

AI and Machine Learning (ML) in Education Supervision: Quality Management Synergy for Improved Learning

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Abstract. The integration of artificial intelligence (AI) and machine learning (ML) in educational supervision has emerged as a transformative force in quality management. AI-driven analytics provide real-time data insights, predictive modeling, and automated feedback mechanisms, facilitating evidence-based decision-making among educators and administrators. This research aims to explore the synergies between AI and machine learning in the context of educational supervision, as well as how these integrations can contribute to improving the overall quality of education. The research method used is quantitative experimental, with data analysis based on a systematic review model. Data was collected through surveys and interviews with education stakeholders, and the results were analyzed using the SmartPLS application to understand the relationships between variables involved in quality management. Key results show that the application of AI and machine learning significantly improves accuracy in classroom supervision and student needs identification. The conclusion of this study is that the synergy between AI and machine learning not only has the potential to change the way education supervision is conducted, but also strengthen the quality of education through the creation of a more responsive and adaptive learning environment. By leveraging AI and ML, educational institutions can optimize resource allocation, improve teacher performance assessments, and personalize student learning experiences, ultimately leading to better educational outcomes.

Keywords: AI; Machine Learning (ML); Education Supervision; Quality Management; Learning Enhancement

INTRODUCTION

In recent years, the rapid development of artificial intelligence (AI) and machine learning (ML) technology has had a significant impact on various sectors, including education. These technologies not only simplify the process of data collection and analysis but also enable automation in various managerial and operational aspects (Mohanty et al., 2024). One area that has received increasing attention is educational supervision, where these technologies have the potential to greatly enhance the quality of management and evaluation of the learning process. AI and ML can provide deeper insights through more accurate and predictive data analysis, as well as allow more efficient monitoring of teacher performance and student progress (Esomonu, 2024). As a result, educational supervision becomes more evidence-based, strengthening decision-making and continuous improvement in learning quality (Ouyang et al., 2023). These advancements in AI and ML have also shown promising applications in other fields, such as predictive medicine (Sharma et al., 2024) and next-generation wireless networks (Kibria et al., 2018), which further underline the transformative power of these technologies. Moreover, AI models can be

evaluated and enhanced to predict student learning outcomes, ensuring a data-driven approach to improving educational experiences (Farhood et al., 2024).

Effective educational supervision is a key factor in ensuring that the educational process runs optimally and in accordance with the established quality standards. In a complex education system, supervision plays an important role in ensuring that policies and learning strategies are implemented correctly (Binti Ismail, 2018). Proper supervision not only assesses learning outcomes but also identifies and addresses problems that arise during the learning process (Darmayanti, 2022). This is crucial to ensure that every aspect of education, from the curriculum to facilities and social interactions, supports the optimal development of students. Furthermore, good supervision can help improve the quality of teaching and create a conducive learning environment for all parties.

However, despite the development of educational supervision in many institutions, challenges related to accuracy and efficiency remain a major issue (Farhood et al., 2024). Many educational supervisors still rely on manual methods for evaluation, which are often time-consuming and fail to provide an accurate picture of the existing educational conditions. These traditional methods often cannot capture issues in real-time, which can hinder quick responses to emerging problems (Campanella et al., 2019). Additionally, manual data collection can lead to errors in data interpretation and fail to provide a comprehensive view of classroom dynamics. Therefore, technologies that can address these limitations are crucial to improving the effectiveness of educational supervision (Gao et al., 2022; Musarat et al., 2024).

Many educational supervisors still rely on manual methods to conduct evaluations, which often take a long time and do not provide an accurate representation of the current educational conditions. Manual evaluations often rely on reports that are compiled subjectively and take a long time to analyze the available data (Ramesh & Sanampudi, 2022). This causes delays in the improvement process and reduces the potential for rapid enhancement of educational quality. With the advent of AI and ML technology, evaluations can be conducted automatically and more objectively, allowing supervisors to obtain more accurate information in a shorter time (Kurt Bayrakdar et al., 2021). The use of these technologies can accelerate decision-making processes and support educational improvements more efficiently (Rane et al., 2024). Therefore, a more advanced, responsive, and adaptive supervision system is needed to cope with the evolving dynamics of education. A technology-based supervision system can leverage big data and analytics to provide sharper and deeper insights into educational conditions (Almanasra, 2024). This technology can also adapt to changes in curriculum or evolving educational policies, allowing for more flexible and relevant supervision (Lin et al., 2024). Additionally, by utilizing AI and ML, supervision can become more proactive in identifying problems and suggesting improvements before they escalate, thus making education more dynamic and aligned with the needs of students and the development of the times.

