Chapter 8 - Application of Artificial Intelligence in Teachers' Performance Management: A Mini-Review and Research Opportunities

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Chapter Highlights

➤ This study argues that advances in artificial intelligence (AI) are a new focus of global competition and a new possibility for organizational progress. In doing so, it highlights the potential of AI in education and specifically addresses its applications in improving teachers' performance and evaluation.

➤ Successful organizations are using AI in their performance management systems to monitor and guide employee performance. Performance management is defined as a strategic managerial process of monitoring an organization's performance in terms of effectiveness, efficiency, and impact through frequent planning, regular measurement, and evaluation techniques and tools.

➤ Teachers' performance is managed through performance appraisal, a process of continuous evaluation to help educational institutions achieve their goals. Performance appraisal helps teachers identify and improve their strengths and weaknesses, while at the same time increasing student achievement.

➤ AI is used in teacher performance evaluation processes, ensuring objective results. This technology helps teachers identify their strengths and weaknesses, improve their teaching strategies, and better serve students. AI also improves the quality of education by providing teachers with fast and effective feedback.

➤ Teachers' work efficiency plays a strategic role in ensuring the quality of education. Technologies such as AI and machine learning are being used to measure and improve teachers' productivity. The use of AI allows us to evaluate teachers' performance more objectively and increase productivity.

Abstract

Global attention has been drawn to recent advances in artificial intelligence (AI), as it is evolving into a new area of concentration for global competition and a new possibility for human and organizational progress. As AI technology has flourished, so have its applications in education, with tremendous potential to deliver dynamic assessments and enhance teachers' performance. Performance management processes are extensive and stretched out throughout the year, leaving evaluators to record and grade teachers based on their recent accomplishments. Furthermore, since evaluators are always preoccupied, they simply record this action as completed with a tick mark, obscuring or skewing the results, thus, making it impossible to grasp the individual's potential in the process. These drawbacks have necessitated the implementation of AI methodologies and tools in the performance management systems of educational institutions. AI in performance management systems creates a data-driven appraisal system that helps maintain transparency and avoids misapprehension, distrust, and biases. In this study, we looked at the introduction of AI in education by assessing the impact of AI on performance management. The study adopted the PRISMA framework to conduct a systematic literature review on the subject of interest. Laying its foundation on the PRISMA framework, the methodology comprises the search strategy, the selection criteria, quality assessment, and data extraction. The study shows that using AI in performance management as a means for teacher evaluation and assessment can serve as a decision-making guide for the administration of institutions. It helps to reveal teachers' true abilities, helps teachers focus on teaching challenges and key issues, highlights the shortcomings in their teaching activities, and enhances the essential assurance and support for teachers to make genuine progress.

Introduction

Global attention has been drawn to recent advances in artificial intelligence (AI), as it is evolving into a new area of concentration for global competition and a new possibility for human and organizational progress. Most countries have begun to pay attention to the changes AI can offer to the growth of organizations (Yang, 2019). As AI technology has flourished, so have its applications in education, with tremendous potential to deliver dynamic assessments and enhance teachers' performance (Zhang, Xiao, Li, Hou, et al., 2021). AI is improving education efficiency by helping with academic and administrative tasks (Ahmad et al., 2022). Well-organized staff performance is one of the components of any organizational progress, and good performance is demonstrated by factors like dependability, affordability, efficacy, and client focus. Therefore, to identify and manage the factors that affect employee performance and behavior, successful organizations worldwide have implemented artificial intelligence (AI), in Performance Management Systems (PMS). A performance management system is defined as a strategic managerial process that gives managers, leaders, employees, and interested parties at different levels a set of techniques and tools to monitor and maintain, frequently plan, irregularly measure, and assess the performance of the organization in terms of efficiency, effectiveness, and impact. The purpose of performance management is to align an employee's performance with the organization's ultimate success (Rath, 2018).

In the education sector, the performance management system is been implemented through performance appraisal which is a continuous evaluation procedure and a goal-oriented process used by educational institutions to achieve

their objectives by constantly measuring and providing feedback to teachers to improve their performance and help them achieve better results (Yambi & Yambi, 2020; Zhou et al., 2022). Through routine performance appraisals (PA), which include continuing assessments of each teacher's performance, these institutions gauge and raise the value of their teaching force (Sułkowski et al., 2020). Teachers' performance appraisal offers a systematic framework to construct and guarantee a culture of professionals dedicated to catering to educational requirements, such as increasing teachers' effectiveness and students' achievement. Thus, the appraisal of teachers is critical in the study of performance management because it also makes extensive use of goal-setting and metrics to identify progress and areas of individual strength. This offers many additional advantages not provided by the yearly traditional assessment process (Sánchez-Prieto et al., 2020).

However, despite these benefits, performance management systems present some drawbacks, such as a lack of automation and the potential for human errors. In addition, the performance management processes are extensive and stretched out throughout the year, leaving evaluators to record and grade teachers based on just their recent accomplishments. Furthermore, since evaluators are always preoccupied, they simply record this action as completed with a tick mark, obscuring or skewing the results, thus, making it impossible to grasp the individual's potential in the process. These drawbacks have necessitated the implementation of AI methodologies and tools in the performance management systems of educational institutions (Sánchez-Prieto et al., 2020). AI in performance management systems creates a data-driven appraisal system that helps maintain transparency and avoids misapprehension, distrust, and biases. Their applications in educational evaluation and appraisal are increasing and have attracted much attention in recent years (Zawacki-Richter et al., 2019). Applications of AI in performance appraisal open new possibilities for digital education, from automating and augmenting teaching and evaluation in the classroom to enabling the next generation of digital education enhanced by AI (Popenici & Kerr, 2017; Vanleeuwen et al., 2020). This review seeks to examine the effectiveness of AI in teacher performance evaluation, feedback, and productivity of higher education teachers.

