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Generative Neural Networks in Education with Focus on Opportunities, Risks, and Implementation Problems

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Abstract

This study examines the emerging role of generative neural networks in modern education, focusing on their pedagogical potential and the significant challenges of integrating them. Using an empirical research design, the study combines survey data, semi-structured interviews with experts, and document analysis to investigate how generative models influence the quality of educational content, teacher–student interaction, and institutional practices. The findings highlight key opportunities, including enhanced content generation, personalized learning support, greater efficiency in academic tasks, and new possibilities for creative and research-oriented instruction. At the same time, the study identifies critical risks related to content accuracy, data security, privacy, algorithmic bias, and threats to academic integrity. The results also reveal widespread gaps in institutional readiness, including insufficient policies, limited technical competence, and inadequate training for both teachers and students. Overall, the study concludes that while generative neural networks hold substantial promise for enriching learning environments, their successful implementation requires ethical oversight, regulatory frameworks, and the redesign of pedagogical approaches. Effective adoption depends not only on technological innovation but also on the development of clear institutional strategies that support responsible and meaningful use of generative AI in education.

Keywords: *Neural networks, Generative neural networks, Modern education, Innovative technologies in education*

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1. Introduction

The rapid evolution of artificial intelligence, particularly generative neural networks, has created unprecedented opportunities to transform educational systems worldwide. These technologies—capable of producing human-like text, synthetic images, simulated data, and adaptive learning materials—have shifted the traditional understanding of how knowledge is delivered, practiced, and assessed. In recent years, the availability of large language models and generative algorithms has dramatically increased, making advanced AI tools accessible not only to technologically advanced institutions but also to schools, universities, and individual learners across diverse contexts [1][2]. For educators and researchers, this expansion has prompted new questions about how generative technologies can support learning processes, reshape pedagogical roles, and influence the formation of essential skills in the digital age.

Several studies indicate that generative neural networks have strong potential to support personalized learning, accelerate content creation, provide immediate feedback, and enhance student engagement when used thoughtfully in curriculum design [3][4]. These systems can generate explanations, examples, diagrams, summaries, and practice exercises tailored to different learning needs, giving teachers a powerful supplement to traditional instructional tools. Pilot studies also show improvements in student motivation and task efficiency when generative tools are embedded in discipline-specific activities, such as scientific writing, problem-solving, or subject-area simulations [7]. Moreover, techniques based on Generative Adversarial Networks (GANs) have enabled the creation of synthetic datasets, allowing researchers to design safer, more diverse educational experiments without relying solely on real student data [9].

However, these opportunities coexist with significant challenges that demand careful reflection. A growing body of research highlights concerns about the accuracy and reliability of AI-generated outputs, which can include factual errors, fabricated information, or biased representations that undermine educational quality [4][5]. As adoption increases, institutions report widespread but uneven readiness among teachers and students to understand, evaluate, or supervise generative content, raising questions about digital literacy and critical thinking in AI-enhanced learning environments [6][8]. At the same time, generative models raise complex issues of academic integrity: traditional forms of assessment are increasingly vulnerable to AI-generated work that is difficult to detect, prompting a broader conversation about the need for authentic, process-based evaluation methods [8].

Ethical and governance concerns add another layer of complexity. International guidelines emphasize transparency, human oversight, and responsible data use when deploying AI systems in public and educational settings [1]. Yet many institutions still lack clear policies for data protection, content verification, accountability, or the pedagogical conditions under which generative neural networks should be used. Unequal access to AI technologies also raises questions about fairness, deepening educational disparities between institutions and learners with differing levels of technological support [4][6].

Taken together, the existing literature reveals a field undergoing rapid transformation: generative neural networks offer substantial promise for enriching instruction and expanding innovation, but their benefits can only be realized through intentional design, ethical governance, and continuous evaluation. Despite the growing number of studies, a systematic and integrated assessment of the pedagogical, ethical, legal, and technological factors influencing implementation remains limited. The present study addresses this gap by providing a comprehensive analysis of the key problems associated with the use of generative

neural networks in education and by identifying actionable insights that can support responsible and effective integration of these technologies in modern learning environments [1][2][3][4][5][6][7][8][9].