In this context, AI and ML offer great potential to enhance educational supervision. By using AI-based analytics, supervisors can gain more accurate real-time insights into the teaching and learning process, predict potential problems, and provide more precise feedback to teachers and students (Salas-Pilco et al., 2022). For example, AI can be used to analyze student performance data, identify specific educational needs, and provide recommendations to improve learning quality (Kuleto et al., 2021). As a result, these technologies not only improve the effectiveness of educational supervision but also contribute to improving overall educational outcomes (Guleria & Sood, 2023).

Several recent studies have explored the application of artificial intelligence (AI) and machine learning (ML) in educational supervision and the management of educational quality. Ren (2025) developed a hybrid model combining environmental analysis with machine learning to predict AI-based education quality, while Kausar, Munir, and Zahra (2025) demonstrated how the integration of total quality management (TQM) with AI and employee involvement can strengthen quality culture in organizations. Suryanarayana et al. (2024) investigated the application of AI in digital education management systems to improve the efficiency and sustainability of educational management, while Ramirez and Esparrell (2024) highlighted AI's potential to create synergies that enrich the learning

experience. Research by Villegas-Ch et al. (2020) showed improvements in online education models through the integration of machine learning in Learning Management Systems (LMS), and Ayanwale et al. (2024) provided a perspective on the evolution of machine learning in educational research. While many studies have discussed the application of AI and ML in education, few have specifically examined the synergy between these two technologies in educational supervision to directly improve learning quality, particularly in the context of student needs identification and real-time teacher performance evaluation. This research provides novelty by integrating AI-based analytics in classroom supervision and student needs identification to create a more responsive and adaptive educational supervision system, addressing gaps in the broader application of these technologies in educational supervision, with a focus on improving student learning outcomes.

The urgency of this research lies in the significant challenges faced by education systems worldwide, particularly in effective supervision that responds to student needs and teaching dynamics. Traditional supervision systems relying on manual evaluation have proven insufficient in dealing with the complexity and rapid changes in the educational environment. With the continuous advancement of technology, particularly AI and ML, there is now an opportunity to create more sophisticated systems that provide deeper and more accurate insights, as well as support more timely decision-making. Additionally, improving the quality of educational supervision can lead to enhanced teacher performance, more accurate identification of student needs, and, ultimately, improved learning outcomes. Therefore, this research is crucial to understanding how AI and ML technologies can be applied in educational supervision and how these technologies can create a more responsive, adaptive, and high-quality educational ecosystem.

The aim of this research is to examine how the integration of AI and ML in educational supervision can help address existing challenges and improve educational management quality. The focus of this research is on the application of AI-based analytics in classroom supervision and student needs identification. It is expected that this research will provide new insights into how these technologies can be effectively integrated into educational supervision systems. Furthermore, this research will analyze the relationship between the use of AI and ML and the improvement of supervision quality, as well as their impact on student learning outcomes.

LITERATURE REVIEW

Educational Supervision

Educational supervision is a critical component of the education system, aimed at ensuring that the teaching and learning process operates effectively and in accordance with established standards. Alam, Haque, & Banu (2021) explains that educational supervision involves a series of activities, including monitoring various aspects of education, from teaching processes to curriculum management and facilities. The primary goal of supervision is to detect and address issues within the education system, such as discrepancies between the curriculum and the teaching provided. Effective supervision can enhance teaching quality and help create a conducive learning environment for students. However, traditional educational supervision often relies on manual approaches, which have limitations in terms of time, accuracy, and efficiency in analyzing the available data.

With the advancement of technology, particularly artificial intelligence (AI) and machine learning (ML), educational supervision can become more efficient and data-driven. Sghir, Adadi & Lahmer (2023) notes that technology can accelerate data collection and analysis, providing more accurate and timely information to educational supervisors. AI can help analyze data in real-time, offering insights into student and teacher performance, and enabling evidence-based decision-making that is more accurate. The use of this technology can reduce dependence on manual evaluation and enhance responsiveness to emerging issues, allowing for a more dynamic and efficient supervisory process.

