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RESEARCH ARTICLE

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Transforming education: exploring the influence of generative AI on teaching performance

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ABSTRACT

The emergence of Generative Artificial Intelligence (AI) marks a revolutionary advancement in education. This study explores the profound impact of implementing Generative AI on teachers' teaching performance, with a focus on enhancing teaching effectiveness and pedagogical practices. This research uses a survey methodology, employing a proportionated stratified random sampling technique. A total of 466 participants, consisting of teachers, were involved in this study, with questionnaires serving as the primary tool for data collection. The primary data analysis method used in this study was the Structural Equation Model (SEM). Research indicates that Generative AI significantly enhances teaching performance by improving ease of use, usefulness, and learning. Teacher perceptions of AI's usability influence its integration into student-focused learning, learning material development, and teaching practice enhancement. Additionally, the ease of learning is crucial for its adoption. Alongside these promising opportunities, the study also highlights challenges that need to be addressed for successful AI integration in education, such as technical limitations and the necessity for teacher training. By exploring the application of Generative AI in depth, this research offers valuable insights into leveraging technology to foster more inclusive, personalized, and practical education in the digital age.

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Introduction

Teaching performance must evolve with technological advancement, as education continually adapts to new technology (Timotheou et al., 2023). Digital transformation has significantly changed the way teaching and learning are carried out globally (Mhlanga, 2022). Recently, technology-based learning has gained popularity, with a significant increase in the use of software, applications, and digital learning platforms.

Despite the many benefits technology brings to education, several challenges remain. One significant challenge is providing learning experiences tailored to students' needs and learning styles (Greenhow et al., 2022). This requires innovation in developing and delivering high-quality, relevant content. In addition, the role of teachers in creating a supportive and motivating learning environment is vital. Teachers do not serve only as instructors but also as facilitators, assessors, and sources of inspiration for students. Therefore, enhancing the quality of teacher teaching is critical for improving the overall effectiveness of the education system.

Generative AI is emerging as an effective solution to these challenges. It can automatically generate new content based on patterns learned from training data, creating learning resources that are more varied, personalized, and relevant to the needs of students and teachers (Pesovski et al., 2024).

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Additionally, Generative AI can assist in developing adaptive learning systems that dynamically adjust the pace, content, and delivery of instruction based on individual learner progress and preferences. By leveraging Generative AI, educators can access a wealth of innovative teaching materials and tools to enhance the effectiveness and efficiency of teaching and learning processes. Moreover, Generative AI's ability to generate real-time content can facilitate the creation of interactive and engaging learning experiences, promoting active participation and deeper understanding among students.

Generative AI, a branch of AI, holds significant potential to transform learning and teaching methods (Ghimire et al., 2024). Understanding how to effectively integrate this technology is crucial for its positive impact on educational. Teachers face various challenges in enhancing their teaching performance, such as adapting to diverse learning styles, providing relevant materials, providing effective feedback, and creating a supportive learning environment. Generative AI is expected to address these challenges (Frey & Osborne, 2023). It can generate content tailored to students' needs, and enhance their engagement and understanding. Additionally, with the constant demands on teachers to keep up with curriculum changes and learning standards, Generative AI can produce content that aligns with current curriculum and standards, assisting teachers in preparing relevant and varied materials (Yu & Guo, 2023).

In the current digital era, artificial intelligence (AI) technology is becoming increasingly pervasive in various aspects of life, including education (Ahmad et al., 2021). A particularly promising branch of AI is Generative AI, which can create new content based on patterns learned from training data. In educational, Generative AI has great potential to enhance teaching and learning quality. It can help educators to develop adaptive learning environments that adjust dynamically to individual student needs and progress (Rane et al., 2023). This technology can revolutionize traditional teaching methods by providing innovative tools and resources that enhance student engagement, retention, and overall learning outcomes. As Generative AI evolves, it promises to unlock new possibilities for educational innovation and transformation. This study, thus, examines the impact of Generative AI on teachers' teaching performance, considering various related factors.

Several studies on the use of generative AI in education have concluded that these tools have significant potential in the classroom. Their creative approaches to student engagement, material adaptation, and individualized learning further improve the efficiency and coherence of instructional activities. By embracing these technological innovations, education can adapt to the challenges of the digital age and remain relevant (Bahroun et al., 2023; Baidoo-Anu and Anisah., 2023; Ratten & Jones, 2023; Ruiz-Rojas et al., 2023).

Additionally, concerns exist about the potential for Generative AI to replace human roles. This technology might reduce the need for human teaching staff and diminish human interaction in learning. There are also worries about the quality of AI-generated learning content, which may not match the depth and nuance provided by human teachers, potentially affecting the quality of education (Preiksaitis & Rose, 2023). Ethical and privacy issues arise as well, as the use of Generative AI in education could lead to the undesirable or unethical use of student data. AI-generative content might also convey that inaccurate information or reinforce existing biases (Chan & Hu, 2023). Moreover, Generative AI could exacerbate the digital divide, giving only a small percentage of institutions or students access to this technology, thus creating inequalities in learning opportunities and access to quality education (Mannuru et al., 2023). Challenges related to implementation and institutional readiness are also significant, as many educational institutions may lack the necessary infrastructure, resources, or expertise to effectively adopt these technologies, potentially leading to suboptimal use or failure (Kohnke et al., 2023).