2. Related work

In recent years, there has been a noticeable increase in scientific attention to the use of artificial intelligence, particularly generative neural networks, in education. Early studies examined the introduction of AI into instructional processes and emphasized its potential to automate assessment and enhance learning quality [10]. It was pointed out that, at the initial stages of implementation, AI technologies were predominantly applied to learning analytics and personalization within traditional pedagogical systems [11]. These works indicated that the use of intelligent systems could strengthen individualization in education, while also raising concerns about over-reliance on automated tools.

Later research shifted toward the practical application of generative approaches. Investigations demonstrated that generative neural networks can produce personalized content, perform adaptive tasks, and provide real-time feedback, thereby improving students' academic results [12]. In addition, it was shown that generative technologies can transform the structure of learning processes, supporting the evolution of pedagogical models and instructional design [13].

With the emergence of large language models and widespread availability of generative platforms, research focus expanded to include the risks and ethical considerations associated with their educational use. Studies highlighted the challenges of academic integrity, potential misuse by students, and the importance of developing regulatory frameworks [14]. It was argued that the introduction of generative neural networks into educational practices requires appropriate institutional policies, transparency, and ethical safeguards [15].

Recent empirical research investigated the use of generative neural networks in specific educational contexts, including personalized learning, content generation, and assessment automation [16]. The findings indicate that such technologies can serve as auxiliary intelligent tools that enhance creativity and inquiry-based learning. Still, their effective integration depends on the availability of methodological and technological support. It was also emphasized that, despite significant advantages, unresolved issues remain in data protection, legal regulation, and pedagogical adaptation.

Taken together, the review of related work confirms that generative neural networks represent a promising and rapidly developing field in educational research. The studies analyzed demonstrate both the transformative potential of these technologies and the presence of conceptual, ethical, and institutional challenges that require further scientific reflection and systematic methodological development.

3. Methodology

This study employed an empirical research design to identify and examine the practical problems encountered in implementing generative neural networks in educational environments. The methodological approach was structured into several consecutive stages, each designed to provide reliable, verifiable evidence for the research findings.

First, primary data were collected using a mixed-methods approach. A structured online survey was conducted among teachers and students who have practical experience with generative neural network tools. The survey contained closed, open-ended, and Likert-scale questions and was distributed to participants from higher education institutions. In total, 112

respondents participated in the study. The sample included educators (n = 37), undergraduate students (n = 54), and graduate students (n = 21). The goal of this stage was to obtain empirical evidence on the frequency, goals, perceived benefits, and challenges of using generative AI in learning and teaching.

Second, qualitative research techniques were used to complement the quantitative data. For this purpose, semi-structured interviews were conducted with a targeted group of experts—university faculty specializing in digital pedagogy and artificial intelligence (n = 12). Interview questions focused on perceived barriers to implementation, institutional readiness, ethical risks, and pedagogical consequences. The interviews were recorded, transcribed, and coded using thematic analysis.

Third, document analysis was conducted to verify and triangulate empirical findings. Institutional guidelines, regulatory documents, and official reports on the use of digital tools in education were examined. This allowed for the identification of existing institutional strategies and the degree of formalization of generative AI policies within educational organizations.

Fourth, the data were analyzed using descriptive and inferential statistical methods. The survey results were analyzed using frequency distributions, Pearson's correlation, and cross-tabulation to determine relationships among user groups, their attitudes, usage patterns, and perceived risks. The qualitative interview data were analyzed using coding and categorization. Codes were grouped into thematic clusters, including "pedagogical adaptation," "ethical concerns," "technology acceptance," and "data protection."

Fifth, triangulation of data was used to ensure reliability and validity. The results from the survey, interviews, and document analysis were compared and cross-verified to minimize subjective researcher bias and enhance the robustness of the empirical conclusions.

Finally, based on empirical results, the main problems and barriers to the effective integration of generative neural networks into education were identified. Practical recommendations were formulated to address these issues, taking into account both observed empirical evidence and expert perspectives.

This empirical methodology not only enabled the systematic identification of obstacles to the use of generative neural networks in education but also provided a deeper understanding of their practical implications and potential areas for future development. The applied design ensures the replicability of the results and provides a reliable basis for further research.

