and the strict confidentiality requirements by professional practice, apart from legal obligations. The research identifies that healthcare-related disciplines are most sensitive to confidentiality concerns of data privacy, both in relation to professional ethical requirements for handling patient information as well as government regulation requirements. Legal education is also highly responsive to confidentiality concerns because of attorney-client privilege requirements and professional responsibility expectations built into legal practice. The incremental, measured progression of AI technology adoption in such sensitive fields is testimony to institutional caution rather than technology avoidance. This measured implementation approach demonstrates that discipline-specific paradigms for deploying AI must exist, coupled with robust data protection protocols, secure information processing practices, and robust privacy shielding protocols by discipline-specific requirements.

Furthermore, there is a need for sectoral guidelines to integrate AI into professional areas of delicacy. This is a key condition for successful technology adoption. These frameworks must address both near-term privacy challenges and longer-term impact on professional standards of behavior, as well as secure the learning dividends that AI technologies have to offer.

5.4. educational benefits and accuracy concerns (Addressing RQ1 and RQ2)

Aside from the reliability and ethical challenges, ChatGPT also bodes well for education in numerous disciplines. In Nursing, Medical Education, and Computer Engineering, AI chatbots have improved learner engagement, established communication skills, and facilitated learning of technical material. These findings align with constructivist learning theories [65] emphasizing scaffolding of learning, with ChatGPT serving as what [66] would call a ”cognitive apprenticeship tool” mimicking

expert thought and problem-solving approaches.

The converzational nature of ChatGPT appears to create what [67] describes as "parasocial learning relationships," where students engage with AI systems in ways that mimic human tutoring interactions. This phenomenon was particularly evident in Nursing simulations, where students reported high levels of engagement with AI-simulated patients. Such engagement aligns with the Community of Inquiry framework [68], suggesting that AI tools can contribute to teaching presence and cognitive presence in educational settings when appropriately implemented. In Computer Engineering contexts, ChatGPT has provided coding assistance that extends beyond mere productivity enhancement. As [69] found in their analysis of AI coding assistants, such tools can make programming more accessible to novices whilst potentially reinforcing good coding practices through demonstration. The study examining ChatGPT in Computer Engineering [39] supports this theoretical perspective, showing that students found the tool both motivating and helpful for professional development.

However, accuracy and reliability remain significant concerns in Physics, Chemical Engineering, and Chemistry, where precision is paramount. The challenge of automatically generated content, potentially including misleading information, aligns with what [70] terms the "hallucination problem" in large language models. This phenomenon presents particularly acute challenges in disciplines where factual accuracy directly impacts safety or scientific validity. Recent research by [71] on AI-generated scientific content highlights the potential for plausible-sounding but factually incorrect outputs that may not be readily identifiable to students without domain expertise.

These findings extend theoretical work on AI trustworthiness in educational contexts [72], suggesting that appropriate trust calibration varies significantly by discipline. educational approaches must therefore include what is termed as "AI scepticism training" to ensure students develop appropriate evaluation strategies for AI-generated content, particularly in disciplines where accuracy is critical. As recommended in the recent study on GenAI in essay revisions and student engagement [73, 74], educational interventions should focus on developing students' critical evaluation skills alongside technical competence in AI use.

5.5. Gender representation and AI adoption patterns (Addressing RQ3)

The study revealed notable variations in AI adoption patterns across gender distributions within different academic disciplines. Disciplines characterized by substantially higher female participation, including Nursing and Medical Education, demonstrated markedly greater receptiveness to AI integration, particularly for applications involving clinical simulations and patient care contexts. Conversely, disciplines with predominantly male representation, such as Pharmacy and Computer Engineering, exhibited considerably more sceptical attitudes toward ChatGPT adoption, expressing substantive concerns regarding accuracy, reliability, and performance expectations.

