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A scoping review on how generative artificial intelligence transforms assessment in higher education

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Abstract

Generative artificial intelligence provides both opportunities and challenges for higher education. Existing literature has not properly investigated how this technology would impact assessment in higher education. This scoping review took a forward-thinking approach to investigate how generative artificial intelligence transforms assessment in higher education. We used the PRISMA extension for scoping reviews to select articles for review and report the results. In the screening, we retrieved 969 articles and selected 32 empirical studies for analysis. Most of the articles were published in 2023. We used three levels—students, teachers, and institutions—to analyse the articles. Our results suggested that assessment should be transformed to cultivate students' self-regulated learning skills, responsible learning, and integrity. To successfully transform assessment in higher education, the review suggested that (i) teacher professional development activities for assessment, AI, and digital literacy should be provided, (ii) teachers' beliefs about human and AI assessment should be strengthened, and (iii) teachers should be innovative and holistic in their teaching to reflect the assessment transformation. Educational institutions are recommended to review and rethink their assessment policies, as well as provide more inter-disciplinary programs and teaching.

Keywords: Generative artificial intelligence, Scoping review, Higher education, Assessment, Educational policy, Professional development, Assessment literacy, AI literacy

Introduction

Artificial intelligence (AI) technologies have played an important role in improving learning, teaching, assessment, and educational administration (Chen et al., 2020; Zhang & Aslan, 2021; Chiu et al., 2023). With the release of ChatGPT, generative artificial intelligence (GenAI) is seen as having an unprecedented major impact on higher education. How GenAI transforms and influences higher education is still unclear (Al-Zahrani, 2023). GenAI refers to a subset of AI technologies capable of generating new content, ranging from text, images, and music to code and synthetic data (Chiu, 2023, 2024). Unlike typical AI technologies primarily designed for analysis and pattern recognition, GenAI can create novel outputs based on the data they have been trained on (Barrett & Pack, 2023). The advent of GenAI not only

indicates a new era of efficiency and precision but also brings forth a set of challenges and ethical considerations (Perera & Lankathilake, 2023; Chiu, 2024). GenAI stands out as a transformative force at all levels of education, particularly in the field of higher education.

Historically, assessment in higher education has predominantly been a manual and time-intensive task, often constrained by limited human resources and teacher-centered instruction (Broadbent, 2017; Knight & Drysdale, 2020; Penny & Coe, 2004). However, GenAI is starting to reshape these limitations and add more challenges, offering innovative approaches for evaluating student performance, tailoring learning experiences, and improving the overall quality of educational outcomes (Moorhouse et al., 2023; Chiu, 2023; Chiu et al., 2023). Recent research suggests that tools like ChatGPT can aid college students in completing tasks such as essay and proposal writing and take-home examinations, raising concerns about increased risks of cheating and undermining academic integrity (Chiu et al., 2023; Moorhouse et al., 2023). These indicate that two of the major affordances of GenAI will have been transforming what program goals and student learning outcomes should be (Chiu et al., 2023; Chiu, 2024; Guo & Wang, 2023). First, with the aid of this technology, students may be able to complete tasks for which they lack the necessary skills, such as creating photographs and getting some ideas from other disciplines (Guo & Wang, 2023). This opportunity motivates higher education institutions to create more interdisciplinary programs and instructors to employ more interdisciplinary teaching strategies. Second, GenAI could assist students in getting disciplinary subject content by producing content-based assignments and providing answers to questions based on the discipline (Chan, 2023; Chaudhry et al., 2023). The students could access the disciplinary content easier than before for self-regulated learning. GenAI will have been utilized in the workplace. Therefore, what skills graduates should nurture need to be revisited and reconsidered. The traditional assessment method is becoming increasingly inadequate for accurately assessing students' actual learning outcomes. These also indicate that the assessment methods in higher education must evolve in response to the implications of GenAI.

Assessment that is related to the programs and course objectives has a direct impact on learning and teaching for students and teachers (Heeneman et al., 2015; Popham, 2009). Higher education institutions should design and redesign policy and curriculum to address the changes brought about by GenAI; they must adapt to changing educational needs and ensure equitable AI access (Perkins, 2023; Rajabi et al., 2023). However, research on its application in higher education assessment methods is still limited, and opinions vary widely as the majority were conducted in 2023. For future high education, coexisting with evolving AI technology and adapting to an AI-driven environment is a necessary path for employment and life (Chiu, 2024). How GenAI transforms higher education needs more studies. Accordingly, this scoping review addresses this research gap by focusing on the impact of GenAI on three aspects—students, teachers, and institutions—in higher education assessment over the past five years. Through exploring these three aspects, the review aims to provide a detailed understanding of GenAI's role in modernizing and potentially revolutionizing the assessment landscape in higher education. The main research question is: How does GenAI transform assessment in higher education? This question is explored through three sub-questions:

RQ1. How does GenAI add learning opportunities and challenges to student assessment?

RQ2. How does GenAI impact teachers in assessing student learning?

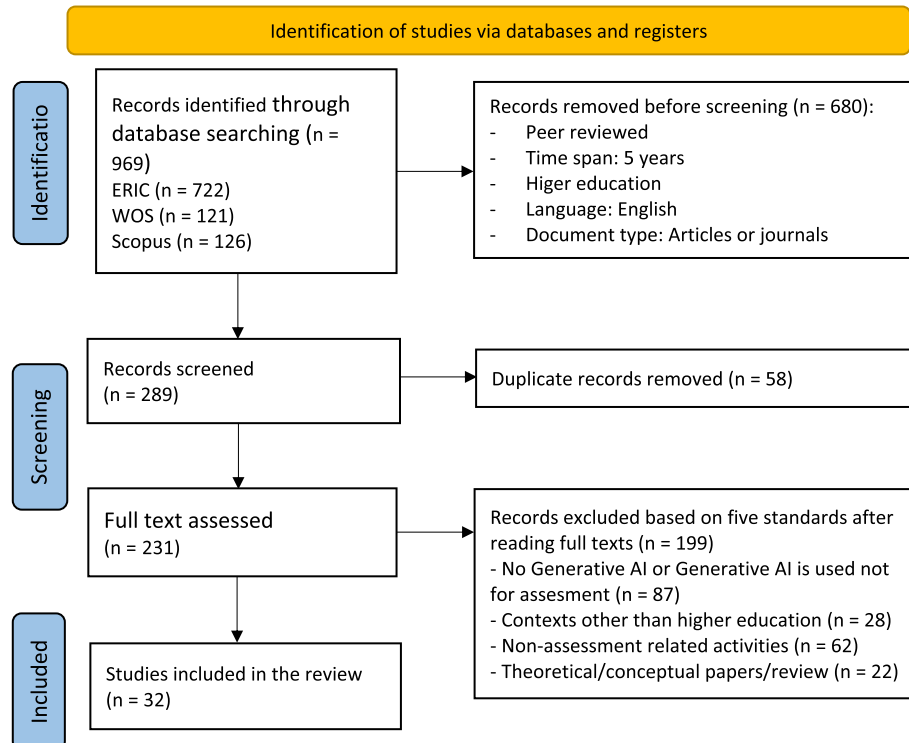
RQ3. How does GenAI impact institution policies on assessments?