In this context, researching the use of Generative AI to improve teachers' teaching performance becomes highly relevant. By thoroughly understanding how Generative AI can impact teaching, we can identify both the opportunities and challenges of integrating this technology in educational contexts. This research aims to contribute a more comprehensive understanding of the role of Generative AI in supporting effective teaching and meaningful learning. It focuses on analyzing the impact of Generative AI on teachers' performance in three main areas: focus on students and learning, lesson content/material, and Learning Practices. Generative AI in education has great potential to increase focus on students and the learning process, enrich and expand learning content, and facilitate innovative and adaptive learning practices.

Literature review

Teaching performance

Teacher's teaching performance is a multifaceted concept that is crucial in shaping student achievement, educational outcomes, and the overall effectiveness of educational institutions. The conceptualization of teaching performance encompasses various components, including instructional delivery, classroom management, assessment and feedback, and professionalism. Instructional delivery refers to teachers' methods and techniques to convey content and facilitate learning, while classroom management involves maintaining a productive and orderly classroom environment. Assessment and feedback pertain to evaluating student learning and providing constructive feedback, and professionalism covers teachers' commitment to professional growth, collaboration, and ethical practices (Danielson, 2007). These interconnected elements underscore the complexity and significance of teaching performance in achieving educational goals.

Several factors influence teaching performance, with professional development being a key element. Continuous professional development is vital for improving teaching performance, encompassing ongoing training, collaboration, and opportunities for reflective practice. As teaching strategies evolve in response to technological advancements, professional development must also adapt to equip teachers with the necessary skills for integrating digital tools effectively. Desimone (2009) emphasizes that effective professional development includes mentoring and coaching programs, which have been shown to enhance teaching skills and instructional effectiveness (Rockoff, 2008). Teaching strategies also play a crucial role; evidence-based strategies such as differentiated instruction and formative assessment positively impact teaching performance (Hattie, 2008).

Building on the significance of professional development and evidence-based teaching strategies, integrating technology is a transformative factor in enhancing teaching performance. Technology integration into teaching enhances instructional delivery, supports differentiated learning, fosters collaboration among educators, and expands the scope of evidence-based teaching strategies. For instance, learning management systems (LMS) and interactive platforms enable teachers to design personalized learning experiences tailored to individual student needs. Research by Tamim et al. (2011) highlights that when appropriately integrated into instruction, technology enhances formative assessment practices by providing real-time feedback and analytics.

Beyond traditional digital tools, emerging technologies like Generative AI offer unprecedented opportunities to personalize learning and streamline administrative tasks. Generative AI, such as OpenAI's GPT-4 language model, provides tools to develop personalized learning materials, deliver automated and detailed feedback to students, and assist in grading assignments more efficiently (Holmes et al., 2022). Additionally, AI can analyze student learning data to offer insights into students' learning patterns and needs, allowing teachers to adjust their teaching strategies. With AI capable of responding to student questions in real time and providing additional guidance, teachers can focus more on personal interaction and classroom management.

However, integrating advanced technologies also presents unique challenges. Farrokhnia et al. (2024) highlight the dual-edged nature of tools like ChatGPT in education, noting both the opportunities and threats such technologies pose. On the positive side, ChatGPT can support teachers in generating instructional content, facilitating discussions, and offering personalized feedback to students (Farrokhnia et al., 2023). Its potential to handle repetitive tasks enables educators to allocate more time to creative and interactive aspects of teaching. Conversely, challenges such as the potential for over-reliance on AI, ethical concerns surrounding data privacy, and the risk of promoting shallow learning must be addressed through proper training and reflective practice. Farrokhnia et al. (2023) emphasize the need for empirical research to understand better the long-term implications of AI adoption in education and its impact on teaching performance.

Despite the growing interest in Generative AI, there remains a significant need for research on its adoption in education, particularly regarding its role in enhancing teaching performance. Future studies should explore how AI tools can be effectively integrated into diverse teaching contexts, how they improve instructional delivery and assessment practices, and the long-term impacts on teacher development and student outcomes. Additionally, understanding teachers' perceptions of AI and the barriers to

adoption, such as technical competence, ethical concerns, and infrastructural limitations, is crucial for designing effective implementation strategies (Farrokhnia et al., 2023; Holmes et al., 2022). Such research is vital for establishing evidence-based guidelines to ensure that AI adoption in education is practical and sustainable.

Digital tools, including AI, also foster collaboration among educators, enabling them to exchange ideas and refine instructional methods through platforms like online professional learning communities (PLCs) or video-based lesson reviews, which aligns with Desimone's (2009) emphasis on collaboration and reflection as critical aspects of professional development. Moreover, virtual simulations and gamified learning experiences create engaging environments where abstract concepts become tangible, supporting Hattie's (2008) findings on the importance of active student engagement in driving academic success.

