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RESEARCH ARTICLE

# The bright highlights and the dark shadows of artificial intelligence in higher education

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## Abstract

### Background

Artificial Intelligence (AI) is reshaping higher education, prompting critical debate about its implications for teaching and learning. While AI offers substantial opportunities, its integration also raises concerns related to academic integrity, skill development, bias, privacy, and educational inequality.

### Methods

This study employed a Systematic Conceptual Review (SCR) of 105 studies drawn from Google Scholar, ERIC, and Scopus and published between January 2021 and July 2025. The literature was analysed through thematic synthesis to examine the dual impact of AI in higher education and the roles of educators, students, and institutions in AI-mediated environments.

### Results

The analysis identified a tension between “Bright Highlights,” including personalised learning, operational efficiency, and enhanced accessibility, and “Dark Shadows,” including risks to academic integrity, loss of basic skills, algorithmic bias, data privacy, and increased educational inequality. The synthesis further identified four factors that mediate these outcomes: pedagogical, ethical and integrity, technical and quality assurance, and sociostructural mediation. These findings informed the development of the Bright-Shadow Integration Model, which conceptualises AI outcomes as

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shaped by the interaction between AI capabilities and these mediating factors.

**Conclusions**

The findings indicate that the effects of AI in higher education are not determined by the technology itself but by how its capabilities are mediated within educational contexts. A proactive approach involving students, educators, institutions, and policymakers, supported by clear policies, pedagogical redesign, ethical guidelines, and attention to equity, is therefore essential for harnessing AI's potential while mitigating its risks.

**Keywords**
Artificial Intelligence, Generative AI, Higher Education, Systematic Review, Conceptual Framework, Academic Integrity, Educational Ethics, Digital Literacy

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## Introduction

Recent technological advances are causing a profound transformation in the higher education landscape. The rise of Artificial Intelligence (AI) has ignited an intellectual debate on the evolving role of universities.[13,25] A major shift towards the use of AI tools calls for reflection and restructuring of higher education to bridge the gap among stakeholders and maintain teaching and learning behaviours.[5,44]

While AI is a long-established field of computer science, its recent proliferation, particularly in the form of Generative AI (GenAI), which uses deep learning to generate human-like content,[69] is triggering a profound transformation across higher education. These systems create novel outputs by leveraging vast datasets of public digital content,[89,95] enabling capabilities that directly impact core academic activities.

The main stakeholders in the higher education sphere fall into roughly three categories. There are the educators: faculty staff who carry out research and who design and implement courses; there are students who are enrolled on those courses who will eventually make use of skills acquired after graduation; finally there are the university institutions that, besides carrying out teaching and research, define the legal, social and educational framework within which these activities take place. The increasing diffusion of AI tools throughout higher education impacts all of these stakeholders. The basic conflict arises because, like most new technologies, AI has pros and cons which impact these different stakeholders in different ways. This tension between opportunity and risk is now recognised across disciplines,[35] and earlier reviews have mapped AI applications in particular regions and settings[99]; what has been missing is a synthesis that treats the two sides as a single, mutually conditioning system rather than a catalogue of benefits set against a catalogue of risks.

One aim of this article is to examine how these competing pros and cons play out differently for educators, students, and institutions, and to propose a framework within which these conflicting aspects of AI can be assessed and reconciled. We discuss this in further detail below.

There have been different reactions from higher education to the use of AI technology. Some, such as the Russell Group of 24 top Universities in the UK, have embraced it by publishing guidelines on how to use AI ethically and effectively, whilst others have strictly banned the use of certain tools. New York City Education Department, for example, was reported to have blocked the use of ChatGPT on school devices and networks for both teachers and students.[36] In Europe, the Sciences Po school in Paris, one of the most prestigious universities in France, has banned the use of ChatGPT without transparent referencing, saying that unauthorised usage could risk sanctions which can go as far as expulsion from the establishment or even from higher learning.

However, the majority of universities have yet to clarify their stance on specific circumstances when the use of tools like ChatGPT may be considered acceptable. There is little consensus on the exact scope and content of such policies.[8,76,79,105,106,108,119] The key challenge for universities and all stakeholders is to find a balance that allows the use of AI without compromising the integrity of the educational process. The main purpose of this article is to synthesise the existing literature on the benefits and risks of AI in higher education into a single conceptual framework, the Bright-Shadow Integration Model, that captures this dual nature and provides higher education stakeholders with a structured approach for assessing and responding to it.

The structure of the article is as follows. Following this introduction, the Methodology section outlines the Systematic Conceptual Review (SCR) approach used to analyze the literature. The Findings section presents a thematic synthesis of the literature, organized into the Bright Highlights and Dark Shadows of AI integration. This synthesis directly informs the subsequent section, which introduces our central contribution: the Bright-Shadow Integration Model, a conceptual framework for understanding the mediating factors that influence AI's impact. The Discussion section then interprets these findings through the lens of the proposed framework. Finally, the Conclusion summarizes the study's contributions and offers practical recommendations for stakeholders based on the model's insights.

## Methodology

This study uses a SCR methodology to synthesise and structure the literature on Artificial Intelligence (AI) in higher education.[17] Unlike a standard Systematic Literature Review (SLR) which often addresses specific empirical questions, an SCR is specifically designed to integrate findings into conceptual categories and construct theoretical frameworks for understanding complex phenomena.

### Research strategy and data sources

The literature search was conducted for the period January 2021–July 2025. This window was selected to capture the first full calendar year of scholarly engagement with GPT-3 based generative AI tools, which entered private beta in mid-2020

**Table 1. Distribution of papers by search phrase and key themes.**

| Search phase | Papers retained | Prominent topics/keywords |
|---|---|---|
| AI in higher education | 99 | Teaching practices, assessment redesign, adaptive learning, teacher workload, student engagement |
| Academic integrity | 33 | Plagiarism, misconduct, cheating, originality, fairness in evaluation |
| Ethical dilemmas | 44 | Data privacy, transparency, algorithmic bias, fairness, institutional responsibility |
| Critical digital literacy | 21 | AI literacy, digital skills, staff training, student preparedness, digital divide |

and saw growing application and discussion through 2021 ahead of their general API release that November, through to July 2025, capturing the continued rapid evolution of Generative AI following the release of ChatGPT in November 2022.[72,77] Three major databases were used: Google Scholar, ERIC, and Scopus. The search strategy employed a precise set of key phrases: "AI in higher education," "academic integrity," "ethical dilemmas," and "critical digital literacy." Each phrase was searched independently, as an exact phrase, restricted to the title and keyword fields where the database allowed such restriction. Searches were run in August 2025. This keyword-restricted approach, rather than a broader full-text search, accounts for the comparatively low number of records identified relative to the total volume of literature on this topic. Because each phrase was searched separately rather than combined into a single query, a study matching more than one phrase could be retrieved under each of the relevant phrases; this is addressed further in Table 1. While "academic integrity" and "ethical dilemmas" both relate to ethical mediation, they were treated at different levels of analysis: academic integrity refers to student-level issues (e.g., plagiarism, misuse of AI writing tools), whereas ethical dilemmas capture institutional or policy-level challenges (e.g., fairness of AI adoption, transparency, data privacy).

Reference lists of relevant papers were also examined, a technique called snowballing,[115] to ensure comprehensive coverage and to identify seminal papers.

## Inclusion and exclusion criteria

Studies were included if they met the following criteria:

- Peer-reviewed journal articles, conference proceedings, institutional policy reports or theoretical frameworks.
- Direct relevance to higher education.
- Focus on AI tools, applications or their ethical, pedagogical or policy implications.
- Published in English between 2021-2025.

Exclusion criteria included:

- Studies focused exclusively on K-12, professional, or corporate training.
- Blog posts, opinions, non-substantive, or promotional content.
- Publications not in English.
- Articles focused solely on technical AI development without clear educational insights or application.

## Screening and selection process

The study identification process (Figure 1) followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and reproducibility.[83] Titles, abstracts, and full texts were screened independently by three reviewers; decisions were then compared and discussed jointly, with disagreements resolved through consensus among all three authors. The initial systematic search strategy was executed across three multidisciplinary electronic databases: Google Scholar, ERIC, and Scopus. Using the four predefined key phrases, 131 records were initially identified. After removing 8 duplicates, 123 unique records remained for screening. Titles and abstracts were assessed against the inclusion criteria, resulting in the exclusion of 12 studies (3 not in English, 1 not about

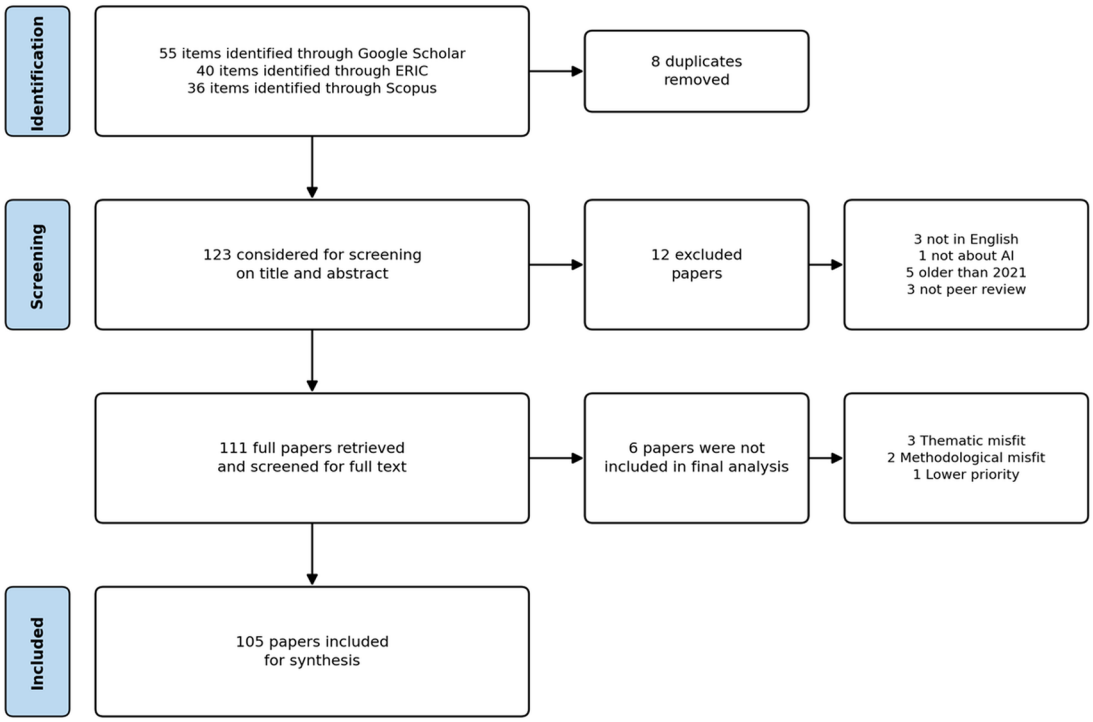



**Figure 1. PRISMA flow diagram of the systematic conceptual review process.**

AI, 5 published before 2021, and 3 not peer reviewed). This left 111 studies for full-text review. Following a detailed assessment, 6 papers were excluded: 3 due to thematic misfit, 2 due to methodological misfit, and 1 ranked as lower priority because its central theme substantially overlapped with an already-included study and its methodological contribution was comparatively weaker. A total of 105 papers were included in the final synthesis.

To provide greater clarity, the retained studies are also broken down by the four search phrases (Table 1). This shows the distribution of articles and the most prominent themes discussed within each category.

Because the four search phrases were queried independently, the per-phrase totals in Table 1 sum to more than the 105 studies included overall; a number of studies were retrieved under, and are counted within, more than one search phrase. Studies were manually classified into themes based on recurring concepts identified through close reading. This approach allowed us to map the thematic landscape without formal coding software.

## Findings/Thematic synthesis

### Data extraction and analysis

For each included study, bibliographic and contextual data were extracted (author, year, country, AI tool/technology, stakeholder group, research focus, etc.). The studies were then analysed using a thematic synthesis approach.

### Full characteristics of all included studies (author, year, country, AI tool/technology, stakeholder group, research focus) are provided in Supplementary Table S1

The analysis was guided by four main concepts mentioned above that formed the basis of the search strategy, resulting in two overarching analytical categories: (i) Bright Highlights – the benefits and positive contributions of AI in higher education; (ii) Dark Shadows – the risks, limitations and ethical challenges associated with the adoption of AI. This synthesis enabled the construction of a conceptual framework (Bright-Shadow Framework for AI in Higher Education), which integrates positive and negative dimensions and highlights the tensions between innovation and ethical responsibility.

### Bright highlights of AI in higher education

Higher education has already entered a new era of AI mediated digital content, and the technologies mentioned above are anticipated to become ever more sophisticated as this era progresses. Many of the impacts of this shift are not only positive

but sufficiently advantageous that institutions should treat personalised learning, operational efficiency, and enhanced accessibility as core priorities for future higher education, rather than optional enhancements.[12,30,63,100,107]

For educators, the literature reports three main impacts of GenAI tools. First, they can cater for diverse learning needs and styles[7,10,39,60,64,66] and facilitate the creation of personalised and interactive educational experiences.[4,21,49,51,82,98,121] Second, they improve access to educational materials across cultures and languages by lowering language barriers through machine translation tools, promoting inclusivity and more equitable access to information.[33] Third, Knowledge Graphs and related tools further enhance this inclusivity by structuring complex information in an accessible and comprehensible way, supporting efficient exploration of large volumes of data.[55] AI support can help teachers move toward more personalised coaching and mentorship for individual students.[46] These findings point to a central challenge for educators: navigating the range of possibilities the technology offers rather than mastering any single capability in isolation.

For students, the reviewed literature reports impacts similar to those for educators, viewed from the learner's position.[26,42,54,59,74,103] Across this literature, students report becoming more efficient at meeting academic requirements while reducing the effort spent on tasks they judge routine or time-consuming, a least-effort dynamic whose implications for skill development are examined in the Discussion.

Finally, there is the perspective of institutions. Several studies argue that higher education institutions need to set out ground rules defining fair use of AI technology, weighing the bright highlights and dark shadows examined throughout this review. [48,102,113] A global comparison of institutional adoption policies confirms that most universities are still working out what such ground rules should contain, with considerable variation in scope and enforcement across institutions and countries.[56] A related shift has been described from technology-based learning to learning with technology.[32]

## Dark shadows of AI in higher education

By effectively demonstrating that the output of AI systems can not only be useful but also presented in a highly accessible form, the release of ChatGPT in November 2022 triggered an unprecedented debate on the potential of GenAI to reshape higher education. As one recent study observes, 'Generative AI tools like ChatGPT have become as ubiquitous as Wi-Fi, quietly shaping how students research, write, and even think' (p. 2).[90] This ubiquity underscores both the potential benefits and the risks that frame our discussion of bright highlights and dark shadows. At the same time, the technology is still highly imperfect at this point in its development, presenting many potential challenges. We can usefully divide these into technical and societal challenges.

## Technical challenges

Technical challenges are posed by shortcomings in the underlying technological framework. Because this is essentially data-driven, one important class of such technical challenges are the result of imperfections in the data used to build the GenAI models. To begin with, there is the problem of bias. Generally speaking, LLMs are often trained on a huge volume of Internet-based data, which, being uncurated, can include stereotypes, misrepresentations, derogatory and exclusionary language that disproportionately affect vulnerable communities.[81] These constitute a "social bias" which, if not mitigated in some way, is inherited by applications which use that data. A comprehensive recent review examines the concept of bias in relation to fairness and discusses a range of mitigation techniques that have been proposed and applied.[43]

A related problem is that of data quality, as indicated by factors such as level of noise, reliability, provenance, completeness, timeliness, level of detail, etc. Generally speaking, the higher the quality, the higher the cost, but this depends to some extent on the availability of data in a particular domain and on the level of curation that is necessary to achieve a minimal level of performance on a given task. The main point is that high-quality data is an expensive resource.

In general, the least costly data is that which can be automatically scraped in large volumes by crawling the web opportunistically, whilst the most costly involves judgment by human experts and manual labelling. The cost can sometimes be mitigated by minimising the amount of data that must be labelled in this way, and developing an algorithm that builds a first model from the small quantity of hand-labelled data that is then used to label a larger quantity of unlabelled data. The now larger labelled data can then be used to build a second, improved model, and the whole cycle is iterated until the desired level of performance is reached.

The reliability of results generated by the models built by such algorithms is not guaranteed and depends upon a wide variety of factors, the details of which are beyond the scope of this paper. But in a nutshell, the algorithms are imperfect and do not necessarily lead to arbitrary improvements in performance.

Recent research has shown that ChatGPT may generate incorrect or fabricated information, which can be problematic for students who rely on it to inform their learning.[47,67] One frequently observed phenomenon is hallucination, which occurs when an underlying AI model (such as an LLM) perceives patterns or objects that are non-existent or imperceptible to human observers. This can create outputs that are literally nonsensical or inaccurate. Examples have been reported for many different systems from all the main technology companies.

Limited up-to-date knowledge and data, generation of incorrect/fake information, and provision of fictitious references are just some of the issues raised recently.[71] Until these limitations are both recognised and mitigated, ChatGPT cannot be integrated straightforwardly within academic contexts in an unsupervised way. Intellectual responsibility, whereby the teacher tries to instil the spirit and techniques of critical thinking in the student, thus remains an important part of the academic tradition, and we should strive to retain it.

### Societal challenges

Regardless of the potential advantages offered by AI technologies, their adoption also gives rise to contradictions, especially concerning the roles of educators. Several studies highlight a rising need for professional development to equip educators with the skills to integrate AI tools effectively into teaching practice.[19,75,87,94] At the same time, other studies suggest that the efficiency gains driving this need could themselves contribute to reduced demand for educator roles over time. These two strands of findings sit in tension, a point taken up in the Discussion.[28,41,45,53,80,92]

This risk to educator roles calls for a broader paradigm shift in higher education, one that revalues the skills educators need and supports their adaptation to AI-integrated teaching practice.[61] Some studies go further, proposing that the educator's role be redefined from primary knowledge dispenser to facilitator and guide within a technology-mediated learning environment.[78,70] Other studies suggest that tools which seem, at first glance, to work against this role can instead support the quality of interaction that makes it possible.[10,45]

### Loss of basic skills by students

Keyboards and screens are quietly replacing handwriting in everyday tasks, despite evidence that handwriting engages a complex cognitive-motor process involving multiple senses. One study of letter formation in children describes handwriting as requiring sustained attention to the physical coordination of hand and pen and notes that this deeper sensory-motor processing has been linked to stronger reading and spelling outcomes.[93] Whether this same mechanism extends to older students acquiring academic writing skills is a separate question this source does not directly address, but it points to what may be lost when handwriting is replaced entirely rather than supplemented. This is not to say that we should abandon calculators or keyboards, but that we must be aware of what is lost when they are used exclusively.

Given these observations, in our view the underlying question is whether GenAI use is disadvantageous to the wider acquisition of cognitive skills. It has been argued that immediate, hands-on engagement with a skill produces advantages that extend beyond the skill itself, integrating different areas of cognitive activity in ways that more mediated forms of interaction with AI tools do not.[114]

Building on this argument, we suggest a key issue is what might be lost when students use GenAI tools to replace traditional writing processes. A typical scenario is that, faced with a writing assignment, a student provides a prompt and then edits the output until it matches what they judge to be an appropriate answer. Whatever the merits of this activity, we argue that the skills required to edit a machine generated first draft differ substantially from those required to create an original assignment from scratch: evidence gathering and selection, formulation of research questions, and marshalling evidence to support an argument, alongside the writing itself. Since these skills underlie not only a convincing research article but arguably any serious academic activity, we hold that university education should aim to instil them.

Studies have found evidence that critical thinking and problem-solving skills are negatively affected by overreliance on ChatGPT, which supports our concern that traditional academic skills could be eroded by technology in the way arithmetic skills were by the calculator.[58,86]

We would distinguish, however, between cases like long division, where automation frees cognitive capacity for more demanding tasks, and cases like writing assignments, where depth of understanding, engagement with context, and creativity remain central to producing work that goes beyond the immediate task. In our assessment, GenAI use in higher education sits closer to the second case than the first.

### Ethical considerations on the use of AI in education

A paramount concern that universities face is to ensure that the usage of AI tools in education is ethically acceptable.[2,40,52,73] Research on stakeholder perspectives underlines that these ethical concerns are perceived differently by educators, students, and institutions, so that what counts as acceptable use is itself contested.[50] Because the models upon which these tools are based are constructed from huge quantities of data, a number of ethical issues arise. The data may be non-representative, leading to biased, potentially harmful conclusions affecting particular social subgroups. There is also the risk of privacy breaches and misuse of sensitive information.[22,39] One reason for this is that the origin of data is not always explicit. Inadvertent or deliberate misuse of intellectual property without acknowledging the source can undermine the academic integrity of the educational process.

Finally, the widespread use of ChatGPT as a shortcut may contribute to a culture of academic dishonesty. Several studies identify student plagiarism as a significant and growing concern for educational institutions following the widespread adoption of AI writing tools.[46,62,68,84] In our reading, this risk illustrates the role of ethical mediation directly: where institutional policies are absent or unclear, a Bright capability, content generation, can devolve into a Dark Shadow. Survey evidence supports the scale of the underlying behaviour. A BestColleges survey conducted in November 2023 found that 56% of college students reported having used such tools for assignments, and a separate survey by Intelligent.com in February 2024 found that 40% of college students admitted to using ChatGPT on assignments, with 86% of those students reporting that their use went undetected.[57] Studies report that GenAI-generated assignments and essays are not easily identified by current anti-plagiarism software.[85,120] Evidence also suggests that students who use ChatGPT for assignments are more likely to engage in plagiarism than those who do not.[9] Furthermore, ChatGPT-generated compositions have been shown to bypass plagiarism checks.[69] Recent syntheses of this literature converge on the same conclusion. A systematic review of generative AI and academic integrity found that while these tools can enhance engagement and efficiency, they carry substantial risk of academic dishonesty.[15] A broader critical review covering 54 studies from 2023 to 2025 similarly identified persistent inconsistency in detection, fragmented institutional policy, and unresolved questions of authorship across the field.[104] Turning to the student perspective specifically, a scoping review of 38 empirical studies on student voices found that students navigate GenAI use as an ethical grey zone, actively interpreting and adapting institutional expectations rather than simply complying with or violating them.[118]

An important question that currently lacks an answer is what exactly constitutes plagiarism when such tools are used. Is the fact that text has been generated by a machine sufficient grounds in itself for the attribution of plagiarism, or is there a minimal level of student-originated alteration that nullifies that attribution[1,117]? Furthermore, is it sufficient for the student to acknowledge the use of the tool to lift the attribution? Another issue is assessment, since, as some researchers have suggested, AI tools can also be used as a vital tool in grading.[6,14] However, when students use ChatGPT for assignments, it is quite difficult to determine whether their output reflects their understanding and knowledge of the course material or their competence to use AI tools. A critical concern is therefore whether the assessment should target the student, ChatGPT, or the ability of the student to use ChatGPT in this situation.

The above remarks suggest that the following goals are of key importance to address concerns about plagiarism arising from the use of GenAI tools: (i) practical definitions of plagiarism involving the use of GenAI tools; (ii) development of AI systems that can help distinguish between AI-generated and human-written text in order to underline the significance of academic integrity and reinforce the value of original work within educational settings[46] (iii) criteria to determine what can usefully be assessed when using AI tools to support the activity of assessment.[37,109]

## Conceptual framework: The Bright-Shadow Integration Model

According to the presented thematic synthesis, the impact of Artificial Intelligence (AI) in higher education is not uniform, so the attempt to integrate it must respond to a complex duality of opportunities and challenges. To understand this interaction, we propose a conceptual model: the Bright-Shadow Integration Model for AI in Higher Education (see Figure 2). This framework asserts that the outcome of AI adoption is not determined by the technology itself, but by the dynamic interaction between its inherent capabilities and mediating factors that enhance its benefits or exacerbate its risks.

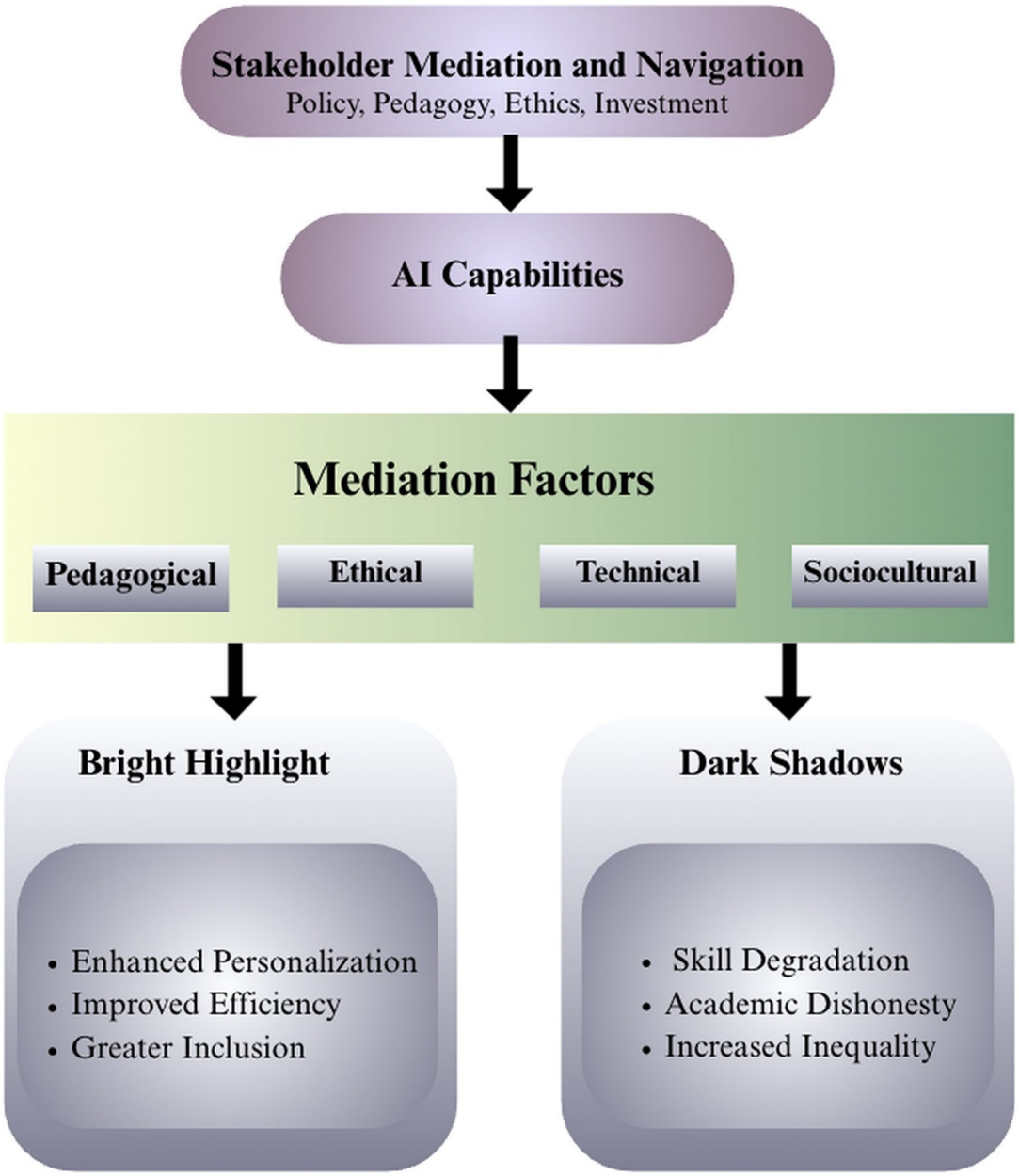



**Figure 2. A conceptual framework illustrating how the outcomes of AI integration are mediated by pedagogical, ethical, technical, and sociostructural factors.** Strategic navigation by stakeholders is required to channel AI capabilities toward positive outcomes (Bright Highlights) and away from negative consequences (Dark Shadows).

This model is built on two fundamental axes derived from our analysis:

1. AI capability axis: This represents the main functionalities of AI tools, ranging from content generation (e.g., text, code, media creation via tools like ChatGPT) [58,97] and personalized teaching (adaptive learning paths and real-time feedback)[4,49] to data analytics and knowledge structuring (e.g., via knowledge graphs for improved access to information and inference)[55,88] and automation (of administrative and assessment tasks). [14,46]

2. Mediation axis: This represents the critical intervening factors that determine whether a specific AI capability manifests as a "Bright Highlight" or a "Dark Shadow." Our synthesis identifies four key mediators:

- Pedagogical mediation: AI can support personalised learning (a Highlight), but it can also lead to skill atrophy if it replaces critical cognitive processes (a Shadow).[86,114] The outcome depends on whether assessments target the product or the process of learning.[14,37]

- Ethical and Integrity Mediation: The same content generation capability can be a tool for idea exchange and support (a Highlight) or a mechanism for plagiarism and academic dishonesty (a Shadow).[46,62] This is mediated by the presence of clear policies on acceptable use, transparency, and authorship.[2,105]

- Technical and Quality Assurance Mediation: The analytical power of AI is moderated by issues of bias, hallucinations, and data quality. These technical flaws can perpetuate bias and spread misinformation if unchecked (Dark Shadows).[43,81] Mitigation requires ongoing technical refinement and critical engagement by users.

- Sociostructural mediation: The benefits of AI depend on equitable access to technology and training. Without intervention, AI adoption risks exacerbating existing educational inequalities, creating a digital divide between institutions and students.[11,38,53]

The deployment of an AI capability must pass through the filter of these four mediators. Effective navigation through strategic policy, pedagogical redesign, ethical guidelines, and efforts to ensure equity channels the capability toward the positive pole, realising the Key Bright Highlights of improved personalisation, efficiency, and inclusion. In contrast, the lack of mediation allows inherent risks to dominate, resulting in Dark Shadows of ethical compromise, skill degradation, and increasing inequality.

This framework provides a sketch of a diagnostic process by first emphasising that the future of AI in higher education is not predetermined, but must be actively shaped by all stakeholders involved. It highlights the need for coordination across all stakeholders, including students, educators, institutions, and other policymakers, to steer the integration of AI toward its transformative potential while rigorously mitigating its inherent risks.

## Discussion

The thematic synthesis presented in this study confirms that the integration of AI in higher education is essentially dualistic, characterised by a constant tension between significant Bright Highlights and profound Dark Shadows. The proposed Bright Shadow Integration Model provides an essential framework for understanding this duality as a dynamic outcome mediated by pedagogical, ethical, technical, and sociostructural factors. Although AI has transformed the education landscape in general, higher education institutions remain crucial in educating and preparing students for the future. In support of this, the role of educators has been described as shifting from knowledge transmitters to learning facilitators in the AI era.[29,45] It has also been argued that pedagogical strategies require fundamental rethinking to support the development of new skills for the effective use of AI tools.[60,111] Unless such strategies are formulated and implemented, educational inequalities will be amplified, issues related to data privacy and the risks of widening educational inequalities must be addressed despite the complexity of their ethical implications.[23] Thus, risk of inequality is a key Dark Shadow mediated by sociostructural factors, such as institutional resources and policy. The rapid pace of AI development, which outstrips current regulatory and policy frameworks, will lead to uncertainties in governance and standardisation if not tackled.[116] This governance gap is measurable rather than merely anticipated. An EDUCAUSE survey conducted in January 2026 found that 94 percent of higher education staff had used AI tools for work in the preceding six months, yet only 54 percent were aware of their institution's AI policy.[96] Regulatory frameworks are beginning to close this gap unevenly across regions. The European Union's AI Act designates AI systems used in admissions and student performance analytics as high risk, with obligations applying from August 2026, while South Korea's AI Basic Act, in force since January 2026, introduces comparable requirements for transparency and human oversight. This governance gap represents a critical lack of ethical mediation, which our framework identifies as essential for mitigating risks. Outright bans on tools such as ChatGPT have been criticised as placing students at institutions where such restrictions apply at a disadvantage compared with those where the tools remain available.[34] Universities have instead been encouraged to focus on informing students about academic integrity policies and the consequences of academic misconduct.[112] ChatGPT has also been reported to provide features that educators can use to design interactive lessons, improve teaching strategies, and adapt learning resources to diverse student needs.[46] A broader shift from technology-based learning to learning with technology has also been described, in which AI support enables teachers to reduce administrative workload and redirect their focus towards lesson design and professional development.[32] This perspective has been extended through a process-aware pedagogical model in which generative AI functions as a cognitive scaffold rather than a substitute for learning, combined with transparent, process-oriented assessment and institutional governance.[101] In our view, these findings together illustrate the Bright Highlights achievable through

effective pedagogical mediation, where AI empowers educators rather than replacing them, provided institutions also invest in the professional development needed to realise this potential.

Despite the benefits, the integration of AI into higher education also presents significant ethical, social, and educational challenges.[5] An ethical threat is presented by the unacknowledged use of AI models to generate or contribute to assignments and papers in a way that is difficult to distinguish from human writing. This threat is a direct manifestation of insufficient ethical mediation. Closely related to this are the societal challenges posed by easy-to-use automated simulations of fundamental academic skills, which lack the breadth and depth of the genuine article. We also recognise technical challenges such as bias and hallucinations, which arise from the imperfect nature of the machinery used.

The challenges and benefits are very finely balanced. Clearly, the technical challenges will eventually be addressed. However, with the ethical and societal challenges, our view is that cooperation among all stakeholders must be fostered so that the academic community as a whole can work together to maximise the positive impact of AI whilst mitigating potential risks. That said, the perspective of students deserves some priority, since they are the ones in the best position to understand and reap the benefits of a technology whose speed of evolution is without precedent.[3,18,20,27,65,110]

For the framework to be of practical use, its consequences for institutional organisation need to be spelled out. We propose that stakeholders operationalise the two axes through dedicated working groups. An AI capabilities working group would focus on fleshing out the nature and scope of what the respective AI technologies can offer, whilst a set of mediation working groups, one for each of the four mediators, would evaluate the capabilities group's output from their respective perspectives. A third, decision-making group would take input from both, representing stakeholder navigation, and would formulate policies that maximise the Bright Highlights and minimise the Dark Shadows. This proposal is consistent with, and further supported by, findings from a global Delphi study,[31] in which governance experts across 22 countries independently converged on a comparable eight-part framework spanning academic integrity, ethical use, privacy, equitable access, AI literacy, integration strategy, human oversight, and institutional support, together with a structured process for keeping such policies current. In short, the contribution of this paper is not only a conceptual framework but a practical method for operationalising it. This direction is consistent with recent calls for research to focus on institution-wide strategies for the responsible integration of generative AI, including governance, pedagogy, assessment, and long-term organisational transformation.[24]

### Limitations

This review has several limitations worth noting. First, the search strategy used exact-phrase matching restricted to title and keyword fields rather than full-text search, which was a deliberate choice to keep the corpus manageable but which may have excluded relevant studies using different terminology to describe the same concepts. Second, the review was limited to English-language publications, which may have excluded relevant scholarship published in other languages, particularly given the global nature of AI adoption in higher education. Third, while three major databases were searched (Google Scholar, ERIC, and Scopus), other databases such as Web of Science or IEEE Xplore may hold additional relevant literature not captured here. Fourth, the thematic classification into Bright Highlights and Dark Shadows, while conducted by three reviewers with disagreements resolved through consensus, remains an interpretive process; other researchers working from the same corpus might draw different thematic boundaries. Finally, as a conceptual review, the Bright-Shadow Integration Model synthesises existing literature into a novel framework but has not yet been empirically tested; validating its mediating factors against real institutional or classroom data is an important direction for future research.

## Conclusion

AI technologies provide education with a myriad of opportunities for enhancing the outcomes and experiences of both learners and teachers, but also present significant challenges, a duality captured by our Bright-Shadow Integration Model. Most universities have yet to decide on the adaptation and implementation of AI tools in academic settings. Among the reasons are concerns for the possibility of AI to hinder traditional teaching, over-reliance on AI, and uneven familiarity with AI tools among stakeholders. Given the capability of AI tools to provide sophisticated personalised learning, educators need to consider redefining their roles and responsibilities from knowledge providers to facilitators, thereby acknowledging that AI is a valuable educational tool that will substantially influence modern education.[16]

Recent technological advances have the potential to revolutionise teaching and learning experiences by creating more responsive and adaptable learning environments. This transformation requires new pedagogical strategies to integrate AI effectively in the classroom.[70] Our framework demonstrates that such strategies are essential for mediating AI's capabilities toward positive outcomes. However, such strategies can only be implemented when the creative potential of AI in education is better understood. This aspect is yet to be comprehensively researched and reported.

On the other hand, we should bear in mind that remarkable as the capabilities of AI tools to generate text are, they are not a substitute for human teachers, as they lack humanlike interaction, emotional intelligence, empathy, etc., which human teachers can respond to and that can critically impact students' motivation and performance.

Therefore, to maximise the teaching and learning opportunities AI tools provide while minimising their risks, we recommend a proactive approach in which all stakeholders benefit from clear guidelines and regulations governing how these tools are used.

In the end, higher education institutions need to be proactive with the integration of AI in academic domains, preparing students with the required skills and abilities to thrive in an AI-mediated future. In our view, outright bans on AI tools would be counterproductive to this goal, given the pace at which these technologies are becoming embedded in professional and academic life.

Universities need to engage in open dialogues with all stakeholders - employers, educators and students and establish policies that determine the ethical use of AI tools in steering the future of education. Their future lies in embracing AI as a tool for empowerment, not replacement. By consciously mediating its integration by making practical use of the Framework as described above, we can harness the Bright Highlights of AI while safeguarding the integrity of education, thereby preparing generations to meet the future demands of the job market, as many future careers will undoubtedly involve working with AI tools.

## Ethics and consent

This study is based exclusively on the analysis of published literature and publicly available documents. No human participants, personal data, or identifiable information were involved. Therefore, ethical approval and participant consent were not required for this study.

## Data availability

No primary data were generated or collected in this study. The analysis is based on published literature and publicly available documents. All sources used in the analysis are cited within the article and listed in the reference section. The completed *PRISMA 2020 Checklist* and Supplementary Table S1 are publicly available in Zenodo at https://doi.org/10.5281/zenodo.22132278 under a CC0 license. The Zenodo repository record is also included in the Reference list.[91]

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**Publisher Full Text**

# Open Peer Review

## Current Peer Review Status: ✗ ?

**Version 1**

Reviewer Report 08 October 2026

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?

**Mehmet YAVUZ**
Management Information Systems, Bingöl University, Bingöl, Turkey

- The search strategy is somewhat narrow. Using only four exact phrases may have caused some relevant studies to be overlooked. It would be useful for the authors to provide a stronger justification for the selection of the keywords or to explain why alternative terms were not used.
- The thematic analysis process should be explained in more detail. It is not sufficiently clear how the coding process was carried out, how the themes were formed, and how agreement among the researchers was ensured.
- The quality assessment of the studies is unclear. It should be stated whether the methodological quality or strength of evidence of the 105 included studies was additionally evaluated.
- The exclusion of one study on the basis of “lower priority” should be explained more clearly.
- Although the four mediating factors appear reasonable, the traceability of the model would be improved if a table or mapping showed which themes or groups of studies were transformed into which model components.
- Some statements are written too definitively. For example, stating that technical problems will “eventually be addressed” is a strong assumption.
- The article considers students, faculty members, and institutions; however, the position of other actors such as employers, technology providers, regulatory bodies, and administrative staff within the model could also be briefly discussed.
- Figure 2 is conceptually useful but could be visually improved.
- In the Discussion section, the findings and the authors’ opinions should be distinguished more clearly.

**Is the work original in terms of material and argument?**
Yes

**Does it sufficiently engage with relevant methodologies and secondary literature on the topic?**

Yes

**Is the work clearly and cogently presented?**
Partly

**Is the argument persuasive and supported by evidence?**
Yes

**If any, are all the source data and materials underlying the results available?**
Yes

**Does the research article contribute to the cultural, historical, social understanding of the field?**
Partly

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** Artificial Intelligence, Machine Learning, Deep Learning, AI in Education, Educational Technologies

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Reviewer Report 08 October 2026

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**Theodoros Rachiotis**
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**Summary and overall assessment**
The article reports a Systematic Conceptual Review (SCR) of 105 publications on artificial intelligence in higher education, published between January 2021 and July 2025 and retrieved from Google Scholar, ERIC and Scopus. The literature is organised into benefits (“Bright Highlights”) and risks (“Dark Shadows”), and the authors propose the Bright-Shadow Integration Model, in which four mediating factors (pedagogical, ethical and integrity, technical and quality assurance, sociostructural) determine whether a given AI capability leads to positive or negative outcomes for educators, students and institutions.

The topic is timely, the paper reads easily, and the central proposition, that the effects of AI depend on how its use is mediated and not on the technology alone, is sensible and of practical interest to universities. I also appreciate that the authors deposited a PRISMA 2020 checklist and Supplementary Table S1 in Zenodo, which allowed me to check the included corpus against the text.
My main concerns lie with the review method and with the link between the declared corpus and the synthesis. As reported, the search cannot be reproduced, the counts in Figure 1 and Table 1 do not reconcile, Supplementary Table S1 does not match the studies actually cited as evidence in the Findings, and the route from the coded literature to the four mediators is not shown. Because the article presents itself as a systematic review and derives its model from that synthesis, these points bear directly on its scientific soundness. Some statements on regulation are also out of date.
My answers to the reviewer questions are Partly for questions 1, 2, 3, 5 and 6, and Not applicable for question 4, since no statistical analysis was performed. I have grouped my comments into major issues, which must be addressed for the article to be scientifically sound, and minor issues, which would improve clarity and accuracy. I would be glad to read a revised version.

**Major issues (must be addressed)**
**1. Methodological label and positioning**
The SCR design is attributed to reference 17 (Bond et al., 2024), which is a meta systematic review of AI in higher education and does not, as far as I can see, describe an SCR method. Please cite a methodological source for the design, or describe the study as a systematic review with a conceptual, theory-building synthesis and justify that choice with reference to review typologies (Grant & Booth, 2009) and to the literature on conceptual articles (Jaakkola, 2020).
The novelty claim in the Introduction also needs qualifying. The authors state that no earlier synthesis treats benefits and risks as one mutually conditioning system, yet Lim et al. (2023, ref. 69), which belongs to the corpus, already reads generative AI in education through a paradox lens, and Ivanov (2023) maps the negative side of AI across the processes of higher education institutions in detail. In addition, Adamakis and Rachiotis (2025) paper regarding pedagogical integrity, AI literacy, and policy integration (which is currently not included/cited in the manuscript) further builds around similar concepts of AI in higher education. Please explain what the Bright-Shadow model adds to these frameworks.
**2. Search strategy and reproducibility**
(a) Each of the four phrases was searched on its own. Three of them (“academic integrity”, “ethical dilemmas”, “critical digital literacy”) contain no AI term, so a search run as described would return a very large number of records unrelated to AI, far more than the 131 reported. Please give the exact string for each database as it was run, with field codes (for example TITLE or KEY in Scopus, descriptors in ERIC), Boolean operators, filters, limits and the date of each search, together with the number of hits per phrase and per database. PRISMA-S (Rethlefsen et al., 2021) sets out what is expected.
(b) Google Scholar cannot restrict searches to keyword fields, its results are not stable over time, and only the first 1,000 hits of a query can be viewed (Gusenbauer & Haddaway, 2020). Please explain how the 55 Google Scholar records were selected (for instance, the first n results sorted by relevance, or a title-only search) and add this to the Limitations. Haddaway et al. (2015) give practical guidance on documenting Google Scholar searches.
(c) In the PRISMA checklist, item 7 (search strategy) points to Figure 1, which contains only counts.
(d) The rationale for the start date is hard to follow. The passage on the private beta of GPT-3, its use during 2021 and its API release mixes several dates, while the substantive focus of the review

is generative AI after November 2022. One clear sentence on why January 2021 was chosen would be enough.
(e) Snowballing is mentioned, but the number of records found this way is not reported, and the flow diagram has no box for records identified through other methods, which the PRISMA 2020 template provides for (Page et al., 2021).

**3. The numbers in Figure 1 and Table 1 do not reconcile**

Table 1 assigns the 105 included studies to the four phrases 99, 33, 44 and 21 times, a total of 197 assignments and therefore about 92 repeat assignments. The text explains this as studies being retrieved under, and counted within, more than one search phrase. If that is literally the case, these records should have appeared as duplicates across the phrase searches, yet Figure 1 reports only 8 duplicates among 131 records. Either Table 1 reflects a post hoc thematic classification of the included studies, which the text should then state plainly and keep separate from retrieval, or the deduplication figures are wrong. Please reconcile the two and report how many unique records each phrase contributed. That 99 of the 105 studies fall under “AI in higher education” also suggests that the other three phrases added few unique studies, which is worth stating.

**4. Supplementary Table S1 does not match the evidence used in the synthesis**

I compared Table S1 in the Zenodo deposit with the article and its reference list.
(a) One entry is a placeholder, “John Doe et al., 2023, Canada”, on stakeholder views of ethics in distance education. It appears to correspond to Holmes et al. (2023, ref. 50).
(b) Fourteen entries in Table S1 appear nowhere in the article or the reference list, among them Hutson et al. (2022), Baidoo-Anu et al. (2023), Malik et al. (2023), Alqahtani et al. (2023), Lyu et al. (2024), Gupta et al. (2024), Tzirides et al. (2024), Moukhliss et al. (2024) and Escotet (2024). If these belong to the 105, the reader cannot see what they contributed to the synthesis.
(c) Many sources used as evidence in the Findings and in the model are not in Table S1, for example refs 9, 15, 33, 39, 51, 55, 56, 66, 70, 71, 74, 76, 88, 104, 112, 118 and 121. Two of them (refs 104 and 118) were published in 2026, after the search window had closed.
(d) Several entries in Table S1 seem to fall outside the stated eligibility criteria. Rivas and Zhao (2023) concerns chatbots in marketing, Peres et al. (2023) is an editorial in a marketing journal, Gallegos et al. (2024) is a technical survey of bias in large language models, and Wong and Low (2025) deals with online debate as a method for teaching ethics, with no AI focus. In the Findings, news reports (refs 34 and 36), commercial surveys (BestColleges, Intelligent.com) and an SSRN preprint (ref. 112) are also used as evidence, although blog posts, non-peer-reviewed and promotional sources were excluded.
Please make Table S1 complete and consistent with the reference list, remove the placeholder, replace the truncated cells (“…”) with full entries, and mark the included studies in the reference list (an asterisk is a common convention), so that background sources are clearly separated from the synthesised corpus. Any study kept despite the criteria needs a stated reason.

**5. Transparency of the thematic synthesis and of the derivation of the model**

The Methods state that studies were manually classified into themes on the basis of recurring concepts identified through close reading, and the Findings say that the analysis was guided by the four search concepts, which produced the two categories of Bright Highlights and Dark Shadows. The main split was therefore set in advance. This is a legitimate deductive choice, but it should be declared as such and its consequences discussed. The four mediators, in turn, appear in the model section without any account of how they emerged from the material. Please address the following.
(a) Name and cite the synthesis method. If thematic synthesis was used, describe the three stages proposed by Thomas and Harden (2008), namely line-by-line coding, descriptive themes and analytical themes, and show at which stage the mediators were generated.

(b) State who coded the studies, how many were coded by more than one author, whether a codebook or extraction form was used, and how disagreements were settled. Screening by three reviewers is reported, but nothing equivalent is reported for extraction and coding.
(c) Add an evidence table that links every Bright Highlight, every Dark Shadow and every mediator to its supporting studies, with counts, so that readers can judge how much of the corpus supports each element of the model.
(d) Explain how different kinds of publication were weighed. The corpus mixes surveys, policy analyses, bibliometric studies, technical surveys and essays, and these do not carry the same evidential weight.
ENTREQ (Tong et al., 2012) is a useful reporting guide for this section. A short reflexive note on the disciplinary positions of the three authors, and on how their earlier papers on the topic (refs 90 and 101) shaped the interpretation, would also add credibility.

**6. Stated aims, stakeholder analysis and internal consistency of the model**

The Introduction promises to examine how benefits and risks play out differently for educators, students and institutions. The Findings do not deliver this. The paragraph on students consists of two sentences, and the Dark Shadows section is organised by type of challenge and not by stakeholder. Either develop the stakeholder analysis (a matrix crossing stakeholders with mediators would serve well) or narrow the stated aim.
The model itself is described inconsistently. It is called the Bright-Shadow Integration Model, the Bright-Shadow Framework for AI in Higher Education (Findings), the Bright Shadow Integration Model (Discussion) and the Framework (Conclusion). In Figure 2 the mediators are labelled Pedagogical, Ethical, Technical and Sociocultural, whereas the text uses Ethical and Integrity, Technical and Quality Assurance, and Sociostructural. The Abstract lists algorithmic bias and data privacy among the Dark Shadows, but Figure 2 lists only skill degradation, academic dishonesty and increased inequality. The figure places “Stakeholder Mediation and Navigation” above “AI Capabilities” in a single downward chain, which implies that stakeholders act on the capabilities, while the text says that capabilities pass through mediators which stakeholders shape. Nor does the figure show what decides the direction of the outcome, that is, the presence or absence of mediation. Please align the terminology and redraw the figure. Since the Limitations acknowledge that the model has not been tested, it would also help to state it as a small set of explicit propositions that later empirical work could examine.

**7. Factual accuracy, currency and use of sources**

(a) The Discussion states that the EU AI Act obligations for high-risk systems used in admissions and student performance analytics apply from August 2026. The Digital Omnibus on AI, Regulation (EU) 2026/1744, which entered into force in July 2026, before this article was published, moved the application date for Annex III high-risk systems to 2 December 2027. Please update the statement and cite the legal acts themselves (Regulation (EU) 2024/1689 and its amending regulation). The wording should also follow Annex III, point 3, which covers access and admission, the evaluation of learning outcomes, the assessment of the appropriate level of education and the monitoring of prohibited behaviour during tests, rather than “student performance analytics”.
(b) The statement on South Korea’s AI Basic Act needs a citation to the statute and an indication of which provisions concern higher education.
(c) The EDUCAUSE report (ref. 96) was published in January 2026. Please check whether the survey was in fact conducted in January 2026, as the text says.
(d) In the Introduction, the Russell Group guidance and the Sciences Po policy are not referenced. The New York City example concerns public schools, a K-12 setting that the review itself excludes, and the ban was lifted in May 2023. Please update the example or replace it with one from higher education.

(e) The quotation introduced with the words “one recent study observes” (ref. 90) comes from the authors’ own earlier paper. Self-citation is acceptable, but it should be identified as such, and a descriptive statement should not stand in for evidence of how widespread AI use is.
(f) Several citations do not support the claims to which they are attached. PRISMA is attributed to ref. 83, a scoping review protocol by Moya et al. (2023), instead of Page et al. (2021). Ref. 23 (Chiu, 2021) concerns an AI curriculum for K-12 schools but is used for a claim about inequality in higher education. Ref. 116 (Wong & Low, 2025), on online debate in ethics teaching, is used for the claim that AI development outpaces regulation. Ref. 93 (Prunty & Barnett) examines letter formation in children with developmental coordination disorder and cannot support conclusions about handwriting and reading or spelling in typical learners, still less in university students. For the handwriting argument, Van der Weel and Van der Meer (2024) studied university students directly, although a published commentary (https://doi.org/10.3389/fpsyg.2024.1517235) questions how far their data support claims about learning, and both should be cited. For the claim that reliance on AI weakens critical thinking, Gerlich (2025) addresses the question more directly than the sources currently cited. The figures on student use and undetected use of ChatGPT (56%, 40% and 86%) are attributed to ref. 57, which reports a separate survey at one UK university. If they were taken from that paper’s background section, please cite the primary sources.

**8. Appraisal of the included literature and the PRISMA checklist**

No appraisal of the included studies was carried out. A formal risk-of-bias tool may not suit a conceptual review, but the authors should say so explicitly and give readers some indication of evidential weight, at minimum by classifying each study by type (empirical, review, policy analysis, conceptual or opinion) in Table S1 and reporting how each type contributed to each theme. The PRISMA checklist also needs correcting. Item 11 (risk of bias) points to the screening section, where no appraisal is described, and item 24a (registration) gives the Zenodo DOI of the article itself, which is not a registration. If the review was not registered and no protocol was written, please state this. Items 12 to 15 and 18 to 22 are left blank and should either be addressed or marked as not applicable with a short reason.

**9. Conclusions that go beyond the evidence**

Several statements in the Discussion and Conclusion are stronger than the synthesis allows, for example that the technical challenges will clearly be addressed, that AI will substantially influence modern education, that many future careers will undoubtedly involve AI, and that students are in the best position to understand and benefit from the technology, although several included studies report uneven AI literacy among students. The working-group proposal is described as a practical method for operationalising the model, but it has not been tested and follows from the authors’ reasoning, not from the reviewed evidence. Please present it as a suggestion for practice and either soften the other claims or support them with evidence. The Limitations should also mention the reliance on Google Scholar, the absence of quality appraisal, the deductive origin of the two main categories and the use of grey literature as evidence.

**Minor issues**

1. The Abstract refers to 105 “studies”. Since the corpus includes conceptual papers, policy analyses and editorials, “publications” would be more accurate. The Abstract should also say that the two main categories were defined in advance.
2. “Data extraction and analysis” and the sentence on Supplementary Table S1 belong in the Methods. The sentence on Table S1 is currently formatted as a heading and should be ordinary text.
3. At the full-text stage, one paper was “ranked as lower priority” because of thematic overlap. This is not an eligibility criterion and could introduce selection bias. Please remove it, or name the

study and justify the decision. “Methodological misfit” also needs a definition, since theoretical papers were eligible. PRISMA item 16b asks for excluded full texts to be cited with reasons.
4. The inclusion criteria list institutional policy reports alongside peer-reviewed sources, while three records were excluded at screening as not peer reviewed. Please clarify how grey literature was treated.
5. The statements on knowledge graphs rely on refs 55 and 88, which are general computer science surveys and report no educational outcomes. Please support the educational claim with studies from education or soften it. Ref. 55 should also be updated to its journal version (IEEE Transactions on Neural Networks and Learning Systems, 2022, 33(2), 494–514).
6. The definition of hallucination in the Technical challenges section, a model perceiving patterns or objects that do not exist, comes from computer vision. For language models, hallucination usually refers to fluent output that is not supported by the input or by facts. The paragraph on iterative self-labelling of data is long, is not linked to education, and could be shortened.
7. The first paragraph of the Discussion combines about ten separate points and contains a run-on sentence (“Unless such strategies are formulated and implemented, educational inequalities will be amplified, issues related to data privacy … must be addressed”). Please split it.
8. Describing AI as “a vital tool in grading” (refs 6 and 14) overstates what these sources show.
9. Spelling alternates between British and American forms (personalised and personalized, analysed and analyze, organised and organized). Please harmonise.
10. Figure 2 reads “Bright Highlight” in the singular. In Table 1, “Search phase” should read “Search phrase”.
11. In Table S1 the country column mixes author affiliation, journal location and conference venue (Afifah is coded as “Antalya, Turkey”, Chu et al. as “Australia”, Crompton and Song as “Chile”). It also contains a typo (“Sergia/Romania”), an uncertain entry (“UK / Germany?”) and a stray character after “ChatGPT” in the last row. Some publication years differ from the reference list (Gellai, Wang et al.). Please define the coding rule and correct these entries.
12. Several references are incomplete or malformed. Ref. 2 has no source, ref. 6 repeats the volume and year, ref. 22 contains a broken word (“institu-tions”), refs 58 and 69 contain encoding errors in author names and titles (Küchemann, Ragnarök), ref. 120 is incomplete and partly duplicated, and refs 34 and 36 have no URL. Refs 41 and 73 lack pages or article numbers, and refs 7, 9, 18, 25, 80, 81 and 87 lack a DOI or link. Ref. 91 is the Zenodo record of this article and should be labelled as supplementary material.
13. The Data availability statement mentions a CC0 licence, while the Zenodo record lists both CC BY 4.0 and CC0 and is typed as a journal article. Please clarify the licence. Depositing the extraction sheet and the coding framework as a dataset would make the synthesis easier to verify.

**Additional references cited in this report**

Adamakis, M., & Rachiotis, T. (2025). Artificial Intelligence in Higher Education: A State-of-the-Art Overview of Pedagogical Integrity, Artificial Intelligence Literacy, and Policy Integration. *Encyclopedia, 5*(4), 180. https://doi.org/10.3390/encyclopedia5040180
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Van der Weel, F. R., & Van der Meer, A. L. H. (2024). Handwriting but not typewriting leads to widespread brain connectivity: A high-density EEG study with implications for the classroom. *Frontiers in Psychology, 14*, Article 1219945. https://doi.org/10.3389/fpsyg.2023.1219945

**Is the work original in terms of material and argument?**

Partly

**Does it sufficiently engage with relevant methodologies and secondary literature on the topic?**

Partly

**Is the work clearly and cogently presented?**

Partly

**Is the argument persuasive and supported by evidence?**

Partly

**If any, are all the source data and materials underlying the results available?**

Partly

**Does the research article contribute to the cultural, historical, social understanding of the field?**

Partly

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** Research methods, qualitative research and evidence synthesis (systematic and conceptual reviews, thematic and reflexive thematic analysis), validity, reliability, higher education, physical education, new technologies.

**We confirm that we have read this submission and believe that we have an appropriate level of expertise to state that we do not consider it to be of an acceptable scientific standard, for reasons outlined above.**