Method

Scoping reviews are an ideal tool for determining the scope or coverage of a body of literature on a given topic and giving a clear indication of the volume of the literature while providing a broader overview of its focus (Munn et al., 2018). In particular, the exploratory nature of scoping reviews informs areas for subsequent research. We conducted this scoping review in accordance with the PRISMA Extension for Scoping Reviews (PRISMA-ScR) reporting guidelines and checklist (Tricco et al. 2018). This review focuses on empirical studies conducted in the past five years regarding the application of GenAI in higher education.

Article selection process

To find the targeted literature, we searched three widely used digital academic databases related to education and AI technologies: ERIC, Web of Science, and Scopus. The search terms were constructed with a boolean logic as follows: (assess* OR evaluate*) AND (“higher education” OR universit* OR college* OR undergrad* OR graduate* OR postgrad* OR under-grad* OR post-grad*) AND (“generative artificial intelligence” OR “ChatGPT” OR “generative AI”). During the search process, the following selection criteria were set in the search engine: (a) peer-reviewed journal articles; (b) written in English; (c) published in the last 5 years. As the search engines of different databases have different ways of setting options, the search criteria settings were adjusted to suit each database. The initial search was completed on September 30, 2023.



Article identification

Screening and inclusion procedures were then used to select articles for the main analysis. First, 58 duplicate articles were eliminated. Two of the authors then examined the titles and abstracts of the articles to identify peer-reviewed articles related to GenAI and higher education, thus excluding systematic literature reviews, meta-analyses, commentaries, and editorials. When they disagreed on paper identification, another author assessed the paper and made a final decision. The full texts of the remaining 231 articles were then read, and articles that are not GenAI or GenAI are not used for assessment. Contexts other than higher education ($n=28$), non-assessment-related activities ($n=62$), and theoretical, conceptual, and review studies ($n=22$) were removed. Ultimately, 32 articles were retained for this scoping review; see Table 1. Most of the articles were published in 2023. It is reasonable because GenAI is more accessible to teachers and educational researchers since the launch of ChatGPT on November 30, 2022, by OpenAI.

Coding and analysis

To answer the research questions, we used three levels—students, teachers, and institutions—to code and analyze the reviewed articles on various dimensions. The information extracted from the reviewed articles includes ChatGPT's role and limitations for assessment in higher education, ChatGPT's key challenge for assessment in higher education, the attitudes of students and teachers, and the implications of GenAI for assessment in higher education. A coding form was jointly developed by two authors and reviewed by another author to determine which variables to extract, see Appendix 1. The two coders coded the articles and charted the data continuously in an iterative discussion process using an inductive analysis approach.

Results and findings

While ChatGPT offers significant potential in educational settings, its limitations, impact on academic integrity, and the need for adapted assessment methods and policies are key areas of concern and focus for educators, students, and institutions. As shown in Figs. 1 and 2, the articles reviewed originate from a diverse range of regions, as indicated by the locations of the corresponding authors. In total, they represent 18 different regions and 11 disciplines, with education, medicine, and computer science being the top three disciplines.

How does GenAI place and add learning opportunities and challenges to student assessment?

Twenty-seven of the reviewed articles indicated that GenAI offered learning opportunities and challenges to student assessment. They revealed that the use of GenAI presented significant challenges to academic integrity and raised concerns about ethical behavior (e.g., cheating) in academic settings. Overall, GenAI added three opportunities—perceived unbiased feedback, immediate and diverse feedback, and self-assessment—and a challenge—student academic integrity—to student assessments in the following four aspects (see Fig. 3).