Technology acceptance model

This research employs the Technology Acceptance Model (TAM) as its theoretical foundation to accomplish its aims and thoroughly address the main research question. TAM, extensively used to predict the acceptance and usage of information technologies, has been applied in various research fields (Chen & Huang, 2012; Heijden, 2003; Selim, 2003). The use of TAM in education research is found in research that explores the factors influencing the acceptance of AI in education in Pakistan. This research focuses on teachers' and students' perceptions of AI in educational settings. The main findings show that perceived usefulness (PU) and perceived ease of use (PEOU) significantly influence the intention to use AI in learning. This study also highlights the importance of facilitative conditions and attitudes towards technology as additional factors influencing AI adoption (Alam & Waqar, 2020).

Research evaluating students' acceptance of AI-based educational technology uses TAM as a theoretical framework to measure factors influencing students' intention to use technology. Research results show that PU and PEOU are strong predictors of intention to use AI in learning, with attitudes towards technology use also playing an important role (Teo & Zhou, 2014).

Another study investigating the acceptance of AI-based collaborative technologies in e-learning used an extended TAM. This study added factors such as interactivity and social support to the model. The results showed that apart from PU and PEOU, social support and perceived interactivity significantly influenced the intention to use collaborative technology in e-learning. These findings highlight the importance of social and interactive aspects in accepting AI-based learning technologies (Cheung & Vogel, 2013).

The TAM model is also used to understand the factors influencing the adoption of competency-based online learning systems that use AI. This research expands TAM by adding variables such as self-efficacy and system quality. The results showed that PU, PEOU, self-efficacy, and system quality were the main predictors of intention to use an AI-based online learning system. This study also found that content quality and system interactivity contributed to perceived usefulness (Huang & Kao, 2015).

In another study, TAM was used to analyze the acceptance of AI-based e-learning in South Korea, focusing on the influence of perceived behavioral control, social influence, and self-efficacy. This study found that apart from PU and PEOU, perceived behavioral control and social influence are essential factors influencing the intention to use e-learning. Self-efficacy was also a significant predictor of perceived ease of use. These findings indicate that psychological and social factors play an essential role in the acceptance of AI-based learning technology (Joo & Sang, 2013).

This research uses the TAM model to identify the effect of using generative AI on teacher teaching performance. The TAM factors used to measure the use of generative AI are Perceived of Use (PU), Perceived Ease of Use (PEOU), and Ease of Learning. According to TAM, an individual's intention to adopt technology is predominantly influenced by two crucial factors: perceived usefulness, the belief that the technology will improve job performance, and perceived ease of use, the belief that the technology will be easy to use (Selim, 2003). Perceived Ease of Use refers to the degree to which a person believes using a particular system will be free of effort. This broad concept encompasses various elements contributing to the ease of technology use, including Ease of Learning refers to how quickly and easily a user can learn to use the system (Park, 2009). The ease with which a user can learn to use a

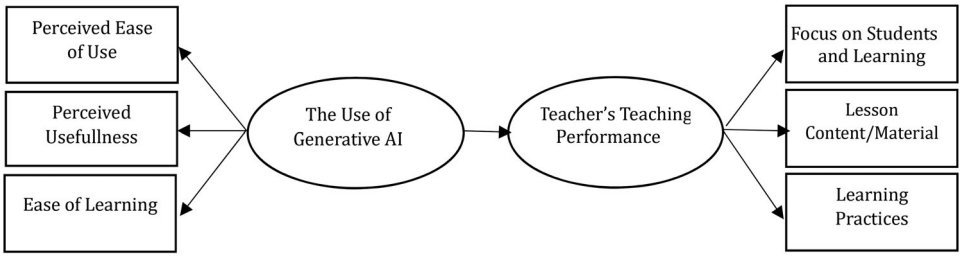

Figure 1. The research model.

system is a critical element that contributes to their perception of its ease of use. In extended models and specific research applications, ease of learning is more explicitly addressed to better capture its impact on technology acceptance.

Figure 1 is a research model demonstrating that the adoption of generative AI technology is influenced by factors such as ease of use, usefulness, and ease of learning. When adopted effectively, these tools positively impact teachers' teaching performance by improving their focus on student, lesson content (materials), and overall learning practices, highlighting AI's transformative role in modern education.

Influencing Factors for the Use of Generative AI: (1) Perceived Ease of Use: Teachers' perception of how easily they can operate Generative AI tools. If teachers find AI tools user-friendly, they are more likely to adopt and utilize them in their teaching processes; (2) Perceived Usefulness: The degree to which teachers believe that Generative AI can improve their teaching effectiveness and student outcomes. Tools perceived as highly useful are more readily adopted; (3) Ease of Learning: The simplicity with which teachers can learn and integrate Generative AI tools into their instructional practices. Accessible learning processes encourage higher usage rates.

The central element represents The Use of Generative AI, which bridges influencing factors (left) and teacher performance outcomes (right). Generative AI tools, when effectively adopted, assist teachers in instructional planning, content creation, student feedback, and classroom management.

Outcomes of Teacher's Teaching Performance: (1) Focus on Students and Learning: Generative AI allows teachers to dedicate more time to personal student interaction and learning engagement, as repetitive administrative tasks can be automated; (2) Lesson Content/Material: Generative AI enables the creation of high-quality, diverse, and customized lesson materials tailored to students' needs, improving instructional delivery; (3) Learning Practices: AI enhances evidence-based learning strategies, such as personalized learning paths, formative assessments, and interactive learning environments, ultimately improving classroom practices.

