

Integrating artificial intelligence into STEM education: Navigating academic integrity



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Abstract The study of the interaction between STEM education and artificial intelligence is relevant for ensuring academic integrity because of the need to guarantee the efficacy and impartiality of the educational process, which must align with contemporary technological demands and ethical standards. The objective of this research article is to identify the challenges and potential for the utilisation of artificial intelligence in the development of STEM education programmes and curricula. This article examines the efficacy of current preventive measures against students' misuse of AI technologies in the context of STEM education. In the course of composing the research article, the authors employed a systematic approach to analysing and generalising the findings of their review of the literature, with the objective of identifying the critical aspects of academic integrity in the use of artificial intelligence in STEM education. The study employed expert assessment to collate data on the total number of coursework items examined and the number of works in which the GPT detector identified indications of AI usage. The calculation of the percentage of violations of academic integrity through the use of artificial intelligence to the total number of coursework for each speciality revealed that the percentage of violations of academic integrity is greater at the Igor Sikorsky Kyiv Polytechnic Institute, where the coursework was checked for the first time for the use of AI (7.46%), than at Taras Shevchenko National University of Kyiv (4.03%), where the check is carried out for two semesters. Concurrently, there is an emerging concern regarding the increasing incidence of academic integrity violations facilitated by AI technologies. This necessitates the formulation of transparent guidelines governing the deployment of AI in the educational sphere, enhancements to the assessment framework, and the integration of AI-based detection tools into the evaluation of student performance. Moreover, it is imperative to cultivate a heightened ethical consciousness among both students and educators.

Keywords: psychology, philosophy, higher education, adult education, academic integrity, educational technologies

1. Introduction

The development of future specialists is contingent upon the advancement of science, technology, engineering, and mathematics (STEM) disciplines, particularly in light of the 10.8% projected job growth in these fields over the next decade (Bureau of Labor Statistics, 2023). The advent of new technologies with a plethora of applications has necessitated a reorientation of the education sector, with curricula and the educational process being adapted to align with the demands of the contemporary labour market and the advancement of science and technology. The most frequently discussed topic among educational institutions is the introduction of the latest teaching methods, including the integration of artificial intelligence (AI) and other digital tools. The interaction between STEM education and artificial intelligence necessitates not only the identification of technical solutions but also the consideration of the psychological factors of those engaged in the educational process and the philosophical justifications for the ethical utilisation of emerging technologies. New technologies facilitate personalised learning, enhance the efficacy of interactions between participants in the educational process and facilitate the acquisition of essential professional and digital competencies. Conversely, they prompt institutions to reconsider conventional approaches to the delivery of education and the assessment of its quality, as well as to address issues of academic integrity. While academic plagiarism, data fabrication, unauthorised collaboration, and bribery were previously considered violations of academic integrity, the advent of AI has prompted educational institutions to recognise the necessity of preventing the abuse of assignments and examinations.



The objective of this research article is to examine the potential applications of artificial intelligence in the development of educational programs and curricula, with a particular focus on the efficacy of a personalised approach to STEM education. The research aims to identify potential issues in integrating artificial intelligence into the educational process and to assess the risks associated with its use in the context of academic integrity. Furthermore, it is crucial to deter students from violating academic integrity during their studies and to evaluate the efficacy of current preventive measures against students' inappropriate utilisation of AI technologies in the context of STEM education.

In light of the accelerated pace of digitalisation and the emergence of novel technological solutions, it is imperative that the education sector undergo a transformation to align itself with the evolving needs of students, educators and the labour market. In this context, ensuring the development of students' essential professional and digital skills, which will form the basis for the development of modern society in the context of digitalisation, is of paramount importance. The results of a survey conducted by Zhylin et al. (2023) as part of their study indicate that the majority of teachers (approximately 79%) currently utilise digital tools on a regular basis. This has significantly altered the nature of the interaction between teachers and students, facilitating comprehensive horizontal communication between all participants in the educational process. However, Bakhmat et al. (2023) observe that the extent of the advancement of digital technologies in higher education institutions gives rise to a notable disparity in the level of professionalism, and more specifically, digital competence, which necessitates an integrated methodology for the development of educational programmes that are founded on equality.