Artificial Intelligence (AI) in Education

Artificial intelligence (AI) refers to the field of computer science focused on developing systems that can mimic human cognitive abilities, such as thinking, learning, and problem-solving. In the context of education, AI plays a vital role in supporting supervision and improving learning quality. Mathew, Brintha, & Jappes (2023) explain that AI allows for automation in data collection and analysis, providing faster and more accurate feedback than manual supervision. AI can be used to analyze large datasets related to student and teacher performance, as well as predict potential problems that may arise in the future. For instance, AI can detect negative trends in exam results or student behavior, which may require further intervention.

Furthermore, AI in education also offers the capability to identify patterns that might not be visible to human supervisors. Hooda et al. (2022) emphasize that AI can help analyze data more deeply, such as mapping the strengths and weaknesses of students based on their learning outcomes. By using AI-based systems, educational supervisors can easily gain insights into areas that need attention, allowing them to design more targeted interventions. Additionally, AI can provide more personalized learning recommendations tailored to the specific needs of each student, thereby enhancing both teaching quality and the learning experience.

Machine Learning (ML) in Education

Machine learning (ML) is a subfield of AI focused on developing algorithms that enable systems to learn from data and make decisions or predictions without being explicitly programmed. Jordan and Mitchell (2015) explain that ML enables computers to learn from experience and improve their performance based on the data provided. In education, ML can be used to analyze data related to student performance, classroom behavior, and student-teacher interactions. This technology allows for the identification of patterns that may be hard for human supervisors to detect, such as students who need more attention or issues with the teaching methods being applied.

One relevant application of ML is in Learning Management Systems (LMS), which can be used to automatically monitor student progress and detect patterns that indicate a need for changes in the teaching approach. Baker and Siemens (2014) reveal that using ML in LMS can enhance the effectiveness of supervision by providing deeper analyses of existing patterns, predicting student learning outcomes, and identifying areas that require further attention. In this way, educational supervision becomes not only more efficient but also more data-driven, supporting better decision-making that leads to improved learning outcomes.

Synergy between AI and ML in Educational Supervision

The integration of AI and ML in educational supervision offers great potential to create a more responsive and adaptive supervision system in education. Paramesha, Rane, & Rane (2024) explain that AI provides real-time insights into teaching and learning conditions, while ML analyzes the data further to identify patterns that are not immediately visible. By leveraging the synergy of these two technologies, educational supervisors can gain a deeper and more comprehensive understanding of classroom conditions, predict potential issues, and provide faster and more relevant feedback. This enables a more proactive supervision process, where problems are not only detected after they occur but also prevented before they escalate.

Furthermore, the synergy between AI and ML enables a more dynamic supervision system that can adjust to changing educational needs over time. Dhananjaya et al. (2024) note that the combination of AI and ML in education can enhance efficiency and supervision quality by providing more personalized learning recommendations and speeding up the evaluation and decision-making process. This is beneficial not only for supervisors but also for teachers and students, as they receive quicker and more relevant feedback and more tailored learning experiences that meet their needs.

Quality Management in Education

Quality management in education is a systematic approach to ensuring that educational processes and learning outcomes meet established standards through continuous evaluation and improvement. Juran (1992) explains that quality management involves three key stages: quality planning, quality control, and quality improvement, all of which need to be executed with a data-driven approach. In education, effective supervision plays a crucial role in ensuring that every component of the education system functions properly and aligns with the set goals (Sa'duh et al., 2024). For this reason, technology-based supervision, such as AI and ML, is highly beneficial in accelerating evaluation processes and improving the quality of education by providing more accurate and reliable data (Sukma & Pahrudin, 2024).

AI and ML can enhance quality management in education by providing more efficient, data-driven analysis. Setyo et al. (2021) show that AI and ML can improve the effectiveness of supervision by offering insights into areas that need improvement, such as curricula that do not align with student needs or teaching methods that are not effective. By using this technology, supervisors can provide more timely and detailed feedback, enabling faster and more sustainable improvements. As such, AI and ML technologies not only accelerate decision-making in educational supervision but also contribute to enhancing the overall quality of education (Tanjung et al., 2022).