Methods

The research method used in this study is based on a quantitative approach, which is very appropriate considering the aim of the investigation to empirically ascertain the impact of the application of Generative AI on teachers' teaching performance. This approach facilitates the collection of numerical data through a structured questionnaire designed to assess the relationships between variables quantitatively. Quantitative methods were justified by the need to analyze a large sample size. Additionally, quantitative methods align with the use of factors of TAM as they allow statistical testing of hypothesized relationships between constructs, thereby providing a robust analysis of the determinants of technology acceptance.

Research participants

This research targeted teachers from Vocational High Schools specializing in business and management across West Java province, Indonesia. The reason for choosing West Java province was due to the highest number of Vocational High Schools in Indonesia. Purposive random sampling was used, resulting in a total of 466 respondents. Data collection involves a questionnaire with a five-point numerical scale response. Research participants were asked to respond to statements on the most appropriate response

choices regarding aspects of the implementation of generative AI and teachers' teaching performance, with responses ranging from 1 (lowest positive value) to 5 (highest positive value). The implementation of generative AI questionnaires is based on perceived ease of use, perceived usefulness, and ease of learning (Juhary, 2014).

Instrument

The teacher's teaching performance questionnaire was arranged according to CCSSO (2013) and the International Schools Teacher Performance Evaluation System from AASA (2010) (Henrikson, 2019). The instrument reliability criteria are r11 > table. The reliability of the implementation of the generative AI variable is 0.89 > 0.70. The reliability of the teacher's teaching performance variable is 0.87 > 0.70. Meanwhile, the Pearson Product Moment correlation coefficient formula was used for the validity test. All items on the instrument are deemed valid as they meet the criteria count > table.

Data analysis

The data analysis technique used in this research was the structural equation model (SEM) method, using version 22.0. The analysis was conducted through seven main steps:

i. Developing a theoretically based model.
ii. Constructing a path diagram of a causal relationship.
iii. Converting the path diagram into a set of structural and measurement models.
iv. Choosing the input matrix type and estimating the proposed model.
v. Assessing the identification of the structural model.
vi. Evaluating goodness-of-fit criteria.
vii. Interpreting and modifying the model.

The structural equation model was chosen to explain the overall relationship between variables in the study. The variables in the study were described using descriptive statistics to summarise average achievement score data, percentages, and categories for each indicator and dimension of the research variable. The calculation formula using the data range provisions (r) = 5.00–1.00 (highest average score minus the lowest average score). Many criteria (k) = 5, a class length (p) = r/k = 4/5 = 0.8.

Findings and discussions

The hypothesis in this research is 'The Use of Generative AI influences Teacher Teaching Performance'. This hypothesis was tested using a structural equation model (X→Y). Based on the results of calculations using the SPSS-AMOS program, the hypothesis was evaluated, and the structural equation model obtained is presented in (Figure 2).

The calculation results of the equation model can be summarized in Table 1.

The hypothesis testing results indicate that the use of the Generative AI directly influences Teacher Teaching Performance. The direct influence is quantified as 0.264 and *t*-count is 9.369. A *fit* test was conducted to compare the theoretical and actual models. If the proposed conceptual model shows a *good fit* with the actual model, this strengthens the model. Conversely, a *poor fit* would indicate that the model is not supported. The results are shown below:

Requirements	Result	Annotation
The chi-square ratio value with a degree of freedom between <5.	13.611	approaching
Value of Root Mean Square Error of Approximation (RMSEA) ≤0.08.	0.110	approaching
Value of Goodness of Fit Index (GFI) ≥0.8.	0.833	approaching
Comparative Fit Index (CFI) ≥0.90.	0.918	approaching
Incremental Fit Index (IFI) ≥0.90.	0.918	approaching

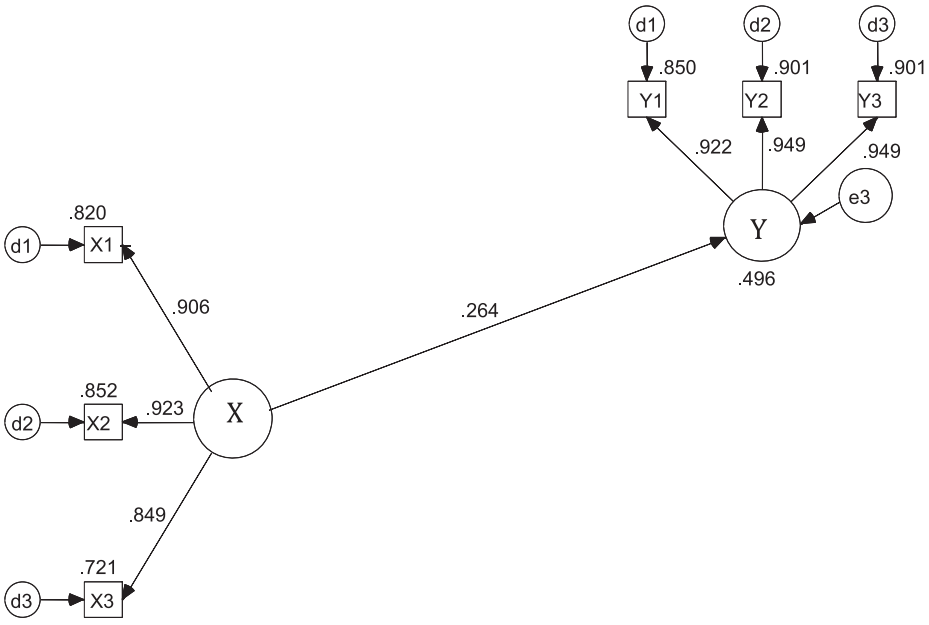

Figure 2. Structural equation model calculation results. The influence of the use of generative AI (X) on teachers teaching performance (Y).