Literature Review

Performance Management System in Education

Educating a population is argued by several economics studies to be a key to its development and prosperity. The human capital concept, upon which these studies are based, states that monetary investments in a person's education and professional development pay off in the form of increased productivity (Carneiro et al., 2010). Further research, according to Benlhabib (2019), has demonstrated a strong positive correlation between development and high-quality education rather than quantity. From their findings they go on to explain, that countries are under increasing pressure to implement performance management measures and accountability in their educational systems, as well as to make substantial financial investments to boost education quality. They argued that advocates of New Public Managerialism believe that schools may be made more efficient and productive if they treat education like a commodity on the market rather than a public good or social service (Benlhabib, 2019). Page (2016) argues that there has been a dearth of studies into the Performance Management System (PMS) at academic institutions and that the studies that have been conducted have been framed in terms of managerialism, performativity, and marketization. Instead of being bound by the constraints of the professional

concept, PMS adopts the framework of the labor process theory and is consistent with the management concept. Page continued by arguing that PMS has gained influence among teachers due to the ethical obligation of teaching since it is generally believed that improved teacher performance translates into more positive learning outcomes for students. From this point of view, school administrators have an ethical obligation to get rid of the "bad teachers", (Page, 2016) who are seen as the "problem" (Chiang et al., 2020) and are actively working against the best interests of their students by avoiding their responsibilities and causing harm to their education.

Likewise, performance management's incorporation into the educational system can be traced back to laws that have been required or other forms of coercion imposed by the government. This is closely related to New Public Management, a set of reforms made in the public sector. This reform in the form of a performance-oriented approach has emerged as a critical competency for school administrators due to a direct result of the severe budget constraints and the growth in expectations to improve the government's efficacy, effectiveness, and transparency. By law, principals must provide feedback on their teachers' work and keep records of their evaluations. For this requirement to be met, school administrators must first delegate tasks that contribute to the school's overall mission. In addition, they must provide regular opportunities for professional development and evaluation for teachers. This puts many teachers in what is called a "performative condition" at work (Naidu, 2011). Schools are expected to have a strategic plan in place to offer the necessary direction, and performance management as a tool helps with this. This means that educational institutions should develop a long-term strategy outlining how they intend to achieve their goals. Employees are also held accountable through performance management systems. In other words, performance management is an effective means by which educational institutions can incorporate additional opportunities for professional development and, thus, contribute to increased workplace performance. This suggests that upper-level administration values professional development and thinks performance management will increase opportunities for it in schools (Bulawa, 2012).

Artificial Intelligence in Education

The introduction of Artificial Intelligence (AI) into the educational contexts can be traced to the 1970s. At that time, researchers were interested in seeing how computers might substitute for one-to-one human tutoring, which is thought to be the most effective approach to teaching but was unavailable to most people (Bloom, 1984). Today, AI technologies are increasingly being used to facilitate the management and delivery of education. Rather than supporting teaching or learning directly, these system-facing applications are designed to automate aspects of school administration, building on Education Management Information Systems. Also, the rise of big data, artificial neural networks, cloud computing, and machine learning have all contributed to the development of a computer capable of mimicking human intellect (Zhai et al., 2021). The term "artificial intelligence" (AI) refers to a group of technologies that produce absolute magical results when combined with data, algorithms, and processing power. AI can also be referred to as a software system, perhaps integrated into hardware built by humans, capable of making a decision based on interpretation, perception, and reasoning using facts gathered from the environment and applied to solve a difficult problem. AI is autonomous, i.e., it can make decisions without requiring human intervention to accomplish a task- or purpose-related objective. It also possesses adaptability, indicating that the system can perceive its surroundings and modify its behavior in response to environmental shifts (Dignum, 2021).

Furthermore, AI in the educational system is due to the increasing workload of teachers and the need to increase teachers' productivity. Artificial Intelligence in Education (AIED) helps identify the gaps in teaching and learning and increases proficiency in education (van der Vorst & Jelicic, 2019). AIED helps the education system in evaluation, assessment, prediction, personification, intelligent tutoring, and adaptive systems. It also has the potential to address some of the biggest challenges in education today, innovate teaching and learning practices, and ultimately accelerate progress toward SDG 4 (Robertson, 1976). Administrative tasks, such as student monitoring, are made easier through automated systems, and the desktop computer has been joined in the classroom by an increasing number of gadgets (Johnson et al., 2016). A huge rise in data generation and computational power has occurred in tandem with the development of digital technologies and their growing interconnectedness. This leads to the widespread use of intelligent systems that can learn from themselves, reason like humans, and generalize from massive datasets (Xu et al., 2021).

Likewise, new AI-based teaching and learning solutions are being developed and tested in areas like performance management (Bates et al., 2020; Roll & Wylie, 2016). Performance management necessitates school administrators to participate in various activities with their respective teachers, such as evaluating the teachers' performance (Wiener & Jacobs, 2011). Successful performance appraisal and management implementation contribute to teachers' efficient and effective teaching performance. Recent advances in artificial intelligence are causing a revolution in the educational system by opening the door to individualized learning, improved teacher evaluation and administration, and many other benefits. AI technologies are helping to determine the performance levels of teaching professionals while simultaneously improving individual students' curriculum and skill levels (Kinshuk et al., 2016; Popenici & Kerr, 2017; Tuomi, 2018).

However, these rapid technological developments inevitably bring multiple risks and challenges, which have outpaced policy debates and regulatory frameworks (Pedro et al., 2019). Irrespective of the glaring benefits of AI in education, there is a potential risk concerning the fundamental human rights of both learners and teachers and relationship building between teachers and students and among students. Berendt et al. (2020) argue that fundamental human rights should be a priority and the starting point for the application of AI in educational systems by considering how AI in education affects individual fundamental human rights and freedom. Students and teachers, rather than AI tools, corporate organizations should be the main beneficiaries of the development, marketing, and integration of AI in education. Guilherme (2019) indicates that the relationship between teachers and students in the classroom should not be undervalued. Policymakers should be intentionally aware of the necessity to balance the 'technologicalisation' of education and the creation of the ideal conditions since, according to (Berendt et al., 2020), beyond data privacy, AI in education has an impact on basic human rights.

The Role of AI in Performance management

A Performance Management System is a method of recording and analyzing data on the accomplishments of groups, individuals, and organizations. The purpose of performance management is to foster the growth of employees' capabilities so that they can fulfill and even exceed their employers' expectations and realize their full potential for the good of both themselves and the organization. It is preferable to carry out performance

management in a manner that is supported by data, such as completion times for jobs or other performance indicators. Artificial intelligence (AI) systems might make this data collection more efficient, making it possible for administrators to obtain the appropriate data at the appropriate time (Stroet, 2020). Artificial intelligence has provided considerably smarter, quicker, and better platforms than ever before, which has completely revolutionized the method by which daily tasks are carried out. Also, the ability of AI to handle massive amounts of information at breakneck speeds, accurately interpret that information, and eliminate human bias has led to extraordinary gains (Pothen, 2022).