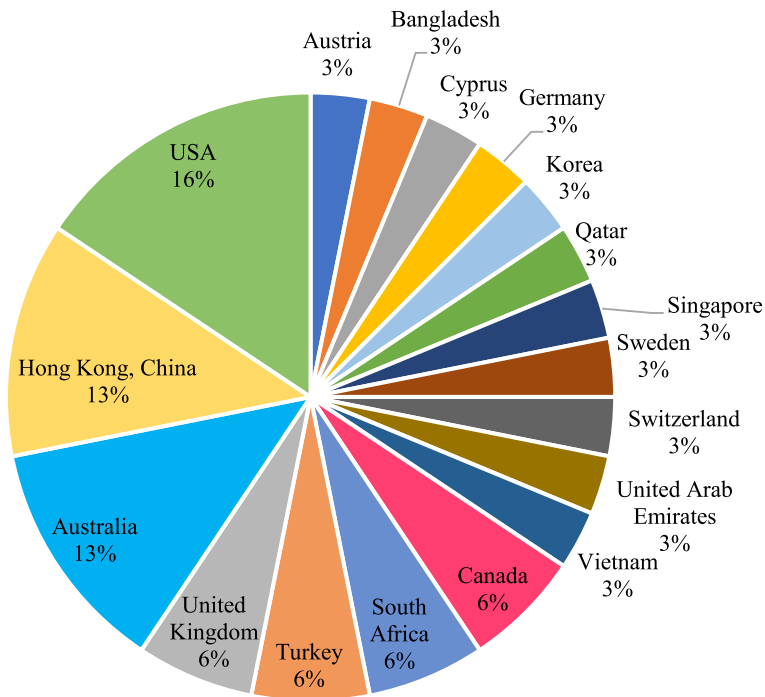


Fig. 1 Region of corresponding author

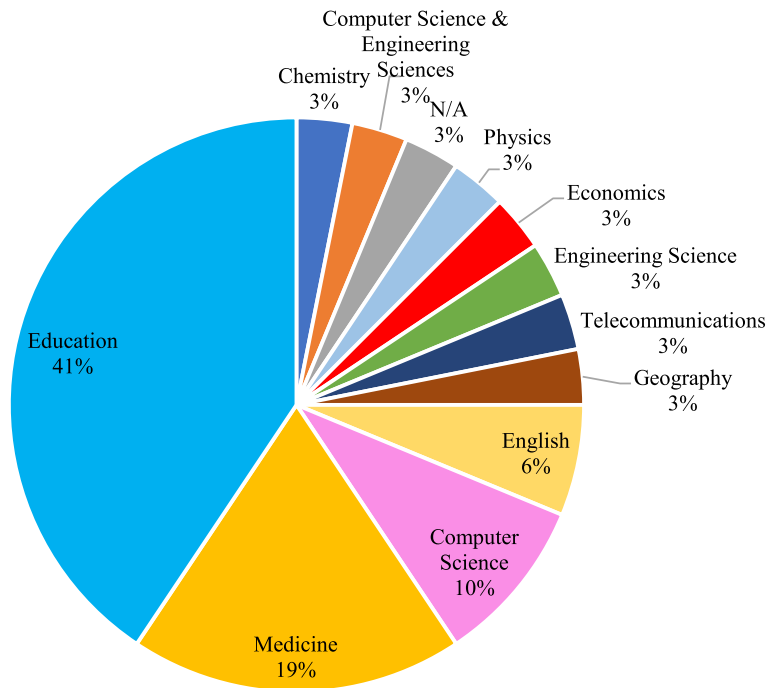


Fig. 2 Discipline

Immediate and diverse feedback

Thirteen percent of the twenty-seven articles revealed that students could get immediate and feedback or preliminary grades and comments from GenAI anytime and anywhere. Moreover, the students could ask GenAI to provide more feedback from

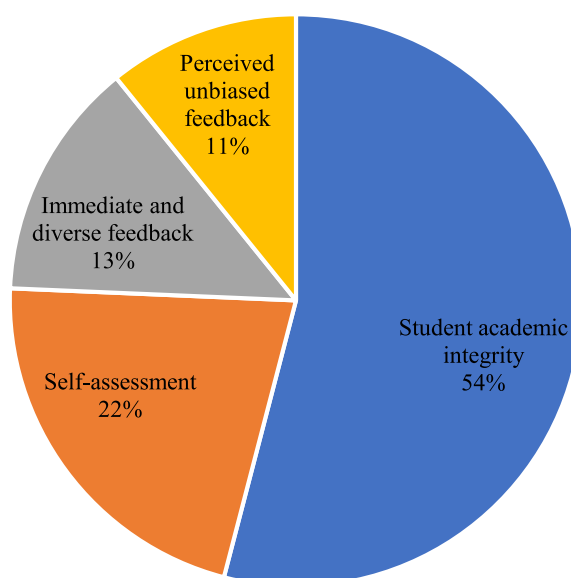


Fig. 3 Keys areas of concern and focus for students

various perspectives. They could gain more understanding through these diverse ranges of feedback (Naidu & Sevnarayan, 2023). Teachers are unable to give feedback to the way GenAI does. With the aid of GenAI, the students were encouraged to use assessment for learning approach in studying their courses. However, GenAI may not be able to generate correct content or course-based feedback (Ali et al., 2024; Cross et al., 2023; Ouh et al., 2023). For example, Guo and Wang (2023) suggested that ChatGPT might use different evaluation criteria from the courses or teachers' own, and its lack of specific knowledge about the class and the students could lead to inappropriate feedback.

Perceived unbiased feedback

Eleven percent of the twenty-seven reviewed articles suggested that, when compared to teachers, students felt that GenAI's feedback was less judgmental, subjective, and biased. AI has the potential to lessen individual biases in grading procedures, including essays, project proposals, and theses (Guo & Wang, 2023). For instance, while evaluating undergraduate and graduate students' theses, AI could lessen the examiners' personal prejudices (Greiner et al., 2023). AI is perceived as a machine; therefore, students feel that it is impartial. However, the output of GenAI, like ChatGPT, might be skewed due to biased training data (Naidu & Sevnarayan, 2023; Rajabi et al., 2023). Unfair evaluations and grades, as well as biased comments, could result from it (Naidu & Sevnarayan, 2023).

Self-assessment

Twenty-two percent of the twenty-seven reviewed articles demonstrated that GenAI can aid student learning through self-assessment. ChatGPT, for example, can help generate ideas and rubrics (Rajabi et al., 2023), as well as learning questions (Cheung et al., 2023;

Cross et al., 2023; Kang, 2023; Naidu & Sevnarayan, 2023) for students' self-assessment. These imply that students might obtain immediate and relevant resources for evaluating their own work, as well as recommendations for improvement and further learning. Furthermore, according to the reviewed articles, the students might learn from the mistakes and errors of a learning task that was suggested by GenAI (Rajabi et al., 2023). The articles highlighted that the learning tasks benefited student learning but did not involve critical thinking (Currie et al., 2023; Rajabi et al., 2023). In addition, the students were suggested to regularly evaluate their progress when interacting with ChatGPT. It was because ChatGPT performs differently on different tests, possibly because it generates output based on different data sources. For example, caution was needed when using ChatGPT in healthcare that is inter-discipline because of inconsistent accuracy (Fuchs et al., 2023). The students should critically assess ChatGPT outputs by using their knowledge, expertise, judgment, and creativity (Dai et al., 2023; Overono & Ditta, 2023). Overall, GenAI provided the students with new possibilities to learn and group by self-assessing their work and GenAI's output.

Student academic integrity

Fifty-four percent of the reviewed articles highlighted that the emergence of GenAI presented a significant challenge to student academic integrity (Adeshola & Adepoju, 2023; Alexander et al., 2023; Chaudhry et al., 2023; Chan, 2023; Dai et al., 2023; Elsayed, 2023; Geerling et al., 2023; Kang, 2023; Nikolic et al., 2023; Ouh et al., 2023; Overono & Ditta, 2023; Perkins, 2023; Smolansky et al., 2023; Stutz et al., 2023). The major concern is that ChatGPT has the potential to encourage cheating and academic dishonesty (Crawford et al., 2023; Currie et al., 2023; Gorichanaz, 2023; Naidu & Sevnarayan, 2023). For example, short-form essays have become an obsolete assessment tool (Yeadon et al., 2023). This is supported by a study examining the effectiveness of ChatGPT in academic settings. For example, it was found that submissions generated by ChatGPT scored impressively, and its performance typically qualifies for a First-Class grade, the highest academic distinction awarded in UK universities (Yeadon et al., 2023). Related research shows that ChatGPT performs well in exams in disciplines such as engineering (Uhlig et al., 2023), economics (Geerling et al., 2023), medicine (Currie et al., 2023), and geography (Stutz et al., 2023), indicating that the issue of academic integrity in higher education is facing unprecedented challenges. Overall, students should be nurtured about the importance of academic integrity and ethical behavior.