Table 1. Hypothesis testing estimation.

Model	Estimation	S.E	C.R. (*t*-count)	*p*-Value	Significance (acceptance)
Y ← X	0.264	0.024	9.369	0.010*	Significance (accepted)
Y ← X		$R^2 = 0.496$; $\varepsilon = 0.504$			Significance (accepted)

Note: *Significant at the level $\alpha = 0.1$.

Table 2. Relationship of dimensions with variables the use of generative AI.

Dimension	Validity coefficient (*r*)	Reliability coefficient (r^2)	Error variance	Annotation
Perceive ease of use	0.906	0.820	0.180	Significant (valid and reliable)
Perceived of usefulness	0.923	0.852	0.148	Significant (valid and reliable)
Ease of learning	0.849	0.721	0.279	Significant (valid and reliable)
Construct reliability coefficient =		0.932		Reliable

Several *goodness-of-fit* tests indicates that the proposed model meets most of the necessary criteria. Additionally, the actual model also shows a *good fit* with the conceptual model, thereby confirming and strengthening the proposed model.

The use of generative AI variable measurement model

In line with the measurement model used for the variable The Use of Generative AI (X), it can be validly and reliably explained by three dimensions, namely: (1) perceived ease of use, (2) perceived usefulness, and (3) ease of learning. Of these three dimensions, the perceived usefulness dimension is the dimension that has a relatively more dominant ability in reflecting or forming The Use of generative AI, as shown in Table 2.

The results of the analysis of The Use of Generative AI variables, presented in Table 2, show that the dimensions are valid and reliable in reflecting The Use of Generative AI, as can be seen from the loading factor value (validity coefficient), which is greater than 0.5. This means that these dimensions are significantly (meaningful) able to reflect the variable The Use of Generative AI.

Overall, these three dimensions can explain the existence of the variable The Use of Generative AI of 0.932 or 93.2% as seen from the construct reliability coefficient value. A construct reliability value of greater than 0.7 indicates that each dimension carries out its measurement function well. This means that all dimensions in The Use of Generative AI have carried out their measuring function well.

Table 3. Relationship of dimensions with teacher teaching performance variables.

Dimension	Validity coefficient (r)	Reliability coefficient (r^2)	Error variance	Annotation
Focus on students and learning	0.922	0.850	0.150	Significant (valid and reliable)
Content/Lesson material	0.949	0.901	0.099	Significant (valid and reliable)
Learning practices	0.949	0.901	0.099	Significant (valid and reliable)
Construct reliability coefficient=		0.958	Reliable	

Teacher teaching performance variable measurement model

In line with the measurement model used for the endogenous latent variable Teacher Teaching Performance (Y), it can be validly and reliably explained by three dimensions, namely (1) Focus on Students and Learning, (2) Content/Lesson Material, and (3) Learning Practices. Of these three dimensions, the Content/Study Material dimension and the Learning Practices dimension have relatively more dominant abilities in reflecting or shaping Teacher Teaching Performance, as shown in the following Table 3.

The results of the analysis of the Teacher Teaching Performance variable, presented in Table 3, show that the dimensions are valid and reliable in reflecting Teacher Teaching Performance. This can be seen from the loading factor value (validity coefficient), which is greater than 0.5, which means that these dimensions are significantly (meaningful) able to reflect the Teacher Teaching Performance variable.

Overall, these three dimensions can explain the existence of the Teacher Teaching Performance variable of 0.958 or 95.8%, as seen from the construct reliability coefficient value. A construct reliability value greater than 0.7 indicates that each dimension performs its measuring function well. This means that all dimensions of Teacher Teaching Performance have performed their measurement functions well.

The hypothesis testing results show that the influence of The Use of Generative AI (X) on Teacher Teaching Performance (Y) is statistically significant, with a path coefficient of 0.264 and a *t*-count of 9.369. This indicates that The Use of Generative AI is crucial in schools for supporting and enhancing teaching performance.

Teacher's teaching performance

Teachers' teaching performance consists of three dimensions, namely: (1) Focus on Students and Learning, (2) Lesson Content/Material, and (3) Learning Practices.

The focus on students and learning

This dimension is rated highly and includes indicators such as student development, student learning differences, and the learning environment. Teachers routinely assess student achievement to tailor their instruction to meet student learning needs. They monitor students' learning progress and adapt their teaching methods accordingly. Additionally, teachers are perceived to design learning activities based on diverse student characteristics and effectively access necessary resources to address varying learning needs. This focus is evident in teachers' efforts to create a positive, open, and respectful learning climate, employing various methods to actively engage students.