The gender-based AI adoption trends noticed are yet not well understood, and a detailed research study is called for to evaluate the actual contribution of demographic factors to the use and orientation of AI tools by different segments in the population. Processes between gender composition and technology adoption in academic contexts need intensive exploration to identify causal effects and establish the basis for differential adoption trends.

5.6. Implications for future research and educational policy (Cross-RQ Synthesis)

The study reveals that while ChatGPT can be used to enhance education, its implementation should be done cautiously and systematically. Establishing discipline-specific policies regarding the use of AI, offering AI literacy training to faculty and students as a prerequisite, and promoting ethical practice in the classroom are some of the critical requirements for effective AI implementation as educational tools.

Long-term cognitive effects of students' use of AI tools will also be examined in future studies, e.g., whether or not AI technology increases intellectual ability for thought like problem-solving, analysis, and memorization. Research priorities should also include exploration of differences in effects across disciplinary and demographic groups like gender, prior experience in using AI, and other determinant variables of interest.

The findings demonstrate that successful integration of AI into educational settings requires comprehensive frameworks that consider technological expertise in addition to ethical concerns. Implementation strategies must guarantee that the use of AI instruments promotes rather than compromises the established academic and professional standards, while maintaining the required processes of engagement necessary for efficient results of learning. The research justifies that although ChatGPT is potentially revolutionary educational technology, successful embedding in learning systems rather than learning standards and professional distinction is contingent upon consistent strategies with ethics and critical engagement mechanisms.

6. Limitations

Although this study has abundant data on the use of Generative AI in education, there are certain methodological limitations that need to be overcome. Strict selection criteria ensured a representative diversity of academic disciplines among papers selected for examination. Yet, each discipline was represented by only one paper in this research. This approach, though methodologically appropriate for scoping review guidelines, has the risk of incurring biases because of selective paper selection within each academic discipline, which may influence the extent of empirical evidence covered for each examined field of study.

Therefore, the analysis focuses on qualitative insights at the expense of quantitative assessment of postulated impacts between multiple academic fields. The research selected articles representing empirical studies that explored strengths and limitations of Generative AI utilization in educational environments. The analysis relies on the accuracy of findings presented within the confines of individual study reports and the methodological quality involved. If any of these reports are based on methodological inconsistencies or inadequate analytical models, those weaknesses would taint the aggregate validity of insights rendered. The research also did not investigate longitudinal AI adoption impacts in educational contexts. Long-term impacts of AI integration on student outcomes, upholding academic integrity, and policy making within institutions are unknown variables requiring systematic investigation. Furthermore, the research does not discuss AI influence on pedagogical processes and academic professional development. Educator perspectives toward adapting to learning settings supported by AI are vital sources of information missing thorough examination.

This work also lacks consideration of institutional variability, technological infrastructure differences, and cultural factors that may influence AI adoption patterns across diverse educational

contexts. These contextual factors are likely to affect generalizability of results between various institutional environments and geographical locales. In view of these recognized limitations, the current study offers useful interdisciplinary contributions toward the implementation of AI in the environments of higher learning. Future research will need to build upon this work through large data comparisons, comparative studies based upon multiple case studies within disciplines, and longitudinal research of AI utilization in higher education to create an overall understanding of educational impacts and implementation outcomes.

7. Conclusions

This study has offered a detailed cross-disciplinary investigation of the incorporation of Generative AI, especially ChatGPT, in the higher education sector. By blending empirical outcomes from various academic fields, the research has shown not only the huge transformative potential of AI tools for actually improving learning experiences but also the huge challenges they bring concerning academic honesty, overreliance, and ethics. The study suggests that while AI-founded technologies offer new promise for personalized learning, problem-solving, and automated testing, their widespread adoption hinges on more nuanced disciplinary needs, pedagogic adaptation, and regulatory coverage.