Furthermore, the approach to providing evaluations and feedback to workers is an essential component of every organization. Its efficient management can contribute to increased levels of productivity among its workforce. However the traditional performance evaluation method is rife with various flaws when put into reality. These inaccuracies significantly impact how objective the evaluation can be considered. Hence, incorporating AI and other scientific evaluation techniques into the appraisal process has helped simplify the procedure. Behavioral tests that are trustworthy and were built using scientific principles have helped executives understand what motivates and encourages their staff (Kumari et al., 2021). Artificial intelligence (AI) has enabled administrators to more accurately evaluate their staff members' work toward achieving predetermined goals. AI not only helps to ensure that performance evaluations are carried out, but it also enables a documentation system that stores the results of various performance management tasks. Again, AI enables administrators to check their judgments and ensure that their feedback is accurate by providing a second opinion. It assists the administrators in getting better and offers them access to more data and information about the employees they are evaluating (Stroet, 2020). Likewise, AI can assist administrators in better-identifying gaps in the talent pool and in providing targeted training ideas to employees by assessing a person's career progression using data from previous performance assessments, skills, and hobbies. This data can be gleaned from an individual's digital profile (Nantham, 2021).

However, utilizing AI provides many advantages and has numerous downsides that prevent it from replacing people in performance management. This is because a significant financial cost is associated with incorporating AI into the performance review process. If the software or the system's hardware becomes dysfunctional, it might need a lot of effort and money to repair (Lucas, 2022). AI lacks a human aspect in that when AI is utilized, the function of the manager shifts from being the individual accountable for conducting performance reviews to that of a facilitator. Also, artificial intelligence can only learn and do tasks per how it was programmed. AI's lack of human intelligence might have a detrimental effect on employees (Nantham, 2021)(*Use of Artificial Intelligence in Performance Reviews | Profit. Co*, n.d.). AI may not be able to perform precisely well in every circumstance. There will be situations in which performance evaluations based on AI won't be able to take certain aspects into account. In states like this, the judgments that need to be made require the wisdom of humans. Therefore, over-reliance on artificial intelligence (AI) and connected technologies can limit human potential and the ability to make sound decisions (Chernov & Chernova, 2019).

Again, the most significant drawback of AI is that it has ethical norms that are open to interpretation. When businesses want more and more data, including personal data, artificial intelligence programs designed to acquire personal data can become very intrusive. Also, employees' reputations may suffer due to the performance reviews related to the data. This might lead to a decline in the level of trust that employees have in the organization. It is

of the utmost importance for organizations to seriously consider how and the specific areas in which they plan to implement AI in the performance evaluation process. They need to carefully draw a boundary where artificial intelligence merely supplements human intellect and assists managers in performing their jobs more effectively and making better judgments, rather than taking over their duties and being intrusive while collecting data (Nantham, 2021)(*Use of Artificial Intelligence in Performance Reviews | Profit.Co*, n.d.).

Method

The introduction of Artificial Intelligence (AI) is changing the face of many sectors. We looked at the introduction of AI in education by assessing the impact of AI on performance management. The current study adopted the PRISMA framework to conduct a systematic literature review on the subject of interest. Laying its foundation on the PRISMA framework, the methodology comprises the search strategy, the selection criteria, quality assessment, and data extraction, as explained below.

The Search Strategy

To identify the relevant literature for the review, the researchers developed objectives that were used for literature identification. We used the Scopus and Web of Science databases and conducted a literature search on August 20, 2022. We developed key works in the first stage to search for the literature. The keywords include "artificial intelligence and performance management." In the second stage, we used a combination of words in the existing literature to conduct another search for the articles. The combined words used are given in Table 1.

Table 1. The combined keywords

Performance Management	"performance management" OR "performance system" OR "teacher performance evaluation" OR "performance appraisal*" OR "teacher productivity" OR "teacher assessment" OR "teacher evaluation" OR "teacher outcome" OR "teacher feedback"
	AND
Artificial Intelligence	"artificial intelligence" OR "machine intelligence" OR "intelligent support" OR "deep learning" OR "machine learning" OR "automated assessor*" OR "intelligent agent*" OR "expert system" OR "neural network" OR "natural language processing" OR "data mining"

Selecting Criteria

We constricted our search to works of literature that have been published in the fields of education alone as our selection criteria. During the evaluation process, we did not include articles unrelated to the study's scope and those falling out of the defined period (i.e., 2000-2022). The researchers also considered only articles in English, and finally, articles that did not address the study's objective were excluded from the evaluation. Below are the summary points;

- Full articles in English only
- Objectives of the articles identified should fall within the themes of the study
- Articles directly related to the research objective

- Published between 2000 and 2022

Quality Assessment

Following the objective set out for the review, we obtained a search result of 285 papers—232 from Scopus and 53 from Web of Science. In the next stage, we filtered out all duplicated articles, which resulted in 280 papers. The third round of screening resulted in the researchers removing 254 more publications because they were not relevant to the study's objective. Eleven (11) more papers were removed due to the methodologies used. Finally, a total of 15 papers were used for this review. The framework in Figure 1 below shows the process of quality assurance.

Data Extraction

We used the Microsoft Excel application to extract relevant information from the papers selected for the review. The Excel sheet contained essential characteristics such as the paper's title, publication date, authors' details, DOI, methodology used, and area of AI.
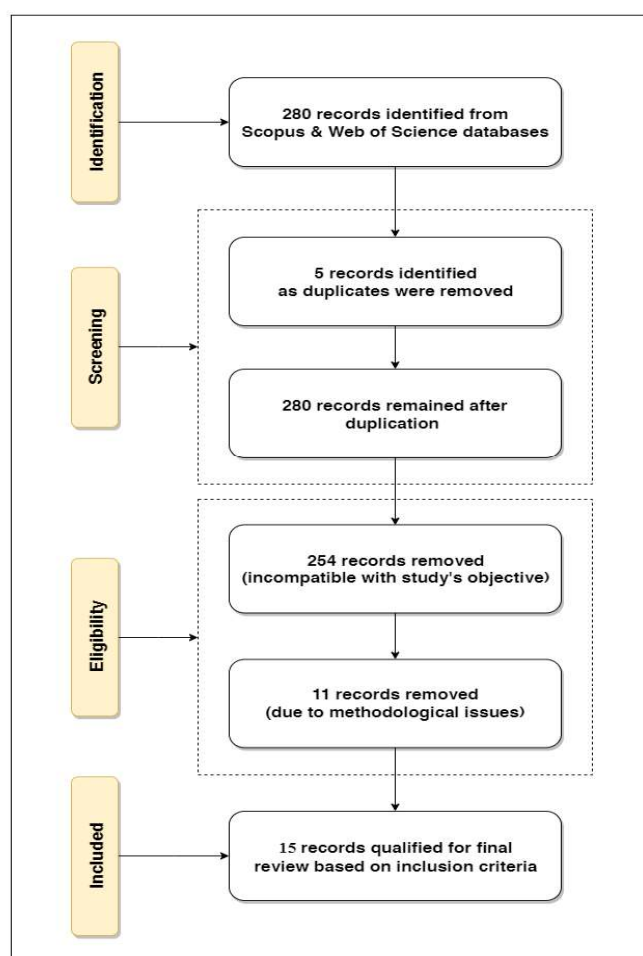