In the context of modernity, the most critical component of science, technology, engineering, and mathematics (STEM) education is the use of innovative educational technologies to prepare students for work in a technologically advanced world and to shape their competitiveness in the labour market (Wu & Anderson, 2015). The integration of the latest technologies, including artificial intelligence, into STEM education should facilitate effective knowledge sharing, cooperation between participants in the educational process, and the development of innovative solutions in science and technology. Verma highlights the potential of integrating ChatGPT into STEM education for data analysis and modelling. This approach could facilitate the analysis of large datasets, identification of patterns and trends, and more accurate predictions. Additionally, it could contribute to the development of more practical solutions and an interactive and engaging learning platform. This could enhance the accessibility and appeal of the educational process for students and adult learners (Verma, 2023).

The necessity of reconsidering the functional aspects of AI arises from the potential utilisation of its constituent elements in the context of workforce training. However, this raises important questions regarding the assurance of educational and ethical standards in higher education (Chan, 2023; Zinchenko et al., 2024). In light of the current focus of modern educational institutions on digital literacy, traditional learning values and professional development, reorientation towards individualised AI-based learning necessitates, among other things, the integration of the latest educational technologies, increased adaptability of curricula and retraining of teaching staff (Bhutoria, 2022; Guan et al., 2020). The quality of such training in the initial stages of AI technology implementation may also be affected by problems with funding and ensuring the equality of conditions for education, confidentiality and protection of personal data, as well as changes in the role of teachers and students in the learning process (Akgun & Greenhow, 2022; Holmes et al., 2021; Pedro et al., 2019).

In addition to the immediate advantages and disadvantages of the widespread use of artificial intelligence, the academic community has expressed concerns about the use of ChatGPT in higher education. Discussions have focused primarily on the implications for academic integrity and innovative assessment methodologies (Sullivan et al., 2023). As ChatGPT is capable of generating student work and eliminating plagiarism, which often encourages students to use it in their assignments, it would be prudent to rethink the system of exams and their assessment as a priority (Rowland, 2023).

At present, the sole means of addressing violations of academic integrity through the utilisation of ChatGPT and analogous technologies (Google Bard, Gemini, Jasper) is the deployment of the GPT Detector (Pudasaini et al., 2024). However, in the context of the development of artificial intelligence in education, it is necessary not only to prevent violations of academic integrity but also to establish clear rules and approaches to governance that will ensure the inclusion of the main benefits of artificial intelligence for all participants in the educational process while avoiding potentially harmful trends (Holmes et al., 2021). The utilisation of artificial intelligence in the field of education is perceived as a valuable tool by contemporary scholars. Its capabilities, as outlined by Lo (2023), encompass the identification of primary sources, the selection of pertinent materials, the evaluation of knowledge, the simplification of information, the clarification of complex terminology (Baracchini & Stary, 2023) and the presentation of data in an analytical format (Maiyanti et al., 2023).

2. Materials and Methods

The study undertook a comprehensive analysis of literature to identify and examine the critical aspects and issues pertaining to academic integrity in the context of the utilisation of artificial intelligence in the field of STEM education. Furthermore, generalisation methods were employed to identify the principal trends in the introduction of AI into the educational process, whereas systematisation was used to analyse the feasibility of applying existing approaches to ensure academic integrity and to develop appropriate recommendations for their improvement.