A main conclusion from this research is the uneven embrace of AI, especially in our most technical fields, influenced by technical applicability, disciplinary ethics, and the nature of learning that occurs within a discipline. Computer science and engineering have taken to AI for its obvious uses in coding and for solving not-so-simple computational problems. However, even in those very technical areas, some practitioners voice concerns about the privacy and accuracy of AI in Medical Education and Pharmacy, which also exemplify a very obvious use of AI. In fact, the decisions made around the application of AI in education raise some very important, and even some questionable, ethical implications. Despite the challenges identified, this study emphasizes the possible role of AI in making teaching more efficient, in helping to engage students, and in making academic work itself more manageable. But this balanced and informed study also suggests that AI be seen as a complement to, rather than a substitute for, pedagogical systems that foster critical thinking and independent learning. It would be good to have the next iterations of this study explore the questions it raises in depth and from various angles.

With continuing advances in AI technology, higher education institutions must adopt and implement strategies to work not only with AI but also with the academic integrity issues that arise from AI's current and future capabilities. These strategies should be informed by established theoretical frameworks, including technology integration models, ethical AI governance approaches, and discipline-specific pedagogical theories. The findings of this study extend existing theoretical understanding of educational technology integration by highlighting how disciplinary practices mediate AI adoption, impact, and ethical implications. Future research should explore these disciplinary variations through longitudinal studies that track the evolution of AI integration across academic fields, potentially using the theoretical framework. Fostering AI literacy, implementing regulatory frameworks, and encouraging interdisciplinary collaboration will help to ensure that education stays innovative and ethically grounded in an increasingly AI-integrated landscape.

Author contributions

R.J.E. conceptualized the study, designed the methodology, conducted the systematic literature search, performed data extraction and analysis, and wrote the original draft. E.G. provided supervision, reviewed and validated the methodology, contributed to the interpretation of results, and provided critical feedback on the manuscript. A.A.-S. assisted with data validation, contributed to the cross-disciplinary analysis, provided supervision, and critically reviewed and edited the manuscript. All authors reviewed and approved the final manuscript.

Use of Generative-AI tools declaration

The authors acknowledge the responsible use of the AI language model ChatGPT for assistance with proofreading, editing, and language refinement in this manuscript. This tool was used responsibly to enhance the clarity and readability of our work, while all original ideas, analyzes, and conclusions remain the sole product of the authors. They affirm that the use of this AI tool does not detract from the originality or integrity of the research.

Conflict of interest

The authors declare no conflicts of interest.

Prof. Ergun Gide is an editorial member for STEM Education, and was not involved in the editorial review or the decision to publish this article.

Ethics declaration

This study involved a systematic review of published literature and did not require ethical approval as no human participants were directly involved.

References

1. Dwivedi, Y.K., Kshetri, N., Hughes, L., Slade, E.L., Jeyaraj, A., Kar, A.K., et al., Opinion Paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of Generative converzational AI for research, practice and policy. *International Journal of Information Management*, 2023, 71: 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642
2. Analytica, O., GenAI will transform workplace tasks across industries. *Emerald Expert Briefings*, 2023.
3. Schuckart, A., Introduction to work with GenAI. In *Proceedings of the 28th European Conference on Pattern Languages of Programs*, (Irsee Germany), 2023, 1–16. ACM. https://doi.org/10.1145/3628034.3628042
4. Yang, A., Li, Z. and Li, J., Advancing GenAI Assisted Programming–A Comparative Study on Prompt Efficiency and Code Quality Between GPT-4 and GLM-4, 2024.

5. Walkington, C., The implications of Generative artificial intelligence for mathematics education. *School Science and Mathematics*, 2025. https://doi.org/10.1111/ssm.18356

6. Kaur, K., Shilpa and Jindal, R., The ChatGPT revolution: Reshaping education through artificial intelligence. In *Recent Advancements in Communication, Computing, and Artificial Intelligence (RACCAI-2023)*, (Mohali, India), 2024, 3121: 040023. https://doi.org/10.1063/5.0221430

7. Khaddage, F., Towards an Innovative Strategy for ChatGPT in Higher Education "Respond, Reimagine, Recreate, & Reform". In *EdMedia + Innovate Learning*, 2023, 274–279. Association for the Advancement of Computing in Education (AACE).