Figure 1. The search, screening, eligibility, and inclusion processes diagram at each stage based on the PRISMA guidelines

Results

The Distribution of Articles by Journals

We analyzed the number of papers published by each journal in this field (see Table 2). The overall analysis from Table 2 shows that the Journal of Mobile Information Systems and the Journal of Wireless Communications and Mobile Computing have published two papers each, representing 13.33%. The rest of the journals have published one article each. The journals published in this field include the Indian Journal of Science and Technology, the International Journal of Innovation and Learning, Frontiers in Psychology, Computer Applications in Engineering Education, etc. This implies that only a few journals significantly influence the publications done in this field.

Table 2. The distribution of articles by journal, percentage, year, and number of publications

The Distribution of Articles by Journals

Name of Journal	Year	Number of Publication	Percentage
International Journal of Intelligent Engineering & Systems	2018	1	6.67
Journal of Innovation and Knowledge	2022	1	6.67
Mobile Information Systems	2022	2	13.33
International Journal of System Assurance Engineering and Management	2021	1	6.67
Indian Journal of Science and Technology	2016	1	6.67
International Journal of Innovation and Learning	2020	1	6.67
Frontiers in Psychology	2022	1	6.67
Computer Applications in Engineering Education	2016	1	6.67
Journal of Intelligent & Fuzzy Systems	2020	1	6.67
Mathematical Problems in Engineering	2022	1	6.67
Journal Of Institutional Research (South East Asia)	2020	1	6.67
Wireless Communications and Mobile Computing	2021 2022	2	13.33
Wireless Personal Communications	2021	1	6.67

Note: The two articles from Mobile Information Systems were published in the same year (2022)

The Distribution of Papers Published Over Time

To understand the publication trend in this field, we analyzed the number of papers published over time (see Figure 1). The result shows that publication has been inconsistent for the past years. The highest number of publications is seen in 2022, with six papers. The early 2000s (i.e., 2000 -2015) saw no work done in this field. Two papers were published in 2016, with one published in 2018. Both 2017 and 2019 did not record any publications. However, the number of publications sharply increased to three for 2020 and 2021. The sharp increase in the publication in 2022 suggests a strong interest in this field among researchers.
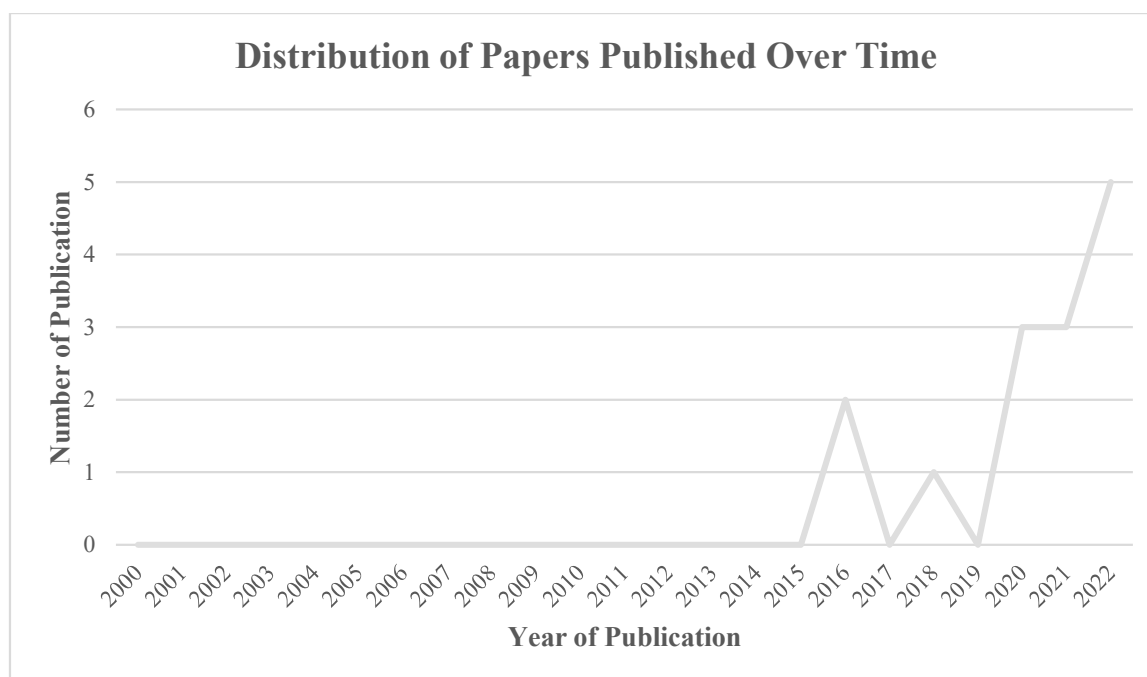
Figure 2. Distribution of papers published over time

Analysis of Author and Co-Authorship

Within this section of the article, we conducted an author and co-authorship analysis to demonstrate the cooperation and mutual understanding that has developed among scholars working within this area. According to the findings, 80% of the articles were co-authored, while 20% were single-authored. In addition, we did not observe any group of writers publishing more than one paper. This can point to the fact that there is less effort in collaboration within this research field.