To ascertain the potential for reducing instances of academic integrity violations through the utilisation of chatbots (ChatGPT, Google Bard, Gemini, Jasper), two groups of experts were interviewed. The first group comprised 19 teachers from

the Igor Sikorsky Kyiv Polytechnic Institute, who had been employing the Plag service to assess first-year students' term papers for a period of one semester. The second group consisted of 17 teachers from the Taras Shevchenko National University of Kyiv, where first-year students' term papers had been evaluated via AIDetect for the previous two semesters. To assess students' academic integrity in STEM education, the relevant specialities at the two universities were selected for analysis. The disciplines included in the study were mathematics, software engineering, computer science, information systems and technology, biotechnology and bioengineering, and electronics. The teachers provided responses on the basis of their own experience conducting inspections or available reports on the total number of papers and those in which the detector identified evidence of AI. The percentage of academic integrity violations identified through the use of artificial intelligence was calculated for each speciality, with the total coursework serving as the denominator. This was performed via the Excel analysis package. The results are presented in a pie chart, with each specialty grouped by percentage. The identified trends suggest that the GPT detector is an effective measure for preventing violations of academic integrity through AI technologies.

3. Results and Discussion

The global educational space is currently engaged in the process of determining the feasibility and effectiveness of innovative approaches and teaching methods that can ensure the active participation of students in the educational process and optimise the work of teachers with curricula and programs. One of the educational approaches that facilitates the integration of related disciplines into the learning process is the STEM approach (science, technology, engineering, and mathematics). This approach entails the formation of curricula on the basis of the combination of natural and mathematical disciplines and technologies. This approach facilitates the development of students' professional and research skills, as well as their creativity, critical thinking, and communication abilities, while also enhancing their motivation (Ahmad, 2020). In this context, the introduction of artificial intelligence in STEM education represents an effective solution to ensure the sharing of knowledge, cooperation between participants in the educational process, and the formation of innovative solutions in science and technology (Verma, 2023; Kubitskyi et al., 2022).

The implementation of artificial intelligence technologies in STEM education at the highest level of quality results in the personalisation of learning. This is achieved by adapting the educational process to students' individual needs, ensuring interactivity and flexibility in learning. The principal benefit of utilising AI is its capacity to analyse student performance data, thereby enabling the customisation of learning and educational content to align with their individual requirements. Compared with the conventional methodology, this approach has been demonstrated to enhance the quality of knowledge and skills acquired (Joseph & Uzundu, 2024). Moreover, personalisation of learning enables the adaptation of the educational process to facilitate the optimal absorption of information in STEM subjects at a pace commensurate with the individual student's capabilities (Rane et al., 2023). Furthermore, the personalised approach offers the potential to provide quality education for students with disabilities. This is because relevant AI technologies are able to convert speech into textual content, which can assist individuals with hearing impairments in acquiring knowledge or in improving learning materials for students with dyslexia.

One of the benefits of utilising chatbots that are based on artificial intelligence, such as ChatGPT, Google Bard, Gemini, and Jasper, is their capacity to process natural language, which enables personalised and interactive learning in the acquisition of professional skills within the STEM field. Moreover, chatbots can be utilised to guarantee the calibre of the educational process, notably in the formulation of curricula and the utilisation of digital learning resources. Furthermore, chatbots can be utilised to analyse substantial quantities of data from a multitude of sources, which can assist STEM students in identifying patterns, trends, and concepts that may not be fully encompassed by conventional research techniques (Merelo et al., 2024). Chatbots also facilitate collaboration between educators and researchers from disparate disciplines, irrespective of geographical location. This enables the formation of a global community of educators engaged in integrating artificial intelligence into STEM education. Some contemporary AI-driven virtual and augmented reality applications possess the requisite functionality to construct simulations of intricate scientific phenomena and virtual laboratories, thereby offering plentiful opportunities for practical experiments devoid of risk to health and involving numerous resources (Dai & Ke, 2022).