METHOD

This study uses a quantitative experimental method to analyze the impact of the integration of artificial intelligence (AI) and machine learning (ML) in educational supervision. This approach was chosen to empirically test how AI and ML technologies can improve the quality of educational supervision management through more accurate and predictive data analysis. Data were collected through surveys and interviews with education stakeholders, including educational supervisors, teachers, and school administrators at SDN Karangdowo, Klaten, to gain insights into the application of AI and ML in the context of educational supervision. The survey was designed to measure the perceptions and experiences of respondents regarding the use of these technologies in classroom supervision, teacher performance evaluation, and student needs identification. In addition, interviews were conducted to gain deeper insights into the challenges and benefits perceived in the use of AI and ML in educational supervision.

Data analysis was conducted using the SmartPLS application to identify the relationships between variables involved in educational quality management, such as classroom supervision, teacher performance assessment, and student needs identification. This analysis model allows for measuring the relationship between the use of AI and ML and the improvement of supervision quality, as well as their impact on student learning outcomes. The study also employs a systematic review model to evaluate the literature related to the integration of technology in educational supervision, providing a comprehensive overview of previous research and the contribution of this study to the development of knowledge in this field. By using a quantitative experimental method, this study is expected to provide empirical evidence on the effectiveness of AI and ML technologies in improving the quality of educational supervision and offer recommendations that can be applied to enhance the overall quality of education.

RESULTS

Improvement in the Accuracy and Efficiency of Educational Supervision

The quantitative data for this point was collected through a survey distributed to educational supervisors, teachers, and administrators. The survey aimed to measure their perceptions of how AI and ML impacted the accuracy and efficiency of educational supervision. Respondents were asked to evaluate the extent to which AI and ML had improved the accuracy of monitoring teacher performance and student progress after these technologies were implemented.

Table 1. Survey Questions for AI and ML Usage in Educational Supervision

No	Question
1	To what extent do you use AI-based tools for monitoring teacher performance?
2	How often do you rely on AI-generated insights to identify issues in the classroom?
3	How effective do you find AI tools in providing real-time data on student performance?
4	How has AI improved the speed of decision-making in your role as an educational supervisor?
5	To what extent do you use ML-based tools for analyzing student data (e.g., exam results, behavior patterns)?
6	How helpful do you find machine learning algorithms in predicting potential learning issues for students?
7	Do you believe that ML-based tools help you in identifying areas for improvement in teaching strategies?

The Smart PLS analysis was conducted to assess the relationships between AI/ML usage and the accuracy of supervision. The measurement model used indicators such as frequency of use and perception of effectiveness for AI and ML, while accuracy of supervision was measured by the speed of identifying issues and the accuracy of feedback provided.

Table 2. Path Coefficients

Path Relationship	Path Coefficient	t-value	p-value	Interpretation
AI Usage → Accuracy of Supervision	0.45	5.2	< 0.01	Significant positive impact on Accuracy of Supervision
ML Usage → Accuracy of Supervision	0.4	4.8	< 0.01	Significant positive impact on Accuracy of Supervision
AI Usage → Efficiency of Supervision	0.38	4.1	< 0.01	Significant positive impact on Efficiency of Supervision
ML Usage → Efficiency of Supervision	0.35	3.9	< 0.01	Significant positive impact on Efficiency of Supervision

Table 3. R-Square (R²)

Variable	R-Square	Interpretation
Accuracy of Supervision	0.58	58% variance explained in Accuracy of Supervision
Efficiency of Supervision	0.52	52% variance explained in Efficiency of Supervision

Table 4. Effect Size (F²)

Path Relationship	F ²	Effect Size
AI → Accuracy of Supervision	0.12	Medium effect
ML → Accuracy of Supervision	0.1	Medium effect
AI → Efficiency of Supervision	0.11	Medium effect
ML → Efficiency of Supervision	0.09	Medium effect

The results of this study highlight the significant impact of AI and ML technologies on improving the accuracy and efficiency of educational supervision. Data collected through surveys distributed to educational supervisors, teachers, and administrators revealed that the use of AI and ML tools had a positive influence on monitoring teacher performance and student progress. Respondents generally agreed that AI and ML enhanced the speed and accuracy of feedback provided in classroom

supervision, with both technologies enabling real-time data analysis and facilitating quicker decision-making.

The Smart PLS analysis conducted to assess the relationship between AI/ML usage and accuracy/efficiency in supervision confirmed these findings. The analysis showed that AI usage had a significant positive impact on both the accuracy (Path coefficient = 0.45, t-value = 5.2, p-value < 0.01) and efficiency (Path coefficient = 0.38, t-value = 4.1, p-value < 0.01) of supervision. Similarly, ML usage also had a significant positive effect on accuracy (Path coefficient = 0.40, t-value = 4.8, p-value < 0.01) and efficiency (Path coefficient = 0.35, t-value = 3.9, p-value < 0.01) in the supervision process.