Discussion

AI in Teacher Performance Evaluation and Assessment

Raising educational standards requires improving the overall quality of instruction, and one of the most essential tools for accomplishing this goal is teacher evaluation. The purpose of evaluating the quality of teaching is to provide support to educational reform, offer learners assistance in problem-solving, lessen the amount of pressure placed on pupils, enhance standards, and encourage intellectual development. As part of educational management, a system for evaluating the quality of instruction needs to be developed and continuously enhanced. Evaluating teaching quality is difficult because of the inherent limitations in the traditional methodologies used to assess the quality of instruction. As a result, the development and improvement of a method for evaluating the effectiveness of teachers are essential for educational management (Zhang, Xiao, Li, Hou, et al., 2021). Zhou et al. (2022) indicate that AI in teacher evaluation not only helps in considering many factors in the evaluation of teachers but also improves teaching quality. This can be attributed to the validity and reliability of AI employed in teacher evaluation which can serve as a decision-making guide for the administration of teaching authority since it can reveal teachers' genuine abilities, help teachers focus on teaching challenges and key issues, highlight the

shortcomings in their teaching activities, and enhance the essential assurance and support for teachers to accomplish genuine progress (Gao et al., 2020).

Similarly, the assessment process is essential to the teaching and learning processes. Instead of serving as a tool for measurement, assessments are now used to help teachers improve their teaching (Ng et al., 2020). Even though implementing performance assessment in education has moved at a snail's pace, this aspect of corporate applications is seeing fast development. Implementing performance assessment in schools helps students learn more practical skills since the practice is centered on enhancing teachers' performance (Meng et al., 2022). Performance assessment is a highly important and delicate process, especially regarding assessing teachers working in educational institutions. With performance assessment, teachers can improve their weaknesses and the quality of teaching at institutions if their weak points are located through a system that provides an early warning to notifications and rewards (Rashid & Ahmad, 2016). In addition, teachers' capability, performance, knowledge, and assessment significantly impact the standard of students' education. These methods enable educational institutions to assess teachers' performance and choose the most qualified candidates for teaching positions. Employing an Artificial Intelligence (AI) based cloud computing system fast-tracks teachers' assessments and helps school administrators conduct efficient recruitments (Kavitha, 2021).

Kavitha (2021) also provided evidence that Cloud Computing based on Data Mining can help educational institutions evaluate and decide the classification rule to determine and hire the most suitable teacher based on knowledge by utilizing a cloud database. This was demonstrated by the research that was conducted by Kavitha. Through the use of the cloud computing platform, one can have access to the various resources that are now available on the World Wide Web in an efficient and scalable manner. With the assistance of data mining, the company can ensure the safety and dependability of the software management as well as the data storage. Zhang, Xiao, Li, Hou, et al. (2021), and Cheng et al. (2020) likewise presented a unique model for evaluating the quality of classroom instruction in higher education institutions based on improved genetic algorithms and neural networks in their research. Their findings demonstrated that improving the neural network's prediction accuracy and convergence speed led to enhanced teaching quality evaluation findings, which in turn led to a more practical framework for evaluating the teaching quality of professors at colleges and universities. AI in evaluating teachers' performance is a suitable technique to evaluate their work since computer intelligence can adapt to various indicators and influencing elements in the assessment.

AI-based evaluation tools enable administrators to fast-track assessment processes without external influences on the assessment outcomes (Ng et al., 2020; Rashid & Ahmad, 2016; Samuel et al., 2014; Yang et al., 2022). Again, using AI in teacher assessment is acceptable to users, especially when the system has been certified and helps better predict teachers' performance (Chen et al., 2021; Lamarca & Ambat, 2018; Samuel et al., 2014). The application of AI in assessing teacher performance is a reasonable way based on the ability of machine learning to different proportion indicators and influencing factors in assessment (Yang et al., 2022). There are many more researchers who have used artificial intelligence in their studies to improve teaching quality, teacher performance, and evaluation; examples are; C5 data mining (Cheng et al., 2020), Decision Tree Algorithm (Yan & Jan, 2022), Convolutional Neural Network (Zhou et al., 2022), Clementine data mining (Gao et al., 2020), etc. By enhancing AI prediction accuracy and convergence speed, teaching quality evaluation is enhanced, leading to a more useful

methodology for assessment (Zhang, Xiao, Li, Hou, et al., 2021). Hence, scientific means of teacher evaluation can be deployed with the use of AI, which will mitigate challenges in the current teaching evaluation system, which is based on indicators of teaching quality achievements or subjective judgments of experts and subject groups that cannot be comprehensive, systematic, and scientific (Yang et al., 2022).

Feedback on Teachers' Performance

Feedback on teaching performance is the communication between teaching managers and teachers about teaching performance. Teacher feedback is important to let the teacher know whether the teaching effectiveness has met the set teaching objectives. Feedback is also one of the mainstreams of evaluation and is the key to the effectiveness of teaching performance management. Simultaneously, schools should develop teaching performance management systems based on big data to support teaching performance at all stages, including feedback. When teachers are being evaluated, there is always a need to provide timely feedback to teachers in other for them to facilitate the judgment of teaching strategies, ensure that the problems reflected in the evaluation are also addressed, and also improve their teaching quality (Xin et al., 2022). Also, through timely feedback, the evaluation result is tailed, classified, summarized, and analyzed through the web terminal. Most teaching performance feedback summarizes the past performance and looks at the new evaluation cycle. Therefore, the feedback process should focus on the performance indicators' content.

The use of AI in teacher performance evaluation has the added advantage of close to accurately predicting the expected performance of teachers based on available data. This enables the provision of corrective measures before the occurrence of such outcomes in the future (Chen et al., 2021). Hence as opposed to the traditional evaluation by subject experts, which cannot accurately provide feedback to mitigate the occurrence of a future happening, the use of AI in evaluation solves that issue. In the field of education, artificial intelligence has the potential to enhance the way administrators and students interact with the evaluation and feedback of teachers. Automating assessment aims to reduce the amount of labor involved in marking and providing feedback. Automation in teachers' assessment and feedback can be enhanced by heavily relying on technology such as natural language processing and artificial intelligence to give alternative assessment forms. Instead of the traditional method of evaluation, which involves subject specialists who cannot offer accurate feedback to prevent the occurrence of future unfair practices, AI automation pushes the education sector towards a more continuous assessment cycle, improving the outcomes and experience of teachers (Chen et al., 2021; Zhou et al., 2022). Providing feedback to educators can assist educators in gaining a better understanding of their capabilities, which can be a vital first step toward improving procedures in the classroom. Recognizing such strengths and shortcomings, providing information to inform decisions regarding resource allocation, and inspiring actors to improve performance are all key elements that can promote policy goals such as school improvement, accountability, and choice. Teachers' professional development as educators, as well as their job security and job satisfaction, are all significantly boosted due to the major impact that feedback has on both the teachers themselves and the work they do (OECD, 2009).