While there are numerous advantages to the use of AI in STEM education, several significant disadvantages currently require clear solutions to address equity, transparency, and accountability issues. It is of paramount importance to consider the necessity of developing AI tools that are equitable and inclusive and to collaborate with developers, educators, policymakers, and other stakeholders to achieve this. Educational institutions are required to process large volumes of personal data in a confidential and secure manner. Furthermore, it is vital to provide students with education regarding the ethical implications of AI, given the growing interaction with these technologies in their studies and future professional activities (Chiu & Li, 2023). It is therefore imperative to guarantee the ethical and secure utilisation of personal data, thus facilitating the engagement of students and other stakeholders in the educational process and the prevention of cyberattacks or the leakage of crucial information.

In the context of the ethical component of the process of applying AI in STEM education, academic integrity represents a fundamental component for the development of technologies and innovations. It encompasses various forms of unethical behaviour that impede the learning process and erode confidence in students' educational and scientific results. The most

common violations of academic integrity include academic plagiarism, data fabrication, bribery in the academic sphere, academic sabotage and fraud, deception, and unauthorised collaboration (Slobodianiuk, 2021). However, with the advent of novel technologies pertaining to AI-based platforms and services, the education sector has encountered the challenge of students' inappropriate utilisation of such tools. The primary academic integrity concerns associated with the utilisation of AI include the automation of plagiarism detection, the deterioration in the calibre of education, and the pervasive deployment of technology in assignments. The emergence of such problems is caused by a number of factors:

1. AI-based technologies (ChatGPT, Google Bard, Gemini, Jasper) can create unique texts on the basis of specified parameters, which significantly complicates the process of detecting plagiarism and undermines the reliability of assessments in practical assignments, term papers, diploma papers, and creative or creative tasks;
2. The use of AI requires precise regulation of the process of its use, as students may be concerned about the logical boundary between learning assistance and the unethical use of technology to obtain grades that are not appropriate for their level of knowledge;
3. Students' reliance on AI to complete assignments requires them to fully understand the material and work with reliable sources, as chatbots or other AI-based technologies often make mistakes in generating answers or inaccurate wording and may have limitations in the relevance of their data. Excessive consumption of AI-generated content leads to a decrease in students' knowledge and slows the development of their critical thinking and analytical skills.

Consequently, measures designed to prevent violations of academic integrity should initially focus on the implementation of technologies capable of detecting information generated by AI, such as the GPT Detector, Plag, AIDetect, and GPTZero, during the assessment of students' knowledge (Pudasaini et al., 2024). Similarly, establishing transparent regulations and methodologies for the utilisation of AI in curriculum development and assignment design is vital. It is imperative that appropriate policies and acceptable use cases for AI are developed. Importantly, the rules define the acceptable limits of AI use and ensure the responsibility of all participants in the educational process (Holmes et al., 2021). At present, the utilisation of AI technologies by students for the purposes of locating primary sources, selecting materials, evaluating knowledge, simplifying complex information, elucidating terminology and presenting information in an analytical manner may be deemed permissible within the context of STEM disciplines. It should be noted, however, that the list may be supplemented depending on the policy developed by the educational institution. It is equally important for modern educational institutions to ensure that their examination and assessment system is adaptable to reduce the likelihood of unethical assistance being provided by AI in completing tasks (Rowland, 2023). Such measures may include oral examinations (although many universities within the Bologna system consider such examinations to be highly contentious), project-based learning that necessitates the individual input of all participants to achieve the desired outcome, and tasks that require a high level of analysis, interpretation of results, and creativity (Table 1).

Table 1 Results of the survey of igor sikorsky kyiv polytechnic institute teachers.

Specialities	Coursework checked, total	Term papers with AI detected in them, total	Percentage of violations of academic integrity through the use of AI, %
111 Mathematics	274	24	8,759124
121 Software engineering	341	12	3,519062
122 Computer science	288	23	7,986111
126 Information systems and technologies	302	31	10,2649
162 Biotechnology and bioengineering	297	26	8,754209
171 Electronics	253	15	5,928854
Total	1755	131	7,464387