8. Forman, N., Udvaros, J. and Avornicului, M.S., ChatGPT: A new study tool shaping the future for high school students. *International Journal of Advanced Natural Sciences and Engineering Researches*, 2023, 7: 95–102. https://doi.org/10.59287/ijanser.562

9. Elbanna S. and Armstrong, L., Exploring the integration of ChatGPT in education: Adapting for the future. *Management & Sustainability: An Arab Review*, 2024, 3: 16–29. https://doi.org/10.1108/MSAR-03-2023-0016

10. Klayklung, P., Chocksathaporn, P., Limna, P., Kraiwanit, T. and Jangjarat, K., Revolutionizing Education with ChatGPT: Enhancing Learning Through Converzational AI. *Universal Journal of educational Research*, 2023, 2(3): 217–225.

11. Gill, S.S., Xu, M., Patros, P., Wu, H., Kaur, R., Kaur, K., et al., Transformative effects of ChatGPT on modern education: Emerging Era of AI Chatbots. *Internet of Things and Cyber-Physical Systems*, 2024, 4: 19–23. https://doi.org/10.1016/j.iotcps.2023.06.002

12. Mhlanga, D., Digital Transformation Education, Opportunities, and Challenges of the Application of ChatGPT to Emerging Economies. *Education Research International*, 2023, 2023: 1–13. https://doi.org/10.1155/2023/7605075

13. Sardana, D., Fagan, T.R. and Wright, J.T., ChatGPT: A disruptive innovation or disrupting innovation in academia?. *The Journal of the American Dental Association*, 2023, 154: 361–364. https://doi.org/10.1016/j.adaj.2023.02.008

14. Lo, C.K., Hew, K.F. and Jong, M.S.Y., The influence of ChatGPT on student engagement: A systematic review and future research agenda. *Computers & Education*, 2024, 219: 105100. https://doi.org/10.1016/j.compedu.2024.105100

15. Borger, J.G., Ng, A.P., Anderton, H., Ashdown, G.W., Auld, M., Blewitt, M.E., et al., Artificial intelligence takes center stage: Exploring the capabilities and implications of ChatGPT and other AI-assisted technologies in scientific research and education. *Immunology & Cell Biology*, 2023: 923–935. https://doi.org/10.1111/imcb.12689

16. Chinonso, O.E., Theresa, A.M.E. and Aduke, T.C., ChatGPT for Teaching, Learning and Research: Prospects and Challenges. *Global Academic Journal of Humanities and Social Sciences*, 2023, 5: 33–40. https://doi.org/10.36348/gajhss.2023.v05i02.001

17. Wach, K., Duong, C.D., Ejdys, J., Kazlauskaitė, R., Korzynski, P., Mazurek, G., et al., The dark side of Generative artificial intelligence: A critical analysis of controversies and risks of ChatGPT. *Entrepreneurial Business and Economics Review*, 2023, 11(2): 7–30. https://doi.org/10.15678/EBER.2023.110201

18. Otto, S., Ejsing-Duun, S. and Lindsay, E., Disruptive tensions and emerging practices: An exploratory inquiry into student perspectives on Generative Artificial Intelligence in a problem-based learning environment. *Education and Information Technologies*, 2025. https://doi.org/10.1007/s10639-025-13533-5

19. Perifanou, M. and Economides, A.A., Collaborative Uses of GenAI Tools in Project-Based Learning. *Education Sciences*, 2025, 15: 354. https://doi.org/10.3390/educsci15030354

20. Shen, Y., Wang, Z. and Fan, Y., Ethical Issues and Value Tensions in the Context of GenAI-Assisted Learning. In *Learning with Generative Artificial Intelligence*, 2025, 222–253, Routledge. https://doi.org/10.4324/9781003632146-8

21. Dai, Y., Why students use or not use Generative AI: Student conceptions, concerns, and implications for engineering education. *Digital Engineering*, 2025, 4: 100019. https://doi.org/10.1016/j.dte.2024.100019

22. Cabrero-Daniel, B., How reliance on GenAI might limit human creativity and critical thinking in Requirements Engineering, 2025.