How does GenAI impact teachers in assessing student learning?

According to 31 reviewed articles, GenAI had a significant impact on teacher abilities and approaches to assessing student learning. Its technologies could facilitate teacher assessment processes and pose challenges to the diversity and innovation of assessment methods. Overall, this includes the following six aspects (see Fig. 4).

Teacher assessment literacy

About one-third of the 31 reviewed articles recognize that GenAI will be changing assessment methods, with a need for educators to prepare for these changes

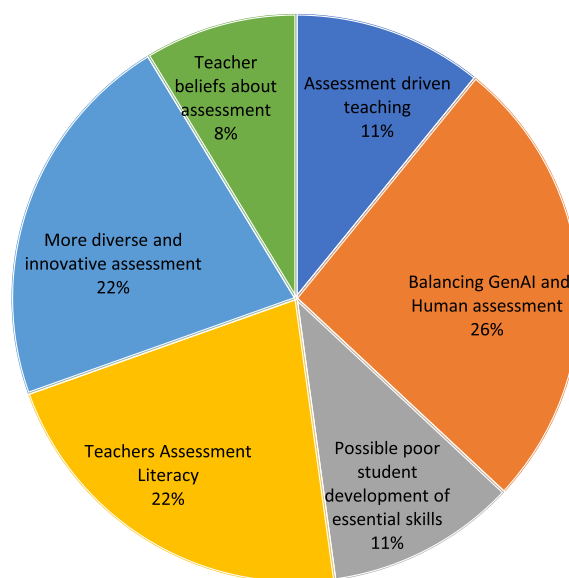


Fig. 4 Keys areas of concern and focus for teachers

(Alexander et al., 2023; Guo & Wang, 2023; Naidu & Sevnarayan, 2023; Ouh et al., 2023; Yeadon et al., 2023). Teachers may need to modify their assessment items and approaches to minimize students' misuse of this technology, including in-class testing and questions requiring deeper understanding (Naidu & Sevnarayan, 2023). Teachers' assessment literacy should include knowledge and skills related to assessment design, implementation, interpretation, and ethical use (Dai et al., 2023). The teachers should focus on critical thinking, problem-solving, and creativity in designing assessments (Chan, 2023; Dai et al., 2023). They also should create valid, reliable, and relevant assessment tasks to minimize AI-generated content dishonesty (Chan, 2023; Dai et al., 2023). For example, Farazouli et al. (2023) revealed that the teachers were more critical when grading student-written texts as they thought their students might finish their assessment tasks with ChatGPT. The teachers should consider designing innovative assessment methods that ensure academic integrity in the era of ChatGPT (Stutz et al., 2023). Overall, teachers should use assessment to promote students' active participation in the learning process and foster the development of students' critical thinking and problem-solving skills (Elsayed, 2023).

More diverse and innovative assessment

Twenty-nine percent of the 31 reviewed articles suggested that more diverse and innovative assessment was needed, which aligns with the previous findings on teacher assessment literacy. First, there is a need for strategies to prevent cheating using GenAI tools in assessments, such as asking questions and assigning tasks that ChatGPT cannot easily answer (Naidu & Sevnarayan, 2023). For example, Smolansky et al. (2023) found that the assignment types rated to be least impacted are presentations and discussions that were either pre-recorded or live; assessments that require product design or creative/artistic work were also rated as moderately affected by ChatGPT. For instance, Nikolic et al. (2023) suggested an alternative assessment method: video-conferencing for

evaluating student assignments through questioning and answering. In addition, assessment methods should be more innovative, like developing podcasts or storyboards, where ChatGPT serves as an auxiliary tool (Currie et al., 2023). Moreover, ChatGPT offers opportunities for authentic assessment by challenging students' beliefs and critical thinking (Crawford et al., 2023; Currie et al., 2023; Geerling et al., 2023). The students can demonstrate their understanding by applying their knowledge to evaluate complex cases generated by ChatGPT. Moving beyond traditional knowledge-based assessments and emphasizing problem-solving, data interpretation, and case-study-based questions is necessary (Ali et al., 2024; Fergus et al., 2023; Gorichanaz, 2023; Rajabi et al., 2023). These highlight a need for carefully designing and framing new assessment approaches in ways that center the process of learning, higher-order thinking, and authentic tasks (Smolansky et al., 2023).

Assessment driven teaching

Assessment acts as a driving force in teaching and learning (Heeneman et al., 2015; Popham, 2009). Higher education aims to prepare students to join the job market; therefore, the assessment should target the competence of the future workforce. GenAI technologies have transformed teaching and learning in higher education (Chiu, 2024). The shift towards AI in education highlights the need for self-regulated learning, supported by AI and digital literacy. The assessment should go beyond traditional coursework (Firat, 2023). For example, Firat (2023) claims that critical thinking, creativity, problem-solving, and AI and digital literacy skills should be explicitly included as learning outcomes in course designs. Teaching and learning with GenAI should be one of the key learning outcomes (Chiu, 2024; Stutz et al., 2023; Uhlig et al., 2023). Overall, teachers should teach and assess the skills needed in an AI-influenced landscape (Chan, 2023; Cheung et al., 2023; Farazouli et al., 2023; Stutz et al., 2023).

Possible poor student development of essential skills

According to seventeen of the 31 reviewed articles, teachers are concerned about student overreliance on ChatGPT. This might impede the development of essential skills like teamwork, leadership, empathy, creativity, critical analysis, and independent thinking—competencies crucial for future job markets (Chan, 2023; Rajabi et al., 2023; Stutz et al., 2023). The use of GenAI in classrooms could potentially lead students to be less prepared for employment if it replaces the learning of vital skills (Rajabi et al., 2023). For example, Firat (2023) claims that to counteract the potential negative impacts, teachers should design assessments that encourage original thinking and reduce dependence on AI-generated solutions, thereby fostering critical engagement and problem-solving abilities. Moreover, the need for humans skilled in working with GenAI is growing. It is because competent employees would produce higher-quality outcomes more effectively when collaborating with Gen AI (Howell & Potgieter, 2023). Students must be prepared for a world where GenAI is prevalent. Teachers should understand GenAI's broader implications for cognition, social interaction, and values so that they can effectively train the students to use GenAI to solve

problems (Smolansky et al., 2023). They should evaluate student abilities to solve problems, but not just their proficiency, with GenAI tools. These involve providing the necessary knowledge and ideas to teachers to design questions that assess students' understanding while minimizing their dependency on GenAI for answers and solutions (Elsayed, 2023).