To ascertain the potential for reducing academic integrity violations through the utilisation of chatbots (ChatGPT, Google Bard, Gemini, Jasper), representatives from two universities (Group 1 = 19 individuals; Group 2 = 17 individuals) specialising in technical disciplines and employing the GPT Detector in their activities were interviewed. The professors were requested to provide the number of term papers they had examined during the 2024 summer session among first-year students or, alternatively, to indicate the number from the lists. Additionally, they were asked to specify the number of papers in which the detector identified traces of AI, that is, those in which students had likely employed artificial intelligence technologies to generate the text of their work. The data were subjected to an interpretative process, whereby the percentage of academic integrity violations committed by students via artificial intelligence was calculated in relation to the total volume of coursework produced within each specialism. The results of the calculations for Group 1 are presented in Table 1, and those for Group 2 are presented in Table 2.

Figure 1 presents a visual representation of the study results, expressed as a percentage of academic integrity violations through the use of artificial intelligence.

Table 2 Results of the survey of taras shevchenko national university of kyiv teachers.

Specialities	Coursework checked, total	Term papers with AI detected in them, total	Percentage of violations of academic integrity through the use of AI, %
111 Mathematics	267	17	6,367041
121 Software engineering	322	9	2,795031
122 Computer science	304	11	3,618421
126 Information systems and technologies	259	14	5,405405
162 Biotechnology and bioengineering	291	10	3,436426
171 Electronics	245	7	2,857143
Total	1688	68	4,028436