The R-squared values for both the accuracy and efficiency of supervision were found to be 0.58 and 0.52, respectively, indicating that AI and ML usage explain a significant portion of the variability in the outcomes. Specifically, 58% of the variance in accuracy of supervision and 52% of the variance in efficiency of supervision can be attributed to the use of these technologies. Furthermore, the effect size (f^2) values for both AI and ML indicated a medium effect on both accuracy and efficiency, with AI having slightly more influence. The effect size values of 0.12 for AI → Accuracy, 0.11 for AI → Efficiency, and 0.10 for ML → Accuracy, and 0.09 for ML → Efficiency, suggest that the impact of AI and ML, while significant, is of moderate strength.

In conclusion, the implementation of AI and ML tools in educational supervision has been shown to significantly improve both the accuracy and efficiency of supervision, supporting better decision-making, quicker identification of issues, and more personalized feedback for teachers and students. The findings indicate that these technologies are valuable assets in educational settings, enhancing the overall quality of supervision and helping to create a more data-driven, efficient, and adaptive learning environment.

In-depth interviews were conducted with key educational stakeholders, including supervisors, teachers, and administrators, to gather qualitative insights into the implementation of AI and ML in educational supervision. The primary objective was to explore their experiences with these technologies and understand how they perceived the impact on educational supervision. The interviews focused on several key areas: the effectiveness of AI and ML tools, the challenges faced during adoption, and the perceived benefits of these technologies. Supervisors reported that AI and ML allowed them to make more informed decisions quickly by providing real-time data, which was crucial in addressing issues before they escalated. Teachers, on the other hand, appreciated the immediate feedback they received, which helped them adjust their teaching strategies to better meet the needs of students.

One of the main advantages highlighted by both supervisors and teachers was the increased efficiency in the supervision process. Supervisors were able to access data on student performance, classroom activities, and teacher behavior more quickly, which allowed them to intervene in a timely manner. The ability to track student progress and identify potential issues before they became significant problems was another key benefit. Teachers noted that with AI tools, they could focus more on personalized instruction for students, as the technology helped them understand where each student needed additional support. This made their teaching process more effective and tailored to the unique needs of each student, improving the overall quality of education.

Despite the many benefits, there were also notable challenges related to the adoption of AI and ML technologies in the educational environment. One of the primary challenges mentioned was the initial resistance to change from some educators, particularly those who were not familiar with technology. Some teachers felt overwhelmed by the new tools and worried about their ability to use them effectively. This reluctance to embrace the technology often stemmed from a lack of training and support during the implementation phase. Supervisors acknowledged that while the technology could enhance the quality of supervision, it required a cultural shift in the way educators and administrators approached teaching and learning.

Training and professional development emerged as crucial factors for the successful implementation of AI and ML. Many respondents emphasized the need for comprehensive and ongoing training to ensure that teachers and supervisors could effectively utilize these technologies. Teachers mentioned that the initial training sessions provided basic knowledge, but more in-depth, hands-on training was necessary to maximize the full potential of AI and ML tools. Supervisors agreed, noting that regular workshops, follow-up sessions, and peer support networks would be essential to address the learning curve associated with these technologies. Providing adequate training resources and technical support would ensure that teachers and supervisors could use AI and ML tools efficiently and with confidence.

Classroom observations further supported the findings from the interviews, demonstrating that AI-based tools helped teachers and supervisors monitor classroom dynamics in real-time. Supervisors were able to observe how well students engaged with lessons, their participation levels, and how quickly they grasped new concepts. AI tools enabled teachers to assess students' understanding instantly, providing immediate insights into where interventions were needed. In some cases, teachers used AI to tailor lesson plans for individual students, which led to more personalized and effective teaching. This was particularly beneficial for students who were struggling or those who needed additional challenges, ensuring that every student's learning was optimized.

Finally, documentation such as performance evaluation records indicated that the introduction of AI and ML significantly impacted the quality of feedback given to teachers. AI-based systems were able to provide more frequent, data-driven feedback on teaching performance, which helped identify areas for improvement. Teachers received detailed reports on their teaching effectiveness, highlighting both strengths and areas that needed attention. Supervisors also noted that AI-generated feedback was more objective, as it was based on measurable data rather than subjective assessments. This allowed for clearer communication between teachers and supervisors, fostering a culture of continuous improvement and professional development.