Teacher beliefs about assessment

Teachers generally agreed that ChatGPT should be integrated into teacher teaching and student learning (Cross et al., 2023). Some teachers already trusted the information that was generated from ChatGPT and used it as a "one-stop shop" for knowledge sourcing (Cross et al., 2023). Some teachers understood GenAI's limitations and its impact on their feedback (Guo & Wang, 2023; Ouh et al., 2023). For example, teachers felt that ChatGPT's feedback, often lengthy and complex, included irrelevant comments. This poses comprehension challenges for students with low abilities (Guo & Wang, 2023). In addition, some teachers noticed that ChatGPT might use different evaluation criteria from their own, and its lack of specific knowledge about the class and students could lead to inappropriate feedback (Morjaria et al., 2023). These limitations indicated that although ChatGPT seemed to be powerful, it could not replace teacher feedback. Teachers should play a role in evaluating machine feedback, even if the machine is as powerful as ChatGPT, the most state-of-the-art AI tool.

Balancing GenAI and human assessment

Twenty-six percent of the 31 reviewed articles encouraged teachers to use GenAI in their assessments. Assessments should incorporate GenAI technologies to enhance learning outcomes (Chan, 2023). However, maintaining academic integrity and high-quality education requires finding a balance between AI-assisted and conventional human-centered teaching methods. It is recommended to use a balanced approach when integrating GenAI into assessment (Chan, 2023; Naidu & Sevnarayan, 2023; Stutz et al., 2023). They suggested using ChatGPT as an education tool and embracing it for various assessment-related tasks (Nikolic et al., 2023). Assessments should go beyond traditional approaches such as examination and essay and focus on evaluating higher-order thinking skills like critical thinking, creativity, and problem solving (Chaudhry et al., 2023; Geerling et al., 2023; Kang, 2023). For example, GenAI can be used to advance writing such as proof-reading, critique, and editing (Currie et al., 2023), create personalized assessments, and simulate conversations (Cheung et al., 2023; Currie et al., 2023). Therefore, the teachers were encouraged to use alternative grading practices, like incorporating nontraditional, authentic assessments that are difficult for AI to replicate without prompting (Chaudhry et al., 2023; Fuchs et al., 2023; Morjaria et al., 2023; Overono & Ditta, 2023; Perkins, 2023). In other words, the students' language can be self-assessed through GenAI, while the students' ideas and logical thinking can be assessed by teachers. Overall, teachers should consider what GenAI can and cannot afford in assessment. The human-centered assessment methods can focus on the items that GenAI cannot. This will move assessment from human-centered or machine-centered to mixed methods, transforming the traditional mode of assessment (Naidu & Sevnarayan, 2023).

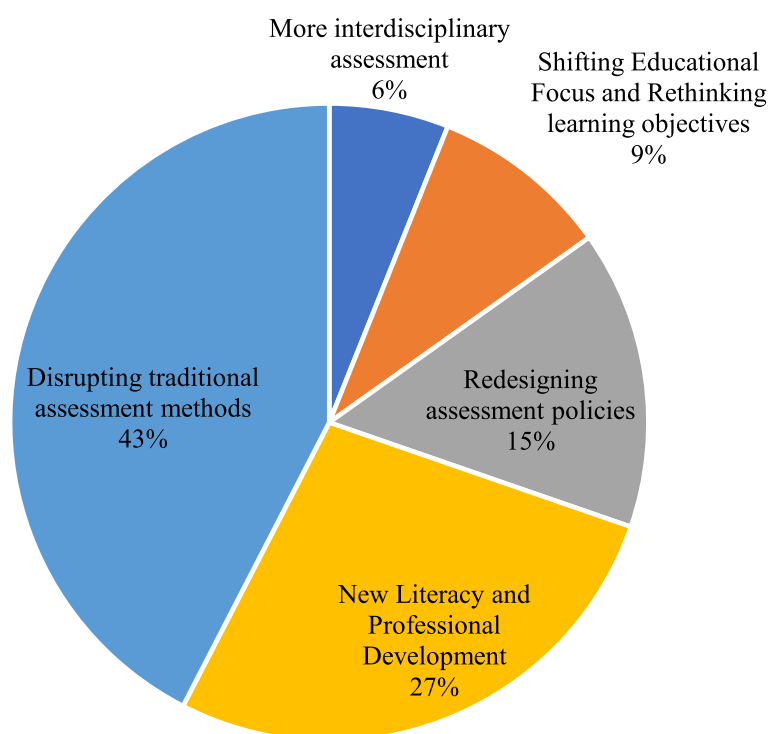


Fig. 5 Keys areas of concern and focus for institutions

How does GenAI impact on institution policies on assessments?

Twenty-six reviewed articles indicated that GenAI greatly disrupted traditional assessment approaches and methods, which significantly impacted the formulation of institutional policies. This specifically includes the following five aspects, see Fig. 5.

Redesigning assessment policies

The use of AI tools like ChatGPT in education requires rethinking assessment policies (Gorichanaz, 2023; Morjaria et al., 2023), as traditional examinations and assignments may become obsolete due to AI-generated content (Geerling et al., 2023; Gorichanaz, 2023). When making policies for assessment, educational institutions should carefully rethink what assessment approaches are needed to ensure academic integrity and meaningful learning (Perkins, 2023; Rajabi et al., 2023). Clear policies on GenAI usage and assessment rules are necessary (Currie et al., 2023; Kang, 2023). For example, the use of these tools may not necessarily be considered plagiarism if students are transparent in how they have been used in any submission (Perkins, 2023). The examination can be turned into a self-learning online platform.

New literacy and professional development for teachers

Researchers emphasize the importance of training in new literacy in light of GenAI advancements (Alexander et al., 2023; Guo & Wang, 2023). Education should focus on developing holistic competencies and generic skills in students (Chan, 2023).