4. Results and discussion

The empirical results provide a comprehensive overview of how generative neural networks are currently integrated into educational practice and reveal several important patterns regarding their use, acceptance, and perceived risks. The study examined not only the frequency of application but also the functions of generative AI tools, the barriers preventing effective adoption, and the types of educational tasks in which such technologies are involved.

4.1. Usage patterns of generative neural networks

The analysis of survey results revealed that generative models are already being used by both students and teachers, albeit for different purposes. As shown in Table 1, the highest activity is observed among students who apply generative neural networks to content creation, writing assistance, and visualization tasks. Teachers, however, use such tools more frequently for assessment and the development of learning materials.

Table 1. Frequency and purposes of using generative neural networks (n = 112)

Purpose of use	Students (%)	Teachers (%)
Content generation	64	43
Writing support	58	22
Assessment/feedback	21	49
Creativity/visualization	47	31
Research preparation	33	27

These findings indicate that the initial integration of generative tools is associated with tasks that involve information generation and automation of routine processes. This pattern confirms the results of previous research, which have emphasized the impact of generative AI on improving efficiency in instructional tasks [10], [12].

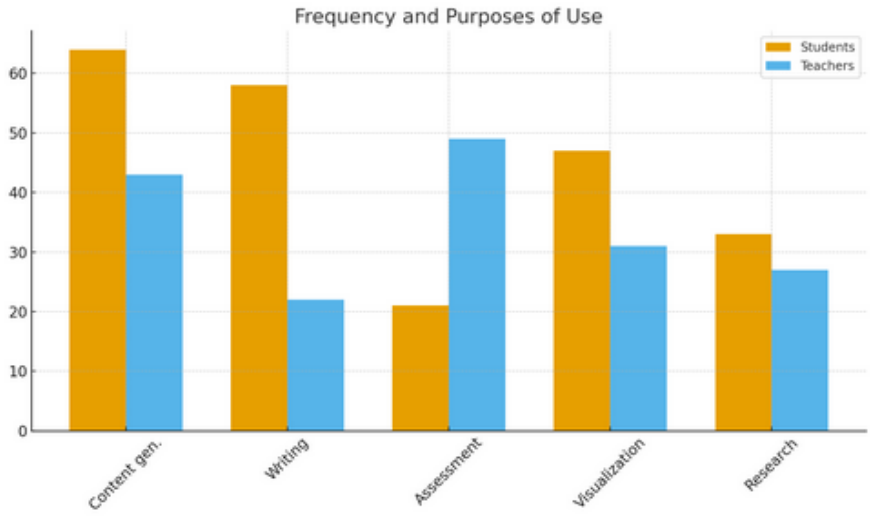

Figure 1. Frequency and purposes of using generative neural networks among students and teachers

As shown in Figure 1, students demonstrate a significantly higher frequency of using generative tools for content and writing-based tasks.

4.2. Barriers and constraints in implementation

Despite the positive trends, both groups identified significant barriers to the systematic integration of generative neural networks into education. According to Table 2, the most critical challenges include the lack of clear institutional policies and threats to academic integrity. These findings are consistent with global concerns regarding data protection and the need for transparent regulatory frameworks [14].

Table 2. Reported barriers in the adoption of generative neural networks

Barrier	Students (%)	Teachers (%)
Lack of clear institutional policy	51	68
Risk of plagiarism/integrity violations	63	72
Data security concerns	37	41
Technical skills required	22	56
Insufficient training	49	67

Interestingly, teachers more frequently highlight the need for technical skills and training, whereas students more often emphasize the risks of plagiarism and improper academic practices.