Work Productivity

Work productivity on the part of teachers plays an essential and strategic role in the provision of quality education. This role can, for example, play a role in determining the progression of education quality through direct encounters with students to provide them with skills and competencies. Because they are directly involved in school pedagogical activities, teachers and educators play an extremely important part in achieving the national education goal. As teachers need to organize, carry out, and supervise every educational activity to benefit the school's goal accomplishment, their productivity becomes a significant component of institutional aspects. These aspects also entail teachers' personalities and physical abilities, especially in the amount of work they do during school hours. As already mentioned above, these productivity matrices can only be accurately measured and improved with the application of automation processes such as AI and machine learning. The application of these techniques for gauging teachers' productivity is gaining significant attention, as seen in (Kavitha, 2021; Meng et al., 2022; Zhang, Xiao, Li, Hou, et al., 2021; Zhou et al., 2022), etc.

Without AI in teacher performance evaluation, some teachers who work hard by combining teaching and administrative work would not be seen as being the product for promotion since they cannot produce research papers like other teachers in other fields such as Science, technology & engineering. Cheng et al. (2020) argue that teachers who fall in the teaching cluster of universities are not seen as efficient and thus do not usually get promoted since they cannot churn out research publications like those in the research clusters in the university environment. The use of AI could improve teaching management quality hence increasing productivity. Meng et al. (2022) demonstrate how using big educational data and benchmarking analysis could yield more insightful results and new information for raising the caliber of teaching management quality and improving teaching performance evaluation.

Conclusion

Since the 1970s, artificial intelligence has been employed in education, and in the present day, AI technologies are being used more often to make educational administration and delivery more efficient. Using AI in performance management as a means for teacher evaluation and assessment can serve as a decision-making guide for the administration of institutions. It helps to reveal teachers' true abilities, helps teachers focus on teaching challenges and key issues, highlights the shortcomings in their teaching activities, and enhances the essential assurance and support for teachers to make genuine progress. Advanced tools such as machine learning and cloud computing present ways to evaluate the quality of classroom instruction in higher education institutions. Additionally, using cloud computing platforms allows efficient access to a wide variety of resources now available on the World Wide Web. In this mini-review, we have explored and summarized the currently available scientific discussions on the use of AI in performance evaluation, particularly in the higher education sector. We analyzed the number of papers published by each journal in this field between 2000 and 2022. A significant finding from the analysis shows that adopting AI tools and processes in performance management in educational institutions is beginning to gain widespread recognition among researchers.

Further analysis of author, co-authorship, and publication revealed that 80% of the articles were co-authored,

while 20% were single-authored. No group of writers was found to have published more than one paper, highlighting less effort in collaboration within this research field. Moreover, the Journal of Mobile Information Systems and the Journal of Wireless Communications and Mobile Computing were found to have published the highest with two papers each, implying only a few journals have influenced publications in this field. One important finding from the review highlights the significance of implementing AI in teacher evaluation to address problems with the current teacher evaluation system, which is largely based on indicators of teaching quality accomplishments or subjective judgments of experts in a subject area and therefore lacks the capability of being comprehensive, systematic, and scientific. This is of the utmost significance since performance management is undergoing a fundamental shift from the outdated practices of the past (performance appraisal) to contemporary practices that are more efficient, transparent, criteria-based, and feedback-oriented.

Older assessment methods have been shown ineffectual, and educational institutions are coming under increasing pressure to bring their systems and capabilities up to speed with the latest trends in technological advancement. Performance evaluations in educational institutions need to be more future-oriented, emphasizing development, coaching, and assessment using innovative software and tools for performance management. These technologies are critical for embracing innovative classroom performance management methods that encourage regular dialogues about students' and instructors' successes, tailored growth, and increased visibility of those accomplishments. In addition, they contribute to the motivation of the teaching staff, which is beneficial given that most educators are driven by appreciation rather than financial compensation. On the other hand, educational institutions must understand the advantages of implementing current performance management trends and endeavor to meet set goals by satisfying their teaching workforce.

The results of this study offer readers, policymakers, and school administrators the most up-to-date information available on the usefulness of AI in assessing, providing feedback on, and increasing the productivity of higher education instructors. This research provides a systematic understanding of how AI-based teacher evaluation can be used to evaluate and enhance teachers' work output, aid in the evaluation of instructional strategies, guarantee that issues highlighted in evaluations are resolved, and ultimately boost the quality of instruction. Incorporating AI into teacher performance evaluations can also ensure effective and constructive feedback to teachers which can boost accountability, transparency, and productivity.

Future Research Opportunities

The review found only two papers using hybrid nature-inspired algorithmic approaches with neural networks (Rashid & Ahmad, 2016; Zhang, Xiao, Li, & Hou, 2021). Nature-inspired algorithms (NIAs) are a group of innovative problem-solving methodologies and approaches derived from natural processes. These algorithms are extremely effective at finding solutions to multi-dimensional and multi-modal problems, as found in neural networks. Popular NIAs such as genetic algorithm (GA) and particle swarm optimization (PSO) have widespread usage in the literature. However, there are some limitations—they are parameter-based algorithms (leading to some biases), longer computational time, and finding the optimum values and solutions is difficult. Thus, to achieve better results in these AI-PM models, future researchers are encouraged to introduce other NIAs, such as

the Jaya algorithm, without parameters algorithm recently developed by (Venkata Rao, 2016).

Future researchers are also encouraged to place more emphasis on the development of AI-PM-based parameters as universal systems to achieve more fruitful outcomes in measuring performance management. These parameters could play the role of a benchmark system, which is vitally important for the continuous monitoring and evaluation of teachers to keep pace with the fast changes in education and the teaching profession.

Future research could be geared toward the use of big data in teacher evaluation. The use of big data in education has received little attention in the literature. Unlike the other aspects of technology use in education, the use of big data which has greater variety, arriving in greater volumes and at an increasing velocity, could help in really understanding the efficiency and productivity of the teacher.