For example, Chan (2023) conducted a mixed-method study aimed at developing an AI Ecological Education Policy Framework for higher education in Hong Kong. This framework comprises Pedagogical, Governance, and Operational dimensions, addressing training and support for teachers, staff, and students in AI literacy. Efforts should be made to address data privacy, transparency, accountability, and security in AI education (Chan, 2023; Cheung et al., 2023; Dai et al., 2023). Institutions must cope with the impact of GenAI on teaching and assessment practices by providing comprehensive AI, data, and digital literacy training and professional development for both teachers and students (Alexander et al., 2023; Elsayed, 2023). The training should encompass the ethical use of AI, understanding its capabilities and limitations (Chan, 2023). Incorporating critical thinking, creativity, problem-solving, AI, and digital competencies into curricula is crucial for students to critically assess and effectively utilize AI outputs (Chan, 2023; Firat, 2023; Nikolic et al., 2023; Uhlig et al., 2023). This holistic approach will empower both teachers and students to navigate GenAI tools responsibly, with an understanding of their social, emotional, and technical aspects. In order to prepare teachers for increasingly automated future classrooms, it is essential that they have a strong understanding of AI and digital competency, which goes beyond simple technical knowledge to include the use of AI and digital tools (Adeshola & Adepoju, 2023).

Shifting educational focus and rethinking learning objectives

Curricula and pedagogical changes caused by GenAI should focus on whole-person development, including personality traits like grit and perseverance (Chiu, 2023; Dai et al., 2023) and critical thinking (Chan, 2023). These attributes help students adapt and persist in the face of unforeseen challenges (Chiu, 2023; Dai et al., 2023). For example, Nikolic and colleagues (2023) investigated how ChatGPT influences the assessment of engineering education, the subjects included ten courses from seven universities in Australia. The study found that ChatGPT did indeed pass some courses and performed well in certain types of assessments. Dai and colleagues (2023) claims shifting the educational focus from the known to the unknown. For example, the cultivation of certain personality traits, such as grit, perseverance, and resistance, should be especially prioritized. Educational institutions should emphasize the importance of re-evaluating learning objectives in programs (Nikolic et al., 2023).

More interdisciplinary assessment

Interdisciplinary learning and assessment were advocated in the 6% of the reviewed articles; however, most classroom teaching is still single-disciplinary-based. GenAI enables students to learn a disciplinary knowledge or do some tasks (e.g., drawing, creating videos) that they are familiar, which fosters interdisciplinary learning such as project- and problem- based. UNESCO's guidance on AI in education recommended institutions to adopt an integrated approach to planning and governance that spans multiple sectors. For example, Chan (2023) claims that policies related to AI and education should be crafted through the synergy of various disciplines, ensuring a well-rounded and inclusive policy framework. Policymakers are advised

to engage with experts in diverse fields such as education, technology, and ethics to formulate policies that comprehensively address the multifaceted nature of AI in the educational sphere (Chan, 2023). Furthermore, it is important to foster learning environments where individuals can thrive while working on collaborative and interdisciplinary projects (Chaudhry et al., 2023). This holistic student development ensures that the workforce is well-equipped for the collaborative and interdisciplinary nature of modern challenges. Therefore, more assessment on interdisciplinary learning is needed.

Disrupting traditional assessment methods

The existing performance-based assessment systems adopted by higher education institutions to ensure that students are learning and developing the necessary skills for future job markets seem likely to be unserviceable with the arrival of ChatGPT (Chaudhry et al., 2023). As GenAI can generate coherent essays that may bypass plagiarism detection software (Nikolic et al., 2023; Perkins, 2023; Yeadon et al., 2023), some researchers argue that traditional assessment methods need to be changed (Geerling et al., 2023; Kang, 2023; Overono & Ditta, 2023). Various assignment types, including essays and computer coding, are impacted differently by GenAI (Fergus et al., 2023; Greiner et al., 2023; Guo & Wang, 2023; Naidu & Sevnarayan, 2023; Ouh et al., 2023; Smolansky et al., 2023). For example, Chaudhry and colleagues (2023) think that existing assessment tools (e.g., essays, problem-solving questions and creative writing) are not adequate to confirm students' learning and performance. Therefore, it is essential to transform the traditional assessment method. As ChatGPT does not pose any threat to knowledge-based assessments conducted directly face-to-face on university campuses (Ali et al., 2024), Nikolic and colleagues (2023) think teachers can use short-term solutions, oral presentation, in-person exams, projects, laboratory work, and other assessments that require creativity and go beyond writing. Overall, the teachers' assessment follows the institution's policies; therefore, institutions should clearly suggest how to assess student skills that are needed for future workforces and also run relevant professional development activities.

Discussion, implications and future research direction

Implications for student learning

Cultivate student self-regulated learning skills

The three opportunities—perceived unbiased feedback, immediate and diverse feedback, and self-assessment—offered by GenAI in the reviewed articles encourage students to study independently. To leverage GenAI opportunities, students need to develop strong self-regulated learning skills, which include goal setting, self-monitoring, self-assessment, and adaptive learning strategies (Xia, et al., 2023; Xia, Chiu, Chai, Xie, 2023; Zimmerman, 2002). Educators can foster these skills by designing GenAI-enhanced curricula that encourage exploration, critical thinking, and problem-solving. This involves creating learning environments where students are guided to set their own learning objectives, monitor their progress with GenAI, and adjust their learning approaches based on feedback (Hooshyar et al., 2020). Additionally, integrating GenAI tools that provide

personalized feedback and adaptive learning paths can help students become more aware of their learning process and outcomes. As a result, the students are not only prepared to navigate the GenAI-driven educational landscape but are also equipped with lifelong learning skills crucial in a rapidly changing world.

Student responsible learning and integrity

GenAI placed a big challenge on academic integrity in student learning and development (Chiu, 2024; Moorhouse et al., 2023; Gou & Wang, 2023). Students must use GenAI tools ethically and responsibly, respecting intellectual property and recognizing GenAI limitations. Educators should foster student critical thinking and analytical skills, guiding them to scrutinize and cross-check GenAI-generated information. These skills are vital for discerning the accuracy and relevance of information, ensuring that their learning is comprehensive and rooted in a deep disciplinary understanding (Firat, 2023; Moorhouse et al., 2023). Besides, educators should view active engagement in learning, setting personal goals, and using GenAI as a supplementary tool as essential learning responsibilities of students. The students should realize the importance of having a deep understanding of disciplinary knowledge when using GenAI for meaningful and well-grounded learning.