23. Cooper, G., Examining Science Education in ChatGPT: An Exploratory Study of Generative Artificial Intelligence. *Journal of Science Education and Technology*, 2023, 32: 444–452. https://doi.org/10.1007/s10956-023-10039-y

24. Wardat, Y., Tashtoush, M.A., AlAli, R. and Jarrah, A.M., ChatGPT: A revolutionary tool for teaching and learning mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, 2023, 19(7): em2286. https://doi.org/10.29333/ejmste/13272

25. Athilingam, P. and He, H.G., ChatGPT in nursing education: Opportunities and challenges. *Teaching and Learning in Nursing*, 2024, 19: 97–101. https://doi.org/10.1016/j.teln.2023.11.004

26. Patel, C.R., Pandya, S.K. and Sojitra, B.M., Perspectives of ChatGPT in Pharmacology Education, and Research in Health Care: A Narrative Review. *Journal of Pharmacology and Pharmacotherapeutics*, 2023, 14: 171–177. https://doi.org/10.1177/0976500X231210427

27. Kodkin, V.L. and Artem'eva, E.V., ChatGPT: Application in Chemistry Education and Challenges. *Journal of Computer and Communications*, 2024, 12(03): 196–206. https://doi.org/10.4236/jcc.2024.123012

28. Andersen-Kiel, N. and Linos, P.P., Using ChatGPT in Undergraduate Computer Science and Software Engineering Courses: A Students' Perspective. In *2024 IEEE Frontiers in Education Conference (FIE)*, 2024, 1–9, IEEE. https://doi.org/10.1109/FIE61694.2024.10892934

29. Biswas, S., Role of ChatGPT in Computer Programming. *Mesopotamian Journal of Computer Science*, 2023, 2023: 9–15. https://doi.org/10.58496/MJCSC/2023/002

30. Zheltukhina, M.R., Sergeeva, O.V., Masalimova, A.R., Budkevich, R.L., Kosarenko, N.N. and Nesterov, G.V., A bibliometric analysis of publications on ChatGPT in education: Research patterns and topics. *Online Journal of Communication and Media Technologies*, 2024, 14: e202405. https://doi.org/10.30935/ojcmt/14103

31. Yang, Y., Yang, M. and Luo, J., Cultivating AI Literacy Skills: How GenAI Tools Prepare Students in Humanities and Social Sciences to Write with Ethical and Critical Insight. In *Effective Practices*

in AI Literacy Education: Case Studies and Reflections (X. O'Dea and D. T. K. Ng, eds.), 2024, 111–118, Emerald Publishing Limited. https://doi.org/10.1108/978-1-83608-852-320241012