In conclusion, the qualitative data gathered through interviews, observations, and documentation provided rich insights into the impact of AI and ML on educational supervision. Despite some initial challenges with adoption, the overall feedback from stakeholders was overwhelmingly positive. AI and ML have proven to be powerful tools in improving the accuracy, efficiency, and effectiveness of educational supervision, leading to better decision-making, more personalized teaching, and more targeted support for students. However, the success of these technologies hinges on providing adequate training, support, and ongoing professional development for educators and administrators to ensure their effective use.

Improvement in The Quality of Teacher Performance and Student Progress

The goal of this section was to measure how the implementation of AI and ML technologies improved the quality of teaching and learning outcomes. The survey aimed to capture educators' perceptions on the effectiveness of AI and ML in supporting teacher performance evaluation and enhancing student learning progress. Respondents were asked to evaluate how AI and ML influenced teacher performance assessments and student progress tracking. The survey data was collected from educational supervisors, teachers, and administrators. The questions focused on how AI and ML helped improve teacher performance evaluations, make student progress tracking more efficient, and provide personalized feedback for both teachers and students. These tools allowed for real-time tracking of student progress, leading to more precise assessments and enabling personalized interventions where needed.

Table 5. Survey Questions for Teacher Performance and Student Progress Improvement

No	Question
1	To what extent do you use AI-based tools for evaluating teacher performance?
2	How often do you rely on AI-generated insights to assess student progress?
3	How effective do you find AI tools in tracking student learning outcomes in real-time?
4	How has AI improved the way you monitor individual student progress?
5	To what extent do you use ML-based tools for predicting student learning outcomes?
6	How helpful do you find machine learning algorithms in identifying gaps in student performance?
7	Do you believe that ML-based tools help improve student engagement and motivation in learning?

The Smart PLS analysis was conducted to understand the relationship between AI/ML usage and the improvement in teacher performance and student progress. The analysis showed that AI and ML technologies significantly contributed to the personalization of teaching and learning by providing more accurate data and real-time insights into student progress. Teachers could identify struggling students more quickly, while supervisors could assess teaching effectiveness with greater precision.

Table 6. Path Coefficients

Path Relationship	Path Coefficient	t-value	p-value	Interpretation
AI Usage → Teacher Performance Improvement	0.42	4.5	< 0.01	Significant positive impact on teacher performance improvement.
ML Usage → Teacher Performance Improvement	0.38	4.0	< 0.01	Significant positive impact on teacher performance improvement.
AI Usage → Student Progress Improvement	0.43	4.6	< 0.01	Significant positive impact on student progress improvement.
ML Usage → Student Progress Improvement	0.37	3.8	< 0.01	Significant positive impact on student progress improvement.

Table 7. R-Square (R²)

Variable	R-Square	Interpretation
Teacher Performance Improvement	0.55	55% variance explained in teacher performance improvement.
Student Progress Improvement	0.60	60% variance explained in student progress improvement.

Table 8. Effect Size (F²)

Path Relationship	f ²	Effect Size
AI → Teacher Performance Improvement	0.13	Medium effect
ML → Teacher Performance Improvement	0.11	Medium effect
AI → Student Progress Improvement	0.14	Medium effect
ML → Student Progress Improvement	0.12	Medium effect

The study found that AI and ML technologies significantly improve both teacher performance and student progress by enabling data-driven insights and more personalized interventions. Survey respondents confirmed that AI and ML had a positive effect on the accuracy and speed of feedback, allowing for real-time adjustments to teaching strategies. Smart PLS analysis confirmed that both AI and ML usage had a medium effect on improving teacher performance (path coefficients of 0.42 and 0.38) and student progress (path coefficients of 0.43 and 0.37). The R-squared values indicated that the models explained a substantial portion of the variance in teacher performance (55%) and student progress (60%).

The findings highlight the significant role of AI and ML in fostering a personalized learning environment and improving the quality of education through enhanced teacher performance evaluation and more effective tracking of student progress. These results indicate that AI and ML are powerful tools that can transform educational practices and outcomes.

In-depth interviews were conducted with key educational stakeholders, including supervisors, teachers, and administrators, to gather qualitative insights into the implementation of AI and ML in educational supervision. The main goal was to understand how these technologies impacted teacher performance evaluations and student progress tracking, along with the challenges and benefits perceived by these stakeholders. The interviews focused on several key areas, including the effectiveness of AI and ML tools, the challenges faced during adoption, and the perceived benefits of these technologies. Supervisors highlighted that AI and ML allowed them to make more data-driven decisions quickly by providing real-time insights, which helped them identify potential problems before they escalated. Teachers, on the other hand, appreciated the immediate feedback that AI and ML tools provided, which helped them adjust their teaching strategies to better meet the needs of students.

One of the main benefits shared by both supervisors and teachers was the improved efficiency of the supervision process. Supervisors reported that AI and ML allowed them to access student performance data, classroom activities, and teacher behavior more quickly, enabling timely interventions. The ability to track student progress and identify potential issues before they became significant problems was another key benefit. Teachers noted that AI tools allowed them to focus more on personalized instruction, as the tools helped them identify where each student needed additional support. This capability made teaching more effective and tailored to the unique needs of each student, contributing to the improvement in overall education quality.

However, despite the many benefits, there were some challenges with the adoption of AI and ML in the educational environment. The most notable challenge was the initial resistance to change from some educators, particularly those who were not familiar with technology. Some teachers expressed concerns about their ability to effectively use the new tools, feeling overwhelmed by the complexity of the systems. This resistance stemmed from a lack of proper training and support during the implementation phase. Supervisors acknowledged that while AI and ML had the potential to enhance the quality of supervision, it required a cultural shift in how teachers and administrators approached teaching and learning.

Training and professional development emerged as crucial factors for the successful implementation of AI and ML in educational settings. Many respondents emphasized the need for comprehensive and ongoing training to ensure that teachers and supervisors could use these tools effectively. Teachers mentioned that while initial training sessions provided basic knowledge, more hands-on, in-depth training was necessary to maximize the potential of AI and ML tools. Supervisors agreed with this sentiment, emphasizing the importance of regular workshops, follow-up sessions, and peer support networks to address the learning curve associated with these technologies. Providing adequate technical support would ensure that educators and administrators could use AI and ML tools with confidence and effectiveness.

Classroom observations further validated the findings from the interviews, with evidence showing that AI-based tools helped both teachers and supervisors to monitor classroom dynamics in real-

time. Supervisors could observe how students were engaging with lessons, their participation levels, and how quickly they were grasping new concepts. AI tools enabled teachers to assess students' understanding instantly, providing immediate insights into areas where interventions were needed. In some cases, teachers used AI to tailor lesson plans for individual students, which resulted in more personalized and effective teaching. This approach was particularly beneficial for struggling students or those who needed additional challenges, ensuring that every student's learning experience was optimized.

Finally, documentation such as performance evaluation records revealed that the introduction of AI and ML significantly impacted the quality of feedback given to teachers. AI-based systems were able to provide more frequent, data-driven feedback on teaching performance, helping to identify areas for improvement. Teachers received detailed reports on their teaching effectiveness, highlighting both strengths and areas needing attention. Supervisors also noted that AI-generated feedback was more objective compared to traditional assessments, as it was based on measurable data rather than subjective opinions. This facilitated clearer communication between teachers and supervisors, promoting a culture of continuous improvement and professional development.

Based interviews, classroom observations, and performance documentation provided valuable insights into the impact of AI and ML on educational supervision. Despite some initial challenges related to adoption, the overall feedback from stakeholders was overwhelmingly positive. AI and ML have proven to be powerful tools in improving the accuracy, efficiency, and effectiveness of educational supervision, leading to better decision-making, more personalized teaching, and more targeted student support. However, the success of these technologies depends on providing adequate training, support, and ongoing professional development to educators and administrators, ensuring their effective use in enhancing educational outcomes.

So, AI and ML technologies have proven to be transformative tools in educational supervision, leading to improved teacher performance, more accurate student progress tracking, and enhanced teaching strategies. These technologies not only improved the quality of educational supervision, but also created a more adaptive, efficient, and responsive learning environment. However, their full potential can only be realized through adequate training, support, and ongoing professional development for educators and administrators.

Discussion

The findings of this study clearly highlight the transformative impact of AI and ML on improving educational supervision, particularly in enhancing the accuracy and efficiency of supervision processes. The results show that both AI and ML have significantly contributed to making educational supervision more effective by providing real-time data, enhancing decision-making, and offering precise insights into student progress and teacher performance. These findings are consistent with previous studies, such as those by Sukma & Pahrudin (2024) and Sa'duh et al. (2024), which emphasize the role of AI in improving quality management and supervision in educational settings. The ability of AI and ML tools to provide real-time data analysis supports faster identification of problems, leading to quicker interventions. Moreover, the medium effect sizes for AI and ML usage in both accuracy and efficiency (f^2 values of 0.12 and 0.11 for AI, and 0.10 and 0.09 for ML) indicate that these technologies have a moderate but meaningful impact on improving educational outcomes.

Further reinforcing the importance of AI and ML in education, Setyo et al. (2021) also observed how the application of these technologies significantly enhanced the quality of educational management. This study, like the current one, found that the use of AI tools allowed supervisors to provide more timely feedback, which improved teaching methods and addressed emerging issues before they escalated. The shift from traditional methods of supervision, which often involve subjective assessments and delayed feedback, to a more objective, data-driven approach facilitated by AI and ML, directly contributes to the efficiency and effectiveness of educational supervision (Tanjung et al., 2022). This finding aligns with the

assertions of Juran (1992), who argued that quality management is dependent on the use of systematic, data-driven processes, which AI and ML technologies significantly support.

In addition to improving supervisory functions, this study's findings also support the notion that AI and ML technologies can improve the overall quality of education by enhancing the personalization of teaching and learning. As shown in the qualitative data, supervisors and teachers highlighted the advantage of being able to focus more on personalized teaching strategies. This observation is supported by Ristianah & Ma'sum (2022), who discussed the benefits of personalized learning enabled by technology, which allows educators to cater to the unique needs of each student. This capability, as highlighted in the current study, not only improves the effectiveness of teaching but also contributes to better student engagement and motivation, a theme echoed by Nur & Junaris (2023), who emphasized the role of AI in boosting student success.

However, while AI and ML present clear benefits, the study also pointed out significant challenges related to the adoption of these technologies, particularly resistance from some educators due to unfamiliarity with the technology. This challenge is consistent with Sa'duh et al. (2024), who observed that the integration of digital tools in education requires not only technological adoption but also a cultural shift in the way educators and administrators approach teaching and learning. Training and professional development emerged as crucial for the successful implementation of AI and ML, as supported by Sanusi et al. (2023) and others, who highlighted the need for continuous training to ensure educators' confidence and competence in using these advanced tools effectively.

Finally, the study's results confirm that AI and ML technologies can transform educational practices by making supervision more adaptive and responsive. This shift aligns with the work of Guleria & Sood (2023), who suggested that AI's ability to adapt to changing educational needs ensures that education systems remain relevant and efficient. AI-based feedback systems also offer more objective evaluations, which enhance the transparency and reliability of performance assessments. Overall, this study supports the integration of AI and ML into educational systems to improve both supervisory practices and educational outcomes, but highlights the critical need for continuous professional development and support for educators to maximize the full potential of these technologies.

CONCLUSION

The integration of AI and ML technologies into educational supervision has demonstrated significant improvements in both the accuracy and efficiency of teacher performance evaluation and student progress tracking. The findings from this research indicate that AI and ML tools enable real-time data analysis, more personalized teaching, and quicker decision-making, ultimately leading to better outcomes for both educators and students. Smart PLS analysis confirmed the significant positive effects of these technologies, with AI and ML having medium-sized effects on improving accuracy and efficiency. The R-squared values showed that these tools explain a substantial portion of the variance in the improvement of educational supervision outcomes, particularly in monitoring teacher performance and tracking student progress.

However, while the implementation of AI and ML tools has proven to be effective, challenges remain, especially in the adoption phase. Resistance to change, lack of sufficient training, and unfamiliarity with the technology were notable barriers identified by respondents. Despite these challenges, the overall feedback from stakeholders was overwhelmingly positive, highlighting that with proper training, support, and professional development, AI and ML can significantly enhance the quality of educational supervision. Therefore, to fully realize the potential of these technologies, educational institutions must prioritize continuous training and provide adequate resources to ensure that these tools are used effectively. The success of AI and ML integration hinges on the commitment to professional development for both educators and administrators, facilitating a responsive, adaptive, and data-driven learning environment.

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