Generative AI enables teachers to use a variety of pedagogical methods tailored to engage students actively in the learning process (Su & Yang, 2023). By using innovative instructional techniques and interactive resources generated by Generative AI, teachers can create dynamic and immersive learning experiences for their students' unique interests and learning styles. Thus, integrating Generative AI into teaching practices highlights its essential role in advancing student-centered education and fostering an environment conducive to academic growth and achievement (Liu et al., 2023).

Lesson content/material

Integrating Generative AI into the teaching performance aspect of lesson content highlights its significant efficacy, specifically in addressing indicators such as student development, learning differences, and the overall learning environment. Teachers are empowered to constantly evaluate student achievement, enabling them to customize their teaching methods to meet their students' diverse learning needs.

This finding aligns with the opinion (Alasadi & Baiz, 2023) that teachers can utilize Generative AI to gain deeper insight into student learning journey and facilitate more information and personalized instructional choices tailored to each student's educational requirements.

The Content/Study Material dimension of the Teacher Teaching Performance variable is also rated high with indicators focusing on knowledge and application of subject matter. Here, teachers are assessed as being able to modify teaching resources to accurately present concepts within their subjects. Teachers are also assessed on their capacity to align the material with students' competency levels. In addition, teachers are evaluated on their effective use of supporting resources and technology to ensure accessibility and relevance for all students. Lastly, teachers are considered to be able to engage students in applying knowledge to everyday problems through interdisciplinary themes.

Incorporating Generative AI into the Content/Study Material dimension of Teacher Teaching Performance offers significant potential, particularly in enhancing the knowledge and application of subject matter (Xu, 2024). Generative AI enables teachers to curate and customize teaching resources dynamically, allowing them to present complex concepts accurately and effectively. By using Generative AI technologies, teachers can adapt study materials to meet the diverse competency demands of their students, ensuring that learning resources are accessible and relevant to all learners (Chen, 2023). Generative AI such as ChatGPT can support teachers by helping them identify and develop suitable teaching materials. Additionally, it can assist in creating lesson plans tailored to specific parameters and constraints (Farrokhnia et al., 2024).

Generative AI enables teachers to explore interdisciplinary themes and real-world applications, enhancing students' ability to apply knowledge to everyday problems and contexts (Ooi et al., 2023). Research shows that Generative AI facilitates the seamless integration of supporting resources and technology into instructional practices, enhancing students' engagement and comprehension. By strategically utilizing AI-generated content and multimedia resources, teachers can create immersive learning experiences that cater to various learning styles and preferences.

However, implementing Generative AI in content creation may also present challenges for teachers. Ensuring the accuracy and quality of AI-generated materials requires careful oversight and validation. Teachers may also encounter issues related to copyright and intellectual property rights associated with AI-generated content. Additionally, balancing the use of AI technologies and maintaining the authenticity and creativity of teaching materials is crucial (Yu & Guo, 2023).

Despite these challenges, the strategic integration of Generative AI into the Content/Study Material dimension offers immense potential to enhance teaching effectiveness and enrich students' learning experiences. By leveraging AI-powered tools and resources, teachers can create dynamic and adaptive learning environments that foster deeper understanding, critical thinking, and interdisciplinary connections among students (Jackson, 2024). Thus, the incorporation of Generative AI promises to advance teaching performance and promote student success in the digital age.

Learning practices

In learning practices, teachers prioritize student-centered approaches to foster a positive and inclusive learning environment marked by openness and mutual respect (Pesovski et al., 2024; Yan et al., 2024). This claim resonates with research indicating that Generative AI supports the creation of tailored learning experiences tailored to each student's unique characteristics, promoting greater inclusivity and equity in education. Generative AI empowers teachers to address diverse student learning needs and preferences effectively by offering access to a diverse range of resources and adaptive learning materials.

The Learning Practices dimension of the Teacher Teaching Performance variable is highly rated, encompassing indicators such as learning planning, implementation, assessment, and follow-up. In this context, the teacher can use the applicable curriculum to prepare learning implementation plans. They are assessed on their efforts to employ varied learning methods and media, and on their ability to implement teaching strategies and resources that meet students' needs. Teachers act as facilitators in the learning process, rather than being the sole source of knowledge. They also assess student learning outcomes, with these assessments reviewed and returned to students. Furthermore, teachers are capable of providing follow-up based on assessment results.

Research shows that Generative AI can help in all stages of the learning process, from planning to assessment and follow-up. It facilitates the exploration and implementation of diverse learning methods and multimedia resources, enriching the instructional environment and catering to diverse learning styles. By strategically integrating AI-driven strategies, teachers can create dynamic and engaging learning experiences that stimulate student interest and participation. Integrating Generative AI in learning practices increases the overall effectiveness of the learning process, allows teachers to plan and implement learning activities more efficiently with relevant and curricula, supported by empirical evidence (Pesovski et al., 2024).

Generative AI enhances teachers' ability to accurately assess student learning outcomes and provide timely feedback (Dai et al., 2023). This research indicates that Generative AI enables teachers to deploy a wide range of strategies and resources to effectively address individual student needs. Acting as facilitators, teachers create a collaborative and interactive learning environment in which students actively engage. By automating aspects of the assessment process and generating insightful analytics, teachers can identify areas for improvement and tailor instructional interventions accordingly. This feedback loop enables teachers to track student progress effectively and provide targeted support where needed.