Reference

Ahmad, S. F., Alam, M. M., Rahmat, M. K., Mubarik, M. S., & Hyder, S. I. (2022). Academic and Administrative Role of Artificial Intelligence in Education. *Sustainability*, *14*(3), 1101. https://doi.org/10.3390/su14031101

Bates, T., Cobo, C., Mariño, O., & Wheeler, S. (2020). Can artificial intelligence transform higher education? *International Journal of Educational Technology in Higher Education*, *17*(1), 42. https://doi.org/10.1186/s41239-020-00218-x

Benlhabib, H. (2019). A Review about Performance Management in Education Systems: Case of Morocco. Proceedings of the International Conference on Industrial Engineering and Operations Management, Morocco.

Berendt, B., Littlejohn, A., & Blakemore, M. (2020). AI in education: learner choice and fundamental rights. *Learning, Media and Technology*, *45*(3), 312-324. https://doi.org/10.1080/17439884.2020.1786399

Bloom, B. S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational researcher*, *13*(6), 4-16. https://files.ascd.org/staticfiles/ascd/pdf/journals/ed_lead/el_198405_bloom.pdf

Bulawa, P. (2012). Implementation of the Performance Management System (PMS) in Senior Secondary Schools in Botswana: An İnvestigation of Senior Management Team's Expected Benefits of the PMS. *European Journal of Educational Research*, *1*, 321-337. https://doi.org/10.12973/eu-jer.1.4.321

Carneiro, P., Dearden, L., & Vignoles, A. (2010). The Economics of Vocational Education and Training. *International Encyclopedia of Education*, 255-261. https://doi.org/10.1016/B978-0-08-044894-7.01737-1

Chen, L., Jagota, V., & Kumar, A. (2021). Research on optimization of scientific research performance management based on BP neural network. *International Journal of System Assurance Engineering and Management*. https://doi.org/10.1007/s13198-021-01263-z

Cheng, T.-M., Hou, H.-Y., Agrawal, D. C., Hsu, S.-C., & Wu, H.-T. (2020). Data Mining The Categories Of Teachers And Offering Promotion Strategies For The Mainstream - Case Of A Technology University In Taiwan. *JIRSEA*, *18*(2), 51-88.

Chernov, A., & Chernova, V. (2019). Artificial Intelligence In Management: Challenges And Opportunities. 38th International Scientific Conference on Economic and Social Development, Rabat, Morocco.

Chiang, T.-H., Thurston, A., & Lee, J. C.-K. (2020). The birth of neoprofessionalism in the context of neoliberal governmentality: The case of productive university teachers. *International Journal of Educational Research*, *103*, 101582. https://doi.org/https://doi.org/10.1016/j.ijer.2020.101582

Dignum, V. (2021). The role and challenges of education for responsible AI. *London Review of Education*, *19*(1). https://doi.org/10.14324/LRE.19.1.01

Gao, F., Isaeva, E., & Rocha, Á. (2020). Establishment of college English teachers' teaching ability evaluation based on Clementine data mining. *Journal of Intelligent & Fuzzy Systems*, *38*(6), 6833-6841. https://doi.org/10.3233/jifs-179761

Guilherme, A. (2019). AI and education: the importance of teacher and student relations. *AI & SOCIETY*, *34*(1), 47-54. https://doi.org/10.1007/s00146-017-0693-8

Johnson, A. M., Jacovina, M. E., Russell, D. G., & Soto, C. M. (2016). Challenges and solutions when using technologies in the classroom. In *Adaptive educational technologies for literacy instruction* (pp. 13-30). Routledge.

Kavitha, K. (2021). Assessing Teacher's Performance Evaluation and Prediction Model Using Cloud Computing Over Multi-dimensional Dataset. *Wireless Personal Communications*, *119*(4), 3207-3221. https://doi.org/10.1007/s11277-021-08394-3

Kinshuk, Chen, N.-S., Cheng, I. L., & Chew, S. W. (2016). Evolution Is not enough: Revolutionizing Current Learning Environments to Smart Learning Environments. *International Journal of Artificial Intelligence in Education*, *26*(2), 561-581. https://doi.org/10.1007/s40593-016-0108-x

Kumari, K., Ali, S., Khan, N., & Abbas, J. (2021). Examining the Role of Motivation and Reward in Employees' Job Performance through Mediating Effect of Job Satisfaction: An Empirical Evidence. *International Journal of Organizational Leadership*, *10*, 401-420. https://doi.org/10.33844/ijol.2021.60606

Lamarca, B., & Ambat, S. (2018). The Development of a Performance Appraisal System Using Decision Tree Analysis and Fuzzy Logic. *International Journal of Intelligent Engineering and Systems*, *11*(4), 11-19. https://doi.org/10.22266/ijies2018.0831.02

Lucas, O. (2022). The Role of Artificial Intelligence in Performance Management. *eLeaP*. https://performance.eleapsoftware.com/the-role-of-artificial-intelligence-in-performance-management/

Meng, L., Zhu, J., Wang, L., & Ning, X. (2022). Classroom Teaching Performance Evaluation Model Guided by Big Data and Mobile Computing. *Wireless Communications and Mobile Computing*, *2022*, 1-9. https://doi.org/10.1155/2022/2084423

Naidu, S. (2011). Performance Management as a Means of Teacher Evaluation: A South Australian Perspective. *Online submission*. https://files.eric.ed.gov/fulltext/ED525413.pdf

Nantham, S. (2021). Use of Artificial Intelligence in Performance Reviews. *Best OKR Software by Profit.co*. https://www.profit.co/blog/performance-management/use-of-artificial-intelligence-in-performance-reviews/

Ng, W. S., Xie, H., Wang, F. L., & Li, T. (2020). Peer assessment of peer assessment plan a deep learning approach of teacher assessment literacy. *Int. J. Innovation and Learning*, *27*(4).