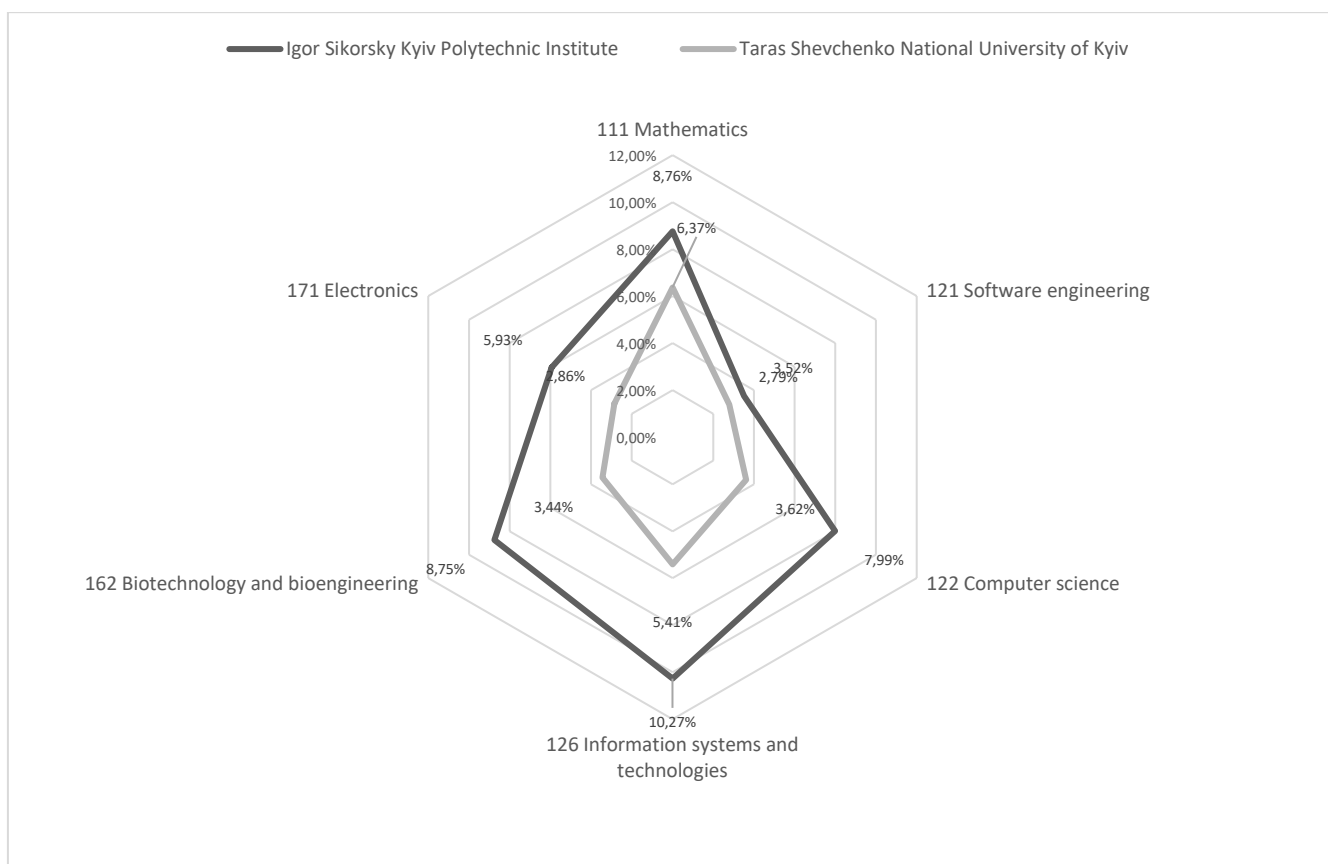


Figure 1 Comparison of academic integrity violations.

At the Igor Sikorsky Kyiv Polytechnic Institute, term papers have been checked with the Plag service since the second semester of this academic year. Consequently, the overall percentage of violations is relatively high (7.46%) in comparison to Taras Shevchenko National University of Kyiv (4.03%), as this university has been conducting this check with AIDetect for the second semester in a row. It can be reasonably assumed that increased awareness among students of the potential consequences of using AI for the generation of scientific conclusions in coursework may serve to reduce the likelihood of such tools being misused in the future. It should be noted, however, that when checking term papers, authorised persons pretranslate the materials into English, which may affect the accuracy of the detector results. Consequently, no measures or restrictions are currently being taken against violators. In light of the findings of this analysis, the work is not being discontinued. Instead, the percentage of instances of AI usage is taken into account when determining the final grade for the term paper and when it is defended.

4. Conclusions

The growing demand for those with skills in science, technology, engineering and mathematics (STEM) is prompting educational institutions to develop effective strategies to attract young professionals and applicants to pursue higher education



in technical specialities, as well as mature individuals to engage in further education with a focus on acquiring skills for STEM fields. In this context, the efficacy of AI technologies is contingent upon their capacity to facilitate an interactive pedagogical approach, engaging individuals from diverse age groups and backgrounds, thereby fostering interest in acquiring competencies in pivotal industries.

The existing concern of educational institutions and the scientific community about the growing number of violations of academic integrity in STEM education is largely attributable to the expansion of artificial intelligence capabilities. Given that AI-based tools are capable of generating texts and answers and imitating human speech automatically, implementing measures to counter the misuse of AI in the educational process is becoming increasingly important. The utilisation of AI detectors for the identification of such texts and analytical data has become a standard procedure in this process. Nevertheless, to preserve the integrity and transparency of the educational process, it is essential to reconsider the assessment system and integrate AI into education in a manner that is guided by clear regulations concerning its utilisation. To support such measures, it is necessary to gradually increase the ethical awareness of all participants in the educational process. The study corroborates the assertion that the implementation of preventive measures has a discernible effect on the learning process, reducing the likelihood of unfair technological utilisation. This is evidenced by the significantly lower prevalence of papers indicating AI usage in educational institutions that have conducted GPT detector assessments during the second semester (4.03%). In contrast, the institution that conducted such an examination for the first time has a higher incidence of academic integrity violations involving AI technologies (7.46%). Nevertheless, a holistic approach that encompasses these tools has the potential to mitigate the adverse effects of AI misuse over time.

A comparison of the results of our analysis with those of the current authors reveals that previous research by Verma (2023) demonstrated the usefulness of ChatGPT for data analysis and modelling in STEM education. This is consistent with the observed changes in student–teacher interaction and knowledge sharing, as indicated in our survey, in which approximately 79% of teachers reported the regular use of digital tools, thereby improving horizontal communication between learning participants.