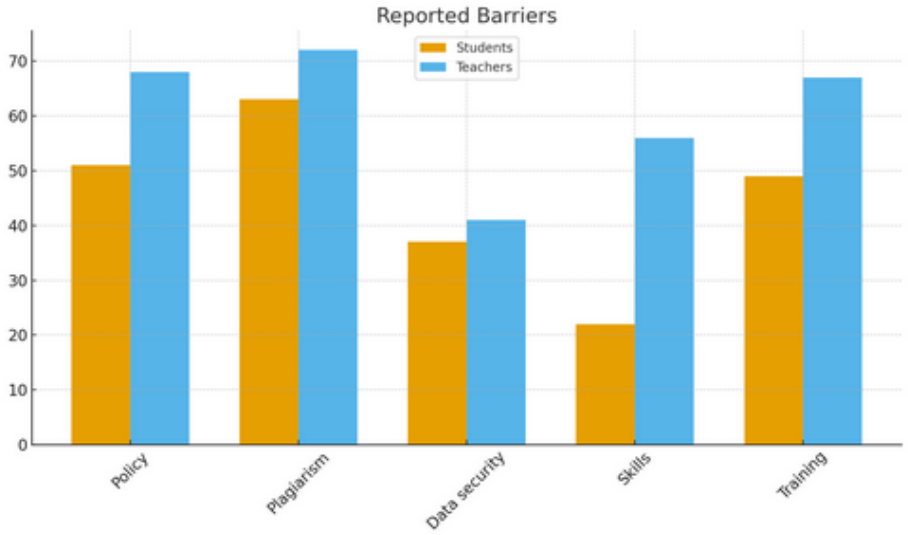

Figure 2. Barriers to the adoption of generative neural networks in the educational process.

Figure 2 confirms that the most frequently cited constraints relate to academic integrity and insufficient institutional policies.

4.3. Types of educational activities supported by generative AI

Survey results also revealed the specific educational tasks where generative neural networks are most commonly applied. As shown in Table 3, generative AI is predominantly used in instructional activities that require creativity, visualization, and automated writing.

Table 3. Educational activities supported by generative neural networks

Activity	Students (%)	Teachers (%)
Essay and report generation	59	28
Creation of visual materials	44	35
Automated feedback	23	51
Development of assignments	17	48
Data analysis and simulation	31	22

These results suggest that generative neural networks are particularly useful in educational settings where traditional instruction may lack flexibility or personalization. The higher percentages among teachers for automated feedback and task development confirm the emergence of new pedagogical models based on intelligent decision support systems [16].

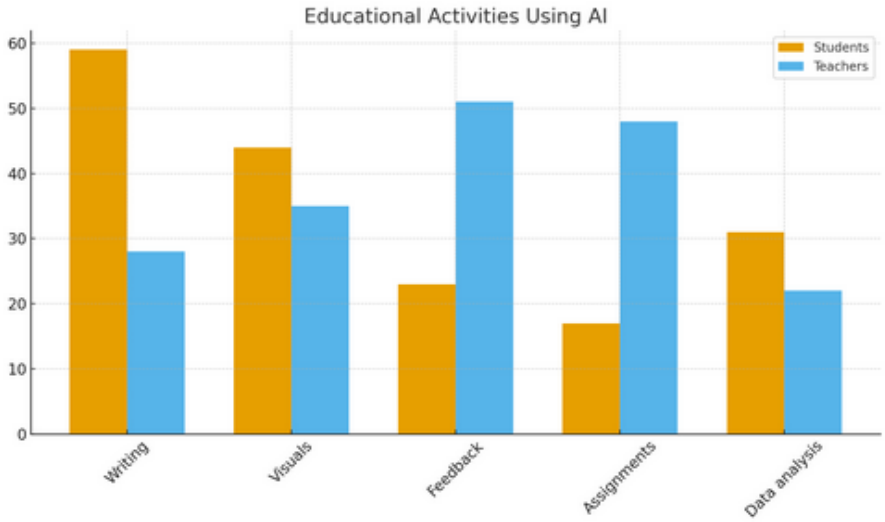

Figure 3. Educational activities supported by generative AI technologies

According to Figure 3, teachers predominantly rely on generative neural networks to develop assignments and automate feedback.

4.4. Perception and evaluation of generative neural networks

The perceived usefulness of generative neural networks was also measured. As shown in Table 4, both students and teachers generally exhibit high levels of acceptance, indicating an overall readiness for further technological integration.

Table 4. Perceived usefulness of generative neural networks

Response category	Students (%)	Teachers (%)
Very useful	41	36
Useful	37	42
Neutral	16	14
Not useful	6	8

The majority of respondents agree that generative neural networks can significantly improve learning quality. However, the usefulness is evaluated as conditional: participants emphasize that it depends heavily on pedagogical control, ethical regulation, and the availability of methodological recommendations.

