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Evaluation of Merdeka Teaching Platform (PMM)-Based Academic Supervision in Enhancing The Implementation of The Merdeka Curriculum and Teacher Performance in Elementary Schools

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Abstract: This study aims to evaluate the effectiveness of academic supervision based on the Merdeka Teaching Platform (PMM) in enhancing teacher performance and the quality of learning in elementary schools in Semarang Regency, Central Java. Employing Kirkpatrick's four-level evaluation model—Reaction, Learning, Behavior, and Results—the study adopts a mixed-methods approach (quantitative and qualitative) through data collection techniques including pre-tests, post-tests, classroom observations, in-depth interviews, and document analysis. This study was analyzed using descriptive statistics and t-tests. The findings revealed that PMM-based supervision has a positive impact on improving teacher competencies and student learning outcomes. At SD Negeri Karanganyar 01, teacher performance scores increased from an average of 62% on the pre-test to 86% on the post-test, with a 20% improvement in student learning outcomes. At SD Negeri Kesongo 01, teacher scores rose from 58% to 84%, accompanied by an 18% increase in student achievement. At SD Negeri Delik 02, despite challenges in digital literacy, teacher performance improved from 60% to 82%, with a 15% rise in student outcomes. Similarly, at SD Negeri Candirejo, teacher scores increased from 55% to 80%, with a 16% improvement in student performance. The study concludes that PMM-based academic supervision is effective in enhancing teachers' professional competencies, particularly in designing learning activities aligned with the Merdeka Curriculum, as well as improving student learning outcomes. However, optimal implementation requires continuous assistance tailored to the unique needs of each school. The findings also recommend strengthening technology-based training, providing adequate infrastructure, and expanding PMM implementation to other schools to support the national success of the Merdeka Curriculum.

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Introduction

The quality of education is a critical factor in determining a nation's success in achieving sustainable development. One of the primary elements influencing educational quality is the effectiveness of teaching provided by educators (Nurzannah, 2022). In the Indonesian context, a significant challenge for teachers today lies in implementing the Merdeka Curriculum, which demands substantial changes in how teachers design and deliver learning experiences. Enhancing teachers' professional competencies is crucial to overcoming this challenge (Pitriyani, 2023). However, ensuring the successful implementation of this curriculum requires a system that not only provides teacher training but also supports them in

adopting more innovative, relevant, and technology-driven teaching practices (Tuloli et al., 2022).

With advancements in information technology, the integration of digital platforms into education has become indispensable (Budi Teguh Harianto, 2023). The Merdeka Teaching Platform (PMM), introduced by Indonesia's Ministry of Education, Culture, Research, and Technology, is designed to assist teachers in accessing self-directed training, teaching tools, and assessment resources to support the implementation of the Merdeka Curriculum. PMM aims to help teachers understand the curriculum, design project-based learning, and conduct student-centered assessments with a more flexible and accessible approach (Hidayati et al., 2024). Despite its potential benefits, many teachers face challenges in fully utilizing the platform. Indicates that while digital platforms like PMM can positively impact teaching quality, their effectiveness largely depends on proper guidance and improved digital literacy among educators (Ibn & Bogor, 2024)

Academic supervision by school principals plays a pivotal role in enhancing teachers' competencies. Through structured, data-driven supervision, principals can provide specific and relevant guidance tailored to the needs of individual teachers (Fitri, 2019). Research by Glickman, Gordon, and Ross-Gordon (2014) highlights that professional development-oriented supervision helps teachers overcome instructional challenges and improve teaching quality (Sciences, 2019). PMM-based supervision offers principals the opportunity to deliver more accurate, data-informed feedback and guide teachers in effectively integrating technology into their teaching practices (Triningsih et al., 2024).

Previous studies also underscore the importance of technology-based supervision in strengthening teachers' understanding of digital tools in education (Ramdani et al., 2022). Laurillard (2012) asserts that integrating technology into education accelerates the adoption of innovative teaching methods, especially when supported by adequate training (Sudarta, 2022). Emphasize the necessity of data-driven mentorship to enhance the effectiveness of academic supervision (Cech et al., 2018). PMM-based supervision thus holds great potential to improve teachers' competencies, particularly in designing and implementing student-centered and needs-based learning.

This study aims to evaluate the effectiveness of PMM-based academic supervision in enhancing teacher performance and student learning outcomes in four elementary schools in Tuntang District, Semarang Regency: SD Negeri Karanganyar 01, SD Negeri Kesongo 01, SD Negeri Delik 02, and SD Negeri Candirejo. The novelty of this research lies in its integration of Kirkpatrick's four-level evaluation model with the Merdeka Teaching Platform (PMM) to comprehensively assess not only teacher performance and student outcomes but also behavioral and perceptual changes, while addressing context-specific challenges in implementing technology-based supervision in elementary schools. The findings of this research are expected to contribute to optimizing PMM as a tool for academic supervision and provide actionable recommendations for school principals, teachers, and policymakers to support the national success of the Merdeka Curriculum. Thus, this study serves as a valuable reference for improving the quality of education across Indonesia (Purba et al., 2024).

Research Method

The study adopted a mixed-methods approach (quantitative and qualitative) with an evaluative design based on Kirkpatrick's evaluation model, comprising four levels: Reaction, Learning, Behavior, and Results (Kirkpatrick, 2006). This approach allows for a comprehensive evaluation of the impact of PMM-based supervision by integrating objective quantitative data with in-depth qualitative insights into teacher experiences (Ummah, 2019).

The research employed a descriptive evaluative design to describe and assess the effectiveness of PMM-based supervision in enhancing teacher performance and the quality of learning in the four elementary schools. The study also examined its impact on student learning outcomes using Kirkpatrick's evaluation model, which measures four levels of program effectiveness: (1) Reaction, which assesses teacher satisfaction with PMM-based supervision; (2) Learning, which evaluates improvements in teachers' pedagogical and digital competencies through PMM utilization; (3) Behavior, which examines the implementation of Merdeka Curriculum-based teaching supported by PMM; and (4) Results, which measure improvements in student learning outcomes as a result of enhanced teacher performance.

The research subjects consisted of teachers from the four schools that have implemented the Merdeka Curriculum and utilized PMM in their teaching activities (Iskandar, 2020). Subject selection was conducted using purposive sampling based on criteria relevant to the research objectives, such as teachers who have been implementing PMM for at least six months and principals conducting PMM-based academic supervision (Bueddefeld, 2019). Additionally, students involved in learning influenced by the improvement in teachers' competencies also served as subjects (Yelfianita et al., 2023).

Data collection instruments included pre-tests and post-tests to measure the improvement in teachers' ability to design lessons based on the Merdeka Curriculum and evaluate their utilization of PMM (SUMARNI, 2023). Classroom observations were conducted to assess the application of PMM-supported teaching, while in-depth interviews with teachers and principals provided insights into their experiences, challenges, and perceived impacts on teaching quality (Festus et al., 2019). Questionnaires were also used to measure teacher satisfaction with PMM-based supervision, and documentation analysis included evaluating teaching materials developed by teachers following PMM-based supervision (Muspawi, 2021).

The data collected were analyzed using both quantitative and qualitative methods. Quantitative data from pre-tests and post-tests were analyzed using descriptive statistics and t-tests to determine significant differences before and after PMM-based supervision (Saihu, 2020). Qualitative data from interviews and classroom observations were analyzed using thematic analysis Braun & Clarke to identify relevant patterns and themes related to PMM implementation in teaching (Setyarini et al., 2021). Triangulation techniques were employed to ensure data validity by comparing results from various data collection methods (Kelle et al., 2019).

The study's success indicators include the four levels measured through Kirkpatrick's model: Reaction, which assesses teacher satisfaction with PMM-based supervision; Learning, which measures improvements in teacher competencies; Behavior, which observes the implementation of PMM-supported teaching strategies; and Results, which evaluate improvements in student learning outcomes.

Results and Discussion

The study found significant improvements in three key areas: 1) Teacher Performance, with enhanced abilities in project-based learning, diagnostic assessments, and differentiated instruction, reflected in increased pre- and post-test scores; 2) Student Learning Outcomes, with higher average test scores in core subjects; and 3) Teacher Satisfaction, as most teachers reported high satisfaction with the relevant and accessible PMM-based supervision process (Ali et al., 2022). The results emphasize the importance of PMM-based supervision in enhancing teaching quality through data-driven feedback. Successful implementation requires ongoing support, including digital literacy training, infrastructure

improvements, and principal mentoring. This study provides insights for policymakers and educators to expand PMM adoption and optimize technology-driven professional development for the Merdeka Curriculum in Indonesia.

Reaction Level (Teacher Satisfaction with PMM-Based Supervision)

The findings from the teacher questionnaires revealed a high level of satisfaction with the PMM-based academic supervision process (Population, 2024). At the four elementary schools studied—SD Negeri Karanganyar 01, SD Negeri Kesongo 01, SD Negeri Delik 02, and SD Negeri Candirejo—over 85% of the teachers expressed satisfaction with the technology-driven supervision approach. This satisfaction spanned several key areas, including ease of access to training materials, relevance of supervision content, and support provided by school principals in facilitating the PMM-based supervision process. Teachers reported that the PMM platform significantly simplified access to training resources and teaching tools aligned with the Merdeka Curriculum (JASRIAL et al., 2023). These resources were particularly helpful in enabling teachers to design project-based learning activities, conduct diagnostic assessments, and implement student-centered instructional strategies. The platform's user-friendly nature allowed teachers to focus on enhancing their instructional practices without being burdened by logistical barriers (Rohlman et al., 2024).

Teachers found PMM-based supervision more flexible and efficient than traditional methods