Implications for teacher instruction

Professional development for teacher assessment and digital literacy

The reviewed articles suggested that more diverse and innovative assessment is needed, which poses new challenges in professional development for teacher literacy, such as assessment, AI and digital literacy (Chan, 2023; Chiu et al., 2024). Teachers need to develop assessment literacy and the ability to set reasonable tasks. They should also be capable of distinguishing between tasks completed by students and those done by GenAI, i.e., AI literacy (Chan, 2023). Additionally, providing timely feedback and assigning fair and reasonable grades to students is essential. Besides, teachers must commit to continuous professional development of AI literacy to stay abreast of evolving GenAI technologies and their applications in education (Chan, 2023). This includes acquiring knowledge about the latest GenAI tools, understanding their pedagogical implications, and learning how to integrate these technologies effectively into the curriculum 2024.

Teacher innovative and holistic teaching that is driven by assessment

Assessment drives teaching, i.e., how to assess is associated with how to teach. The reviewed articles suggested that assessment in GenAI-based learning should cater to holistic (both generic skills and disciplinary knowledge) and innovative teaching (Heeneman et al., 2015; Popham, 2009). Contemporary assessments prioritize student higher-order thinking. Thus, critical thinking, creativity, and problem-solving, as well as AI and digital literacy, should be explicitly incorporated into the learning outcomes of course designs (Chan, 2023; Firat, 2023). For example, instead of reducing reliance on rote and repetitive memorization, enhancing students' understanding of concepts and the

development of higher-order skills are recommended. Teachers can get some new teaching ideas and revise their teaching strategies to fit the needs of students, e.g., what they need for their careers. In summary, the advent of GenAI requires teachers to adapt their instructional strategies to align with diverse assessment methods and address the various learning needs of students.

Teacher belief about human and AI assessment

While ChatGPT is powerful, teachers should have a strong belief that they cannot be replaced by GenAI in many aspects. For assessment, teachers need to understand what GenAI can and cannot offer in assessment, moving from human-centered and machine-centered methods to mixed methods, thereby altering traditional assessment modes (Naidu & Sevnarayan, 2023). Teachers also need to acknowledge the importance of AI and digital literacy for themselves and their students, understanding that proficiency in AI and digital tools is crucial for contemporary education and society. This includes responsible and ethical AI use in classrooms. Despite the advancements of AI, teachers should believe that human judgment and critical thinking remain irreplaceable, emphasizing the teachers' role in guiding students, especially amidst abundant AI-generated content. They should also recognize the need for lifelong learning and continuous professional development to stay abreast of technological changes, adapting their skills and strategies accordingly.

Implications for institutional policy

Assessment policies

As GenAI is here to stay and its usage for learning becomes more popular, higher education institutions need to rethink their assessment policies. This is supported by the three aspects: redesigning assessment policies, new literacy and professional development for teachers, shifting educational focus, and rethinking learning objectives. Gorichanaz (2023) suggests that GenAI requires a significant evolution of traditional assessment methods, as its content-generating capabilities may diminish the effectiveness of standard exams and assignments (Chiu et al., 2023). This evolution calls for a shift in educational focus, along with a re-evaluation of learning objectives and assessment policies, to stay aligned with the evolving AI-integrated educational landscape. The institutions can lead this educational revolution by revising their assessment policies. For example, they could advocate (i) more diverse assessment methods that extend beyond traditional exams and written assignments; (ii) new focused learning outcomes that address student needs for careers; and (iii) innovative teaching with GenAI that better fosters generic skills.

Interdisciplinary programme

The reviewed articles suggested that the adoption of GenAI led to shifting educational focus, rethinking learning objectives, more interdisciplinary assessment, and disrupting traditional assessment methods. Therefore, higher education institutions should consider implementing more interdisciplinary programs that emphasize

curricula and pedagogical changes aimed at whole-person development. Such programs should not only impart knowledge but also focus on developing personality traits like grit and perseverance (Chiu, 2023). The advocacy for interdisciplinary learning and assessment underlines the need to disrupt traditional assessment methods. The institutions can encourage a more holistic form of education, integrating various disciplines to provide students with a more comprehensive understanding and skill set. For example, they can offer specialized funding that is exclusively available to interdisciplinary programs. This approach would incentivize cooperation across different fields, encouraging a more integrated and collaborative educational environment. This shift is crucial in preparing students to navigate and excel in an increasingly complex and interconnected world.

Future research direction

More future studies on diverse and innovative assessment are needed

As discussed, various assessment methods, such as face-to-face tests, oral exams, and non-written tasks, can be employed to mitigate the impact of GenAI in academic assessments. However, there is still a need for a comprehensive assessment strategy tailored to different disciplines in higher education. Future research should focus on developing a precise assessment policy to standardize these methods. This standardized policy would ensure consistency and fairness across different fields of study while effectively addressing the challenges posed by advanced GenAI technologies in educational assessments.

More interdisciplinary assessment approaches

Future research should indeed emphasize more interdisciplinary assessment approaches. This direction is essential in preparing students for the increasingly interconnected and complex challenges of the modern world. Interdisciplinary assessments encourage a broader understanding, integrate knowledge from various fields, and foster critical thinking and problem-solving skills that are vital in today's diverse and dynamic environments. By focusing on these approaches, research can contribute significantly to the development of educational strategies that reflect real-world demands and prepare students for successful, adaptable careers in a rapidly evolving global landscape.

AI literacy for students and teachers

AI literacy equips both students and teachers with an understanding of AI technologies, their capabilities, and their limitations. This knowledge is essential not only for using AI tools effectively, but also for leveraging these tools in various fields of study and research. Institutions should conduct surveys or studies to assess the current level of AI literacy among students and teachers. This can help identify gaps in knowledge and areas that need more focus. Explore how AI literacy can be embedded in various academic disciplines, not just computer science. This includes how AI can be applied in the humanities, social sciences, arts, and other fields. More studies are

needed to understand what AI literacy is for the students and teachers, and how to effectively assess the literacy.

Teacher assessment literacy

In future educational research, focusing on teachers' assessment literacy is crucial. This encompasses understanding assessment purposes, designing effective strategies, and interpreting results accurately. With the integration of AI in education, enhancing teacher assessment literacy is vital for maintaining educational quality and impacting student outcomes. Research should explore how to design effective continuous professional development activities for higher education teachers. We suggest research on the design should emphasize evidence-based approaches that are more convincing.

More student and industry voice

Future research should focus on developing educational policies that actively incorporate feedback from both students and industry professionals. This inclusive approach is crucial for creating policies that are academically robust and aligned with the needs from the real-world. Engaging students in the policy-making process ensures that their diverse needs and learning experiences are addressed, leading to more student-centered educational assessment systems. Similarly, input from industry experts can bridge the gap between academic training and workforce requirements, making education more relevant and practical. This comprehensive and participatory approach in policy development is essential for preparing students effectively for future challenges and opportunities in GenAI society.