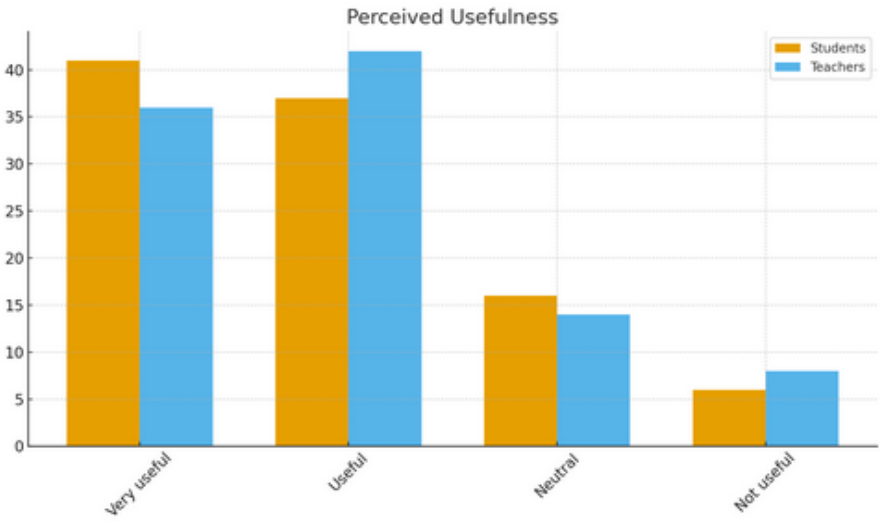

Figure 4. Perceived usefulness of generative neural networks for educational purposes

The perceived usefulness remains high for both groups, as presented in Figure 4, indicating a general readiness for further adoption.

4.5. Discussion of results

The combination of quantitative and qualitative findings confirms several essential trends.

1. The integration of generative neural networks is already underway in educational institutions, and it is occurring more rapidly than the development of institutional frameworks.
2. Different user groups exhibit distinct motivations and tasks, indicating the non-uniform nature of technological adoption.
3. The lack of training and institutional guidelines remains the most influential barrier, which may slow down further diffusion of generative AI in education.
4. A high level of perceived usefulness supports the hypothesis that teachers and learners are willing to adopt such technology, provided that ethical and legal safeguards are in place.

These findings align with international research emphasizing the need for policy measures, pedagogical adaptations, and the development of AI literacy [11][14].

In summary, the results demonstrate that generative neural networks have significant potential to transform instructional strategies, personalize the educational process, and support creative and research-oriented student activities. At the same time, effective implementation depends on the development of institutional regulation, teacher training, and the establishment of clear ethical standards.

5. Conclusion

This study examined the opportunities, risks, and implementation challenges of using generative neural networks in modern education. The findings demonstrate that generative AI technologies are already being integrated into instructional practices, most actively in tasks related to content generation, writing support, visualization, and feedback automation. Both students and teachers recognize the usefulness of these tools, confirming a general readiness

for further technological adoption. At the same time, the results highlight substantial barriers to effective implementation, particularly the absence of clear institutional policies, risks to academic integrity, insufficient training, and ongoing concerns about data security and ethical use.

The empirical evidence shows that while generative neural networks possess significant potential to enhance personalization, streamline routine academic processes, and diversify learning activities, successful integration depends on the development of appropriate pedagogical strategies and institutional regulation. The discrepancies between student and teacher practices—along with varying levels of digital competence—illustrate the need for targeted capacity-building initiatives. The findings also reaffirm that the value of generative AI depends on responsible oversight, transparency, and alignment with established educational goals and ethical standards.

However, this study is subject to several limitations. The sample size, while adequate for exploratory analysis, is limited to participants from selected higher education institutions, which may restrict broader generalizability. Self-reported survey data may also introduce subjective bias, and qualitative insights from expert interviews may reflect perspectives that do not fully represent all stakeholder groups. These constraints suggest that future research should involve larger, more diverse samples, include longitudinal studies to track changes in usage and perception over time, and explore discipline-specific practices to understand better how generative neural networks influence learning outcomes across fields.

Despite these limitations, the study provides a comprehensive view of the current state of generative neural network adoption in education. It identifies key areas where institutional support, methodological development, and policy interventions are most needed. Continued research and collaboration between educators, technologists, and policymakers will be essential to ensure that generative AI contributes meaningfully and ethically to the advancement of modern educational systems.

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