Moreover, Generative AI supports teachers in providing comprehensive feedback based on assessment results, ensuring that learning objectives are met and supporting individual learning paths. Teachers can implement data-driven interventions and personalized learning pathways by leveraging technology-enabled tools and resources, maximizing student engagement and achievement.

The use of generative AI

The Use of the Generative AI component consists of three dimensions, namely: (1) perceived ease of use, (2) perceived usefulness, and (3) ease of learning. Analysis of the results indicates that the perceived usefulness dimension (X2) is relatively most significant compared to other dimensions within the utilization of the Generative AI variable.

The Perceived ease of use dimension in the utilization of Generative AI variables is highly rated in determining and reflecting the effectiveness of using Generative AI in teaching practices. Teachers' levels of technology readiness and skills significantly influence their perceptions about the ease of use of Generative AI. Teachers with more extensive experience and technology skills may find it easier to integrate and use Generative AI in their teaching practices. Previous research also indicates that prior experience with similar technology impacts the perceived ease of use of Generative AI. Teachers accustomed to using technological tools feel more comfortable and confident adopting Generative AI (Ghimire, 2024).

In addition, adequate technical support and training can strengthen the perception of the ease of use of Generative AI. Comprehensive training and ongoing support from technology providers or educational institutions can alleviate feelings of uncertainty and boost teachers' confidence in using Generative AI. An Intuitive and user-friendly interface significantly influences this perception. A straightforward interface and simple navigation can make teachers feel more comfortable accessing and using Generative AI features. These findings support the idea that Generative AI, designed with the needs and challenges of teaching in mind, is more readily accepted by teachers. Generative AI can provide relevant and practical solutions for everyday teaching practice (Su & Yang, 2023).

The perceived usefulness dimension in the use of generative AI variables is also highly rated for its role in shaping and reflecting the effectiveness of using Generative AI in teaching practices. This is evident from its usefulness in creating learning tools. Generative AI can be useful if teachers believe this technology can enhance learning effectiveness. This includes Generative AI's capability to produce learning materials tailored to student needs and preferences, as well as provide relevant feedback to improve student understanding and achievement. The research findings align with previous studies, which have found that Generative AI's ability to generate additional learning materials or provide relevant resources automatically can reduce teachers' workload, and allow them to focus more on direct interactions with students (George, 2023).

Generative AI that enhances education's accessibility and affordability is also considered valuable. By providing learning materials tailored to the needs of students from diverse backgrounds and ability

levels, this technology can promote inclusivity and equality in education. Furthermore, personalized learning experiences enabled by Generative AI can address individual learning needs, improve overall learning outcomes, and ensure no student is left behind. This approach aligns with the principles of universal learning design, aiming to accommodate diverse learning styles and preferences.

Teachers may see this technology as beneficial if it stimulates creativity and innovation in teaching practices. The technology's ability to generate unique and engaging learning content and facilitate innovative learning approaches can help to create more engaging and challenging experiences for students. Generative AI will be seen as valuable if it offers relevant and useful solutions for teachers to overcome challenges and needs in teaching. Its capability to support differentiation learning, adapt curricula to applicable standards, and provide tailored support to students can enhance perceptions of their usefulness (Baidoo-Anu & Ansah, 2023).

The ease of learning dimension in the use of generative AI variables is highly correlated with the effectiveness of teaching practices, This is evident from how easily educators can learn and master generative AI technology. The ease of learning Generative AI in a learning context is influenced by the availability of supporting training resources, such as tutorials, user guides, learning videos, and other learning materials designed to help teachers understand the basics and practical use of Generative AI. An intuitive and user-friendly interface is essential for facilitating this learning process. These findings align with previous research, which indicates that a simple, clear, and easy-to-understand interface can help users, especially teachers, quickly learn the features and functionality of Generative AI technology (Prasad Agrawal, 2023).

The teacher's level of technology skills significantly influences the ease of learning Generative AI. For users with higher technology skills, these technologies may be easier to learn, while users with lower skills may require more assistance and training. The availability of technical support and ongoing training is essential in increasing the ease of learning Generative AI. Prior research has shown that a comprehensive training program and timely technical support can help teachers overcome obstacles and challenges while learning and using this technology (Yu & Guo, 2023).

Online learning resources, such as online courses, webinars, and discussion forums, also play a crucial role in enhancing the ease of learning Generative AI. These resources allow teachers to learn independently and access additional information as needed. Moreover, online learning platforms often offer interactive modules and tutorials designed to cater to various skill levels, making it easier for educators to grasp complex concepts and apply them effectively in their teaching practices.

Impact the use of generative AI on teacher's teaching performance

The discussion highlights the promising potential of Generative AI in enhancing teaching performance. However, teachers face various challenges and obstacles during its implementation. One of the primary difficulties is the initial learning curve associated with adopting new technologies. Teachers may require training and professional development to familiarize themselves with Generative AI tools and platforms, which can be time-consuming and resource-intensive. Previous research has found that integrating Generative AI into existing teaching practices may pose logistical challenges, particularly regarding compatibility with current educational infrastructure and systems (Kamalov et al., 2023). Additionally, technical issues such as software compatibility, data security, and privacy concerns may also arise, necessitating careful planning and implementation strategies.