Concurrently, the research presented in this article concentrates on the tangible risks associated with academic integrity, a topic also explored by Sullivan et al. (2023). The advent of the ChatGPT has given rise to concerns among the modern scientific community regarding plagiarism and other forms of academic dishonesty. The results demonstrate a relatively high percentage of violations at the Igor Sikorsky Kyiv Polytechnic Institute (7.46%) compared with Taras Shevchenko Kyiv National University (4.03%), underscoring the pressing necessity for enhanced AI management in academic settings. The discrepancy in detection rates may be attributed to the differing lengths of experience with AI detection systems at each institution. This finding lends support to the conclusions of previous research that emphasised the importance of early intervention and long-term implementation of such technologies (Rowland, 2023; Shkola et al., 2022).

Moreover, the findings of Bakhmat et al. (2023), who revealed significant discrepancies in digital competence across educational institutions, underscore the necessity for an integrated methodology in the development of educational programs. As Bhutoria (2022) noted, the early implementation of AI-based learning systems necessitates technological adaptation and comprehensive professional development of teaching staff, a point supported by our research. Additionally, Holmes et al. (2021) addressed the potential adverse effects of unequal access to digital tools and the risks to data privacy and student privacy, as previously discussed by Bhutoria (2022).

Despite the benefits and challenges identified, the potential for artificial intelligence and machine learning in STEM education is considerable. The utilisation of AI-based tools has the potential to enhance the learning process by providing an interactive and engaging environment. The adaptation of artificial intelligence technologies to STEM education represents a promising avenue of inquiry within contemporary scientific discourse and practical research. It offers the potential to revolutionise the approach of educational participants to developing essential professional skills, fundamental knowledge and motivation for further work in STEM fields. The provision of knowledge sharing, data analysis, personal development and learning opportunities afforded by AI technologies represents a significant step forward in the advancement of progressive fields such as science, technology, engineering and mathematics. The introduction of an innovative and efficient approach to knowledge and skills acquisition represents a key driver of this progressive development.

During the course of our research, we also identified the current limitations of existing AI detectors, namely, Plag and AIDetect. In this context, Pudasaini et al. (2024) emphasise the need for more sophisticated AI detection tools, a recommendation that our study supports. Moreover, existing tools may not yet be sufficiently robust to address the challenges posed by AI in educational assessment.

One potential avenue for integrating artificial intelligence (AI) into STEM education is to facilitate equal access for educators and researchers from diverse geographical locations to share knowledge through the use of natural language processing (NLP) capabilities. This approach has the potential to enhance the efficiency of communication and the effectiveness of collaboration, which will facilitate the expeditious adoption and generation of innovative solutions in science, technology, engineering, and mathematics. A common practice in the integration of AI into STEM education is its utilisation in data analysis and modelling. This is due to the functional ability of AI to process vast quantities of data in a relatively short period according to specific parameters, thereby enabling more sophisticated assumptions, the identification of novel patterns and the

elimination of errors in trend formation through the application of traditional data analysis methods. This approach ensures the accuracy of the forecast data, the clarity of the formulation of the analysis results and the quality of the conclusions drawn.

In terms of ethical considerations, our study emphasises the need to strike a balance between the advantages of artificial intelligence, such as simplifying intricate concepts, facilitating knowledge verification and enhancing analytical abilities (Baracchini & Sary, 2023), and the implementation of transparent and consistent governance frameworks to prevent the inappropriate utilisation of these technologies, in alignment with the recommendations put forth by Chan (2023) and Zinchenko et al. (2024).

Ethical Considerations

During the research, the author followed all the ethical guidelines. All participants received comprehensive information about the purpose of the study, the nature of their participation, and the measures taken to ensure confidentiality and anonymity. They understood their right to withdraw from the study at any time without any negative repercussions after providing informed consent.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Funding

This research did not receive any financial support.

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