32. Aswathy Prakash, G. and Nair, V., Integrating Generative AI into Legal Education: From Casebooks to Code, Opportunities and Challenges: N.A. *Law, Technology and Humans*, 2024, 6(3): 60–79. https://doi.org/10.5204/lthj.3640
33. Gehring, D.R., Titus, S.K. and George, R., The Perceived Concerns of Nurse Educators' Use of GenAI in Nursing Education: Protocol for a Scoping Review. *Health Science Reports*, 2025, 8: e70411. https://doi.org/10.1002/hsr2.70411
34. Dong, C., Aw, D.C.W., Lee, D.W.C., Low, S.C. and Yan, C.C., Generative AI in Healthcare: Insights from Health Professions Educators and Students. *International Medical Education*, 2025, 4(2): 11. https://doi.org/10.3390/ime4020011
35. Naqvi, W.M., Ganjoo, R., Rowe, M., Pashine, A.A. and Mishra, G.V., Critical thinking in the age of Generative AI: Implications for health sciences education. *Frontiers in Artificial Intelligence*, 2025, 8: 1571527. https://doi.org/10.3389/frai.2025.1571527
36. Ma, J., Wang, P., Li, B., Wang, T., Pang, X.S. and Wang, D., Exploring User Adoption of ChatGPT: A Technology Acceptance Model Perspective. *International Journal of Human–Computer Interaction*, 2025, 41: 1431–1445. https://doi.org/10.1080/10447318.2024.2314358
37. Zhou, X. and Schofield, L., Using social learning theories to explore the role of Generative Artificial Intelligence (AI) in collaborative learning. *Journal of Learning Development in Higher Education*, 2024. https://doi.org/10.47408/jldhe.vi30.1031
38. Radwan, A. and McGinty, J., Toward a conceptual Generative AI ethical framework in teacher education. *Exploring New Horizons: Generative Artificial Intelligence and Teacher Education*, 2024, 88.
39. Shoufan, A., Exploring Students' Perceptions of ChatGPT: Thematic Analysis and Follow-Up Survey. *IEEE Access*, 2023, 11: 38805–38818. https://doi.org/10.1109/ACCESS.2023.3268224
40. Singh, H., Tayarani-Najaran, M.H. and Yaqoob, M., Exploring Computer Science Students' Perception of ChatGPT in Higher Education: A Descriptive and Correlation Study. *Education Sciences*, 2023, 13: 924. https://doi.org/10.3390/educsci13090924
41. Tsai, M.L., Ong, C.W. and Chen, C.L., Exploring the use of large language models (LLMs) in chemical engineering education: Building core course problem models with Chat-GPT. *Education for Chemical Engineers*, 2023, 44: 71–95. https://doi.org/10.1016/j.ece.2023.05.001
42. Sánchez-Ruiz, L.M., Moll-López, S., Nuñez-Pérez, A., Moraño-Fernández, J.A. and Vega-Fleitas, E., ChatGPT Challenges Blended Learning Methodologies in Engineering Education: A Case Study in Mathematics. *Applied Sciences*, 2023, 13: 6039. https://doi.org/10.3390/app13106039
43. Bello, S.B., Suleiman, Z.A., Abdurrahman, M.S., Bashar, A. and Ibrahim, J.A., Perceptions of Ease of Use and Usefulness of Artificial Intelligence ChatGPT among Undergraduate Law Students of Ahmadu Bello University, Zaria.
44. Jowarder, M.I., The Influence of ChatGPT on Social Science Students: Insights Drawn from Undergraduate Students in the United States. *Indonesian Journal of Innovation and Applied Sciences (IJIAS)*, 2023, 3: 194–200. https://doi.org/10.47540/ijias.v3i2.878

45. Ding, L., Li, T., Jiang, S. and Gapud, A., Students' perceptions of using ChatGPT in a physics class as a virtual tutor, *International Journal of educational Technology in Higher Education*, 2023, 20: 63. https://doi.org/10.1186/s41239-023-00434-1

46. Park, H. and Manley, E.D., Using ChatGPT as a proof assistant in a mathematics pathways course. *The Mathematical Education*, 2024, 63: 139–163. https://doi.org/10.63311/mathedu.2024.63.2.139

47. West, J.K., Franz, J.L., Hein, S.M., Leverentz-Culp, H.R., Mauser, J.F., Ruff, E.F., et al., An Analysis of AI-Generated Laboratory Reports across the Chemistry Curriculum and Student Perceptions of ChatGPT. *Journal of Chemical Education*, 2023, 100: 4351–4359. https://doi.org/10.1021/acs.jchemed.3c00581