Generative AI can in significantly enhance teaching performance, particularly in terms of perceived ease of use, perceived usefulness, and ease of learning. Teachers' perceptions of the ease of use of Generative AI will influence how quickly and effectively they can integrate it into their daily teaching practices. If the technology is easy to use and intuitive, teachers will likely adopt it enthusiastically. Additionally, if teachers recognize that Generative AI offers tangible benefits, such as producing customized learning materials or providing timely feedback, they will be more motivated to use it actively. The ease of learning Generative AI is also crucial, as the quicker teachers can master it, the sooner it can be incorporated into their teaching. Focusing on these aspects can help increase the adoption and use of Generative AI in education, thereby enhancing the efficiency and quality of classroom learning.

While Generative AI promises numerous benefits in teaching, its use also presents several difficulties and challenges. One major issue is the technical complexity, requiring teachers to have a deep understanding of AI concepts and the ability to operate complex algorithms. Additionally, the availability of necessary hardware and software resources can be a significant obstacle to implementing Generative AI in teaching (Pedro et al., 2019). Teachers must also navigate privacy policies and data security concerns and overcome resistance or uncertainty from various stakeholders regarding the acceptance of AI technology in educational contexts. Furthermore, the use of Generative AI can strengthen the digital divide, increasing inequalities in student learning outcomes between teachers with better technology access and skills and those without.

Awareness of these challenges can help teachers better prepare to integrate generative AI into their teaching and maximize its benefits for student learning. Generative AI can support teachers by expanding access to information, enabling personalized and advanced learning, and reducing teaching workloads, thereby enhancing the efficiency of key processes and tasks. (Farrokhnia et al., 2024). Building on this, understanding the challenges associated with generative AI allows educators to adopt a more strategic and thoughtful approach to its integration in classrooms. By anticipating potential obstacles—such as ethical concerns, data privacy, or the risk of over-reliance on technology—teachers can implement safeguards and develop clear guidelines for its use. This preparation ensures that the benefits of generative AI, such as enhanced access to diverse resources and tailored learning experiences, are optimized while minimizing risks. Moreover, equipping educators with the necessary skills and training to use generative AI effectively can foster a more engaging and inclusive learning environment, ultimately improving student educational outcomes.

This research has explored these fears and concerns, reflecting the complexity of transitioning to technology in education. It highlights the importance of overcoming psychological and social barriers during the implementation process. By understanding and accommodating these concerns, approaches to integrating technology in education can be more successful and have a positive impact on all parties involved.

It is essential to highlight that Generative AI is not intended to replace teachers but to augment their capabilities and support their efforts to deliver effective instruction. Emphasizing the role of teachers as facilitators and mentors in the learning journey alleviates concerns and fosters a collaborative approach to integrating AI technologies in education. Providing training and professional development opportunities can empower teachers to harness the potential of AI tools to enhance their teaching practices and improve student outcomes.

Despite these challenges, proactive measures can mitigate barriers to the effective utilization of generative AI in teaching. These measures include providing ongoing support and professional development, fostering a culture of innovation and collaboration, and addressing concerns about equity and ethics in AI implementation. By recognizing and addressing these challenges, teachers can harness the transformative potential of Generative AI to enhance teaching performance and improve student outcomes.

Conclusions

The discussion highlights the promising potential of Generative AI in enhancing teaching performance, while also revealing various challenges and obstacles during its implementation. One primary difficulty is the initial learning curve associated with adopting new technologies, which requires teachers to undergo training and professional development to become familiar with Generative AI tools and platforms. Additionally, integrating Generative AI into existing teaching practices may pose logistical challenges, such as compatibility issues with existing educational infrastructure and systems. Technical concerns, including software compatibility, data security, and privacy also require careful consideration and planning.

Generative AI significantly influences teachers' teaching performance, particularly in terms of perceived ease of use, usefulness, and ease of learning. Teachers' perceptions of the ease of Generative AI affect how seamlessly it integrates into daily teaching practices, and its ease of learning is crucial for adoption. Despite its potential benefits, the use of Generative AI may exacerbate inequalities in students'

access to educational resources and digital literacy skills. Teachers must address these disparities to ensure equitable learning opportunities for all students and navigate concerns about job displacement and the limitations of AI in replicating human interaction and pedagogy.

However, proactive measures such as providing ongoing support, fostering a culture of innovation and collaboration, and addressing concerns about equity and ethics in AI implementation can mitigate barriers to the effective use of Generative AI in teaching practice. By recognizing and addressing these challenges, teachers can harness the transformative potential of Generative AI to enhance teaching performance and improve student outcomes.

While the studies presented in this issue collectively highlight the transformative potential of Generative AI on teaching performance, further research is needed to adapt its application across diverse educational contexts and data sets. Research could go beyond specific databases to broaden the scope and depth of inquiry. This approach should include longitudinal studies to capture the evolving perceptions and long-term impacts of Generative AI on teaching performance. Additionally, future studies are encouraged to explore the integration of Generative AI into specific teaching models and curricula, including evaluating its role in formative assessments and its effectiveness across different instructional settings.

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Disclosure statement

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