OECD. (2009). *Creating Effective Teaching and Learning Environments: First Results from TALIS*. OECD. https://doi.org/10.1787/9789264068780-en

Page, D. (2016). Understanding performance management in schools: a dialectical approach. *International*

Journal of Educational Management, *30*, 166-176. https://doi.org/10.1108/IJEM-06-2014-0087

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). Artificial intelligence in education: challenges and opportunities for sustainable development. (no 07), 46 p. https://unesdoc.unesco.org/ark:/48223/pf0000366994?posInSet=22&queryId=9d8ca6cf-6a26-4f09-9b10-5e339c0e75da (UNESCO working papers on education policy, no. 07)

Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, *12*(1), 22. https://doi.org/10.1186/s41039-017-0062-8

Pothen, A. S. (2022). Artificial Intelligence and its Increasing Importance. In (pp. 74-81). https://www.researchgate.net/profile/Ashlyn-S-Pothen/publication/358058444_Artificial_Intelligence_and_its_Increasing_Importance/inline/jsViewer/61eeb1138d338833e390dda6?inViewer=1&pdfJsDownload=1&origin=publication_detail&previewAsPdf=false

Rashid, T. A., & Ahmad, H. A. (2016). Lecturer performance system using neural network with Particle Swarm Optimization. *Computer Applications in Engineering Education*, *24*(4), 629-638. https://doi.org/10.1002/cae.21737

Rath, A. (2018). Evolution of Performance Management System: A Review of Literature. *International Journal of Creative Research Thoughts (IJCRT)*, *6*(2), 874-884. https://www.ijcrt.org/papers/IJCRT1813200.pdf

Robertson, M. (1976). Artificial intelligence in education. *Nature*, *262*(5568), 435-437. https://doi.org/10.1038/262435a0

Roll, I., & Wylie, R. (2016). Evolution and Revolution in Artificial Intelligence in Education. *International Journal of Artificial Intelligence in Education*, *26*(2), 582-599. https://doi.org/10.1007/s40593-016-0110-3

Samuel, O. W., Omisore, M. O., & Atajeromavwo, E. J. (2014). Online fuzzy based decision support system for human resource performance appraisal. *Measurement*, *55*, 452-461. https://doi.org/10.1016/j.measurement.2014.05.024

Sánchez-Prieto, J., Cruz-Benito, J., Therón, R., & García-Peñalvo, F. (2020). Assessed by Machines: Development of a TAM-Based Tool to Measure AI-based Assessment Acceptance Among Students. *International Journal of Interactive Multimedia and Artificial Intelligence*, *6*, 80-86. https://doi.org/10.9781/ijimai.2020.11.009

Stroet, H. P. (2020). *AI in performance management: what are the effects for line managers?* University of Twente]. https://purl.utwente.nl/essays/77429

Sułkowski, Ł., Przytuła, S., Borg, C., & Kulikowski, K. (2020). Performance Appraisal in Universities—Assessing the Tension in Public Service Motivation (PSM). *Education Sciences*, *10*, 174. https://doi.org/10.3390/educsci10070174

Tuomi, I. (2018). *The impact of Artificial Intelligence on learning, teaching, and education*. Publications Office. https://doi.org/10.2760/12297

van der Vorst, T., & Jelicic, N. (2019). Artificial Intelligence in Education: Can AI bring the full potential of personalized learning to education? https://www.econstor.eu/bitstream/10419/205222/1/van-der-Vorst-Jelicic.pdf

Vanleeuwen, C., Veletsianos, G., Belikov, O., & Johnson, N. (2020). Institutional Perspectives on Faculty Development for Digital Education in Canada. *Canadian Journal of Learning and Technology*, *46*. https://doi.org/10.21432/cjlt27944

Venkata Rao, R. (2016). Jaya: A simple and new optimization algorithm for solving constrained and unconstrained optimization problems. *International Journal of Industrial Engineering Computations*, 19-34. https://doi.org/10.5267/j.ijiec.2015.8.004

Wiener, R., & Jacobs, A. (2011). Designing and Implementing Teacher Performance Management Systems: Pitfalls and Possibilities. *Aspen Institute*. https://files.eric.ed.gov/fulltext/ED521073.pdf

Xin, X., Shu-Jiang, Y., Nan, P., ChenXu, D., & Dan, L. (2022). Review on A big data-based innovative knowledge teaching evaluation system in universities. *Journal of Innovation & Knowledge*, *7*(3). https://doi.org/10.1016/j.jik.2022.100197

Xu, Y., Liu, X., Cao, X., Huang, C., Liu, E., Qian, S., Liu, X., Wu, Y., Dong, F., Qiu, C.-W., Qiu, J., Hua, K., Su, W., Wu, J., Xu, H., Han, Y., Fu, C., Yin, Z., Liu, M., . . . Zhang, J. (2021). Artificial intelligence: A powerful paradigm for scientific research. *The Innovation*, *2*(4), 100179. https://doi.org/https://doi.org/10.1016/j.xinn.2021.100179

Yambi, T., & Yambi, C. (2020). Assessment And Evaluation In Education. https://www.researchgate.net/profile/Tomas-Yambi/publication/342918149_ASSESSMENT_AND_EVALUATION_IN_EDUCATION/inline/jsViewer/5f0d737aa6fdcc547aee9fb3?inViewer=1&pdfJsDownload=1&origin=publication_detail&previewAsPdf=false

Yan, Y., & Jan, N. (2022). Decision Tree Algorithm in the Performance Evaluation of School-Enterprise Cooperation for Higher Vocational Education. *Mathematical Problems in Engineering*, *2022*, 1-9. https://doi.org/10.1155/2022/4151168

Yang, A., Yu, S., & Khattak, H. A. (2022). Research on Teaching Evaluation System Based on Machine Learning. *Mobile Information Systems*, *2022*, 1-10. https://doi.org/10.1155/2022/9255064

Yang, X. (2019). Accelerated Move for AI Education in China. *ECNU Review of Education*, *2*(3), 347-352. https://doi.org/10.1177/2096531119878590

Zawacki-Richter, O., Marín, V., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education -where are the educators? *International Journal of Educational Technology in Higher Education*, *16*, 1-27. https://doi.org/10.1186/s41239-019-0171-0

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., Liu, J.-B., Yuan, J., & Li, Y. (2021). A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. *Complexity*, *2021*, 8812542. https://doi.org/10.1155/2021/8812542

Zhang, H., Xiao, B., Li, J., & Hou, M. (2021). An Improved Genetic Algorithm and Neural Network-Based Evaluation Model of Classroom Teaching Quality in Colleges and Universities. *Wireless Communications and Mobile Computing*, *2021*, 1-7. https://doi.org/10.1155/2021/2602385

Zhang, H., Xiao, B., Li, J., Hou, M., & Zhong, S. (2021). An Improved Genetic Algorithm and Neural Network-Based Evaluation Model of Classroom Teaching Quality in Colleges and Universities. *Wireless Communications and Mobile Computing*, *2021*, 1-7. https://doi.org/10.1155/2021/2602385

Zhou, D., He, S., & Khattak, H. A. (2022). Performance Management of Education and Teaching Reform Based

on Convolutional Neural Network. *Mobile Information Systems*, *2022*, 1-9. https://doi.org/10.1155/2022/5321629

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