48. Alkhaaldi, S.M.I., Kassab, C.H., Dimassi, Z., Oyoun Alsoud, L., Al Fahim, M., Al Hageh, C., et al., Medical Student Experiences and Perceptions of ChatGPT and Artificial Intelligence: Cross-Sectional Study. *JMIR Medical Education*, 2023, 9: e51302. https://doi.org/10.2196/51302

49. Zawiah, M., Al-Ashwal, F., Gharaibeh, L., Abu Farha, R., Alzoubi, K., Abu Hammour, K., et al., ChatGPT and Clinical Training: Perception, Concerns, and Practice of Pharm-D Students. *Journal of Multidisciplinary Healthcare*, 2023, 16: 4099–4110. https://doi.org/10.2147/JMDH.S439223

50. Benfatah, M., Marfak, A., Saad, E., Hilali, A., Nejjari, C. and Youlyouz-Marfak, I., Assessing the efficacy of ChatGPT as a virtual patient in nursing simulation training: A study on nursing students' experience. *Teaching and Learning in Nursing*, 2024, 19: e486–e493. https://doi.org/10.1016/j.teln.2024.02.005

51. Baig, M.I. and Yadegaridehkordi, E., ChatGPT in the higher education: A systematic literature review and research challenges. *International Journal of educational Research*, 2024, 127: 102411. https://doi.org/10.1016/j.ijer.2024.102411

52. Montenegro-Rueda, M., Fernández-Cerero, J., Fernández-Batanero, J.M. and López-Meneses, E., Impact of the Implementation of ChatGPT in Education: A Systematic Review. *Computers*, 2023, 12: 153. https://doi.org/10.3390/computers12080153

53. Dempere, J., Modugu, K., Hesham, A. and Ramasamy, L.K., The impact of ChatGPT on higher education. *Frontiers in Education*, 2023, 8: 1206936. https://doi.org/10.3389/feduc.2023.1206936

54. Lo, C.K., What Is the Impact of ChatGPT on Education? A Rapid Review of the Literature. *Education Sciences*, 2023, 13: 410. https://doi.org/10.3390/educsci13040410

55. Bhullar, P.S., Joshi, M. and Chugh, R., ChatGPT in higher education - a synthesis of the literature and a future research agenda. *Education and Information Technologies*, 2024, 29: 21501–21522. https://doi.org/10.1007/s10639-024-12723-x

56. İpek, Z.H., Gözüm, A.İ.C., Papadakis, S. and Kallogiannakis, M., educational Applications of the ChatGPT AI System: A Systematic Review Research. *educational Process International Journal*, 2023, 12(3): 26–55. https://doi.org/10.22521/edupij.2023.123.2

57. Xu, X., Chen, Y. and Miao, J., Opportunities, challenges, and future directions of large language models, including ChatGPT in medical education: A systematic scoping review. *Journal of educational Evaluation for Health Professions*, 2024, 21: 6. https://doi.org/10.3352/jeehp.2024.21.6

58. Pradana, M., Elisa, H.P. and Syarifuddin, S., Discussing ChatGPT in education: A literature review and bibliometric analysis. *Cogent Education*, 2023, 10: 2243134. https://doi.org/10.1080/2331186X.2023.2243134

59. Sallam, M., ChatGPT Utility in Healthcare Education, Research, and Practice: Systematic Review on the Promising Perspectives and Valid Concerns. *Healthcare*, 2023, 11: 887. https://doi.org/10.3390/healthcare11060887

60. Hallström, J., Embodying the past, designing the future: Technological determinism reconsidered in technology education. *International Journal of Technology and Design Education*, 2022, 32: 17–31. https://doi.org/10.1007/s10798-020-09600-2

61. Al-Mamary, Y.H., Alfalah, A.A., Alshammari, M.M. and Abubakar, A.A., Exploring factors influencing university students' intentions to use ChatGPT: Analyzing task-technology fit theory to enhance behavioural intentions in higher education. *Future Business Journal*, 2024, 10: 119. https://doi.org/10.1186/s43093-024-00406-5

62. Balalle, H. and Pannilage, S., Reassessing academic integrity in the age of AI: A systematic literature review on AI and academic integrity. *Social Sciences & Humanities Open*, 2025, 11: 101299. https://doi.org/10.1016/j.ssaho.2025.101299

63. Qadhi, S.M., Alduais, A., Chaaban, Y. and Khraisheh, M., Generative AI, Research Ethics, and Higher Education Research: Insights from a Scientometric Analysis. *Information*, 2024, 15: 325. https://doi.org/10.3390/info15060325

64. LaFlamme, K.A., Scaffolding AI literacy: An instructional model for academic librarianship. *The Journal of Academic Librarianship*, 2025, 51: 103041. https://doi.org/10.1016/j.acalib.2025.103041

65. Rasul, T., Nair, S., Kalendra, D., Robin, M., de Oliveira Santini, F., Ladeira, W.J., et al., The role of ChatGPT in higher education: Benefits, challenges, and future research directions. *Journal of Applied Learning & Teaching*, 2023, 6(1): 41–56. https://doi.org/10.37074/jalt.2023.6.1.29

66. Tabib, F.M. and Alrabeei, M.M., Can Guided ChatGPT Use Enhance Students' Cognitive and Metacognitive Skills? In *Artificial Intelligence in Education: The Power and Dangers of ChatGPT in the Classroom* (A. Al-Marzouqi, S. A. Salloum, M. Al-Saidat, A. Aburayya, and B. Gupta, eds.), 2024, 144: 143–154, Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-52280-2_10

67. Orts-Cardador, J.J., Hernández Garrido, R., Pérez Calañas, C. and Carvajal-Trujillo, E., Factors Influencing Student Use of ChatGPT: An Exploration of The Benefits and Risks of Adopting and Using ChatGPT. In *19th International Technology, Education and Development Conference*, (Valencia, Spain), 2025, 2134–2138. https://doi.org/10.21125/inted.2025.0608

68. Ba, S., Zhan, Y., Huang, L. and Lu, G., Investigating the impact of ChatGPT-assisted feedback on the dynamics and outcomes of online inquiry-based discussion. *British Journal of educational Technology*, 2025. https://doi.org/10.1111/bjet.13605

69. Kazemitabaar, M., Chow, J., Ma, C.K.T., Ericson, B.J., Weintrop, D. and Grossman, T., Studying the effect of AI Code Generators on Supporting Novice Learners in Introductory Programming. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, (Hamburg Germany), 2023, 1–23, ACM. https://doi.org/10.1145/3544548.3580919

70. Schiller, C.A., The Human Factor in Detecting Errors of Large Language Models: A Systematic Literature Review and Future Research Directions, 2024.

71. Elsayed, H., The Impact of Hallucinated Information in Large Language Models on Student Learning Outcomes: A Critical Examination of Misinformation Risks in AI-Assisted Education. *Northern Reviews on Algorithmic Research, Theoretical Computation, and Complexity*, 2024, 9: 11–23.

72. Kastania, N.P.P., Building Trust in AI Education: Addressing Transparency and Ensuring Trustworthiness. In *Trust and Inclusion in AI-Mediated Education* (D. Kourkoulou, A.-O. Tzirides, B. Cope, and M. Kalantzis, eds.), 2024, 73–90, Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-64487-0_4

73. Zhao, J., Chapman, E. and Sabet, P.G., Generative AI and educational Assessments: A Systematic Review. *Education Research and Perspectives*, 2024, 51: 124–155. https://doi.org/10.70953/ERPv51.2412006

74. Lo, N., Wong, A. and Chan, S., The impact of Generative AI on essay revisions and student engagement. *Computers and Education Open*, 2025, 100249. https://doi.org/10.1016/j.caeo.2025.100249

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