Conclusion and limitations

Thirty-two articles over the past five years in ERIC, Web of Science, and Scopus were selected for review to provide evidence how GenAI transform assessment in higher education. This scoping review used three levels - students, teachers and institutions - to summarize how GenAI impacts assessment. Although the results of this review are preliminary, they provide a different understanding of GenAI's role in modernizing and potentially revolutionizing the assessment landscape in higher education. This review highlights valuable trends and proposes future research directions in GenAI for both researchers and practitioners, but two limitations should be noted. Firstly, as a scoping review, the study cannot provide specific recommendations. To gain a better understanding of how GenAI impacts students, teachers, and institutions in higher education assessments, systematic reviews and meta-analyses are advised once a larger body of related research is available. Secondly, some of the studies reviewed discussed the application of GenAI in a general context without detailing specific technologies. Consequently, the findings related to the roles of GenAI in this review may not be sufficiently detailed.

Appendix 1

Coding table

ID	Author	Year	Displine	Region of corresponding author	Key areas of concern and focus for students	Key areas of concern and focus for teachers	Key areas of concern and focus for institutions
1	Fergus et al.	2023	Chemistry	United Kingdom	N/A	T1	I3
2	Rajabi et al.	2023	Computer Science & Engineering Sciences	Canada	S1 S2 S3	T1 T2.	I4
3	Naidu & Sevnarayan	2023	Education	South Africa	S1 S2 S3 S4	T3. T1 T4	I3
4	Guo & Wang	2023	English	Hong Kong SAR, China	S2	T3 T5	I1. I3.
5	Ouh et al.	2023	Computer Science	Singapore	S4 S1	T3 T5	I3
6	Alexander et al.	2023	English	Cyprus	S4	T3	I1
7	Yeadon et al.	2023	Physics	United Kingdom	S4	T3	I3
8	Smolansky et al.	2023	Education	USA	S4	T1 T2.	I3
9	Greiner et al.	2023	Education	Germany	S2	T4	I3
10	Dai et al.	2023	Education	Hong Kong SAR, China	S3 S4	T3	I1 I2
11	Chan	2023	Education	Hong Kong SAR, China	S4	T3 T6 T2	I2 I5
12	Cheung et al.	2023	Medicine	Hong Kong SAR, China	S3	T4 T6	I1
13	Kang	2023	Education	Korea	S3 S4	T4	I4 I3
14	Uhlig et al.	2023	Computer Science	Bangladesh	S4	T6	I1
15	Gorichanaz	2023	Education	USA	S4	T1	I4
16	Geerling et al.	2023	Economics	USA	N/A	T1	I3
17	Currie et al.	2023	Medicine	Australia	S3 S4	T1 T4	I4
18	Firat	2023	Education	Turkey	S4	T1	I1
19	Crawford et al.	2023	Education	Australia	S4	T1	N/A
20	Overono & Ditta	2023	Education	USA	S4	T4	I3
21	Perkins	2023	Education	Vietnam	S4	T4	I3
22	Chaudhry et al.	2023	Education	United Arab Emirates	S4	T4	I5 I3
23	Stutz et al.	2023	geography	Austria	S4	T3 T6 T2 T4	N/A
24	Nikolic et al.	2023	engineering education	Australia	S4	T4	I1 I2 I3
25	Howell & Potgieter	2023	telecommuni-cations	South Africa	N/A	T2	N/A

ID	Author	Year	Displine	Region of corresponding author	Key areas of concern and focus for students	Key areas of concern and focus for teachers	Key areas of concern and focus for institutions
26	Farazouli et al.	2023	Education	Sweden	N/A	T6. T3	N/A
27	Ali et al.	2024	Medicine	Qatar	S1	T1	I3
28	Fuchs et al.	2023b	Medicine	Switzerland	S3	T4	N/A
29	Cross et al.	2023	Medicine	USA	S1 S3	T5	N/A
30	Morjaria et al.	2023	Medicine	Canada	N/A	T5 T4	I4
31	Adeshola & Adepoju	2023	N/A	Turkey	S4	N/A	I1
32	Elsayed	2023	Computer Science	Australia	S4	T3	I1

Legend of coding table

RQ	Code	Topic	Example
1	Key areas of concern and focus for students	S1 S2 S3 S4 Immediate and diverse feed-back (5 times) Perceived unbiased feedback (4) Self-assessment (8) Student academic integrity (20)	Students get answers when needed; students can receive different answers from ChatGPT. Students feel fairness; their feedback differs from other students, and they don't know the reason for the feedback discrepancy. ChatGPT can be used for self-assessment by students. Students may copy answers from ChatGPT.
2	Key areas of concern and focus for teachers	T1 T2 T3 T4 T5 T6 More diverse and innovative assessment (10) Possible poor student development of essential skills (5) Teachers Assessment Literacy (10) Balancing GenAI and Human assessment (12) Teacher beliefs about assessment (4) Assessment driven teaching (5)	Teachers need different assessment so that students can't rely on ChatGPT. Poor students can get higher score with ChatGPT, so teachers can't find poor students. Teacher should know the significance and new method of assessment. Combine teachers' and machine's assessment. Teachers should play a role in evaluating machine feedback. Assessment acts as a driving force in teaching and learning.
3	Key areas of concern and focus for institutions	I1 I2 I3 I4 I5 New Literacy and Professional Development (9) Shifting Educational Focus and Rethinking learning objectives (3) Disrupting traditional assessment methods (14) Redesigning assessment policies (5) More interdisciplinary assessment (2)	Institutions should improve students' and teachers' AI literacy Institutions should focus on holistic education. The traditional test GenAI can pass, so it must be changed to evaluation. Reformulate evaluation policies. Policies related to AI and education should be crafted through the synergy of various discipline

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Authors' contributions

Q.X.: Conceptualization, Methodology, Formal analysis, Validation, Writing - Original Draft, Writing - Review & Editing. X.W.: Formal analysis, Validation, Writing - Review & Editing. F.O.: Validation, Writing - Review & Editing. T.L.: Validation, Writing - Review & Editing. T.K.F.C.: Funding acquisition, Conceptualization, Methodology, Formal analysis, Validation, Writing - Original Draft, Writing - Review & Editing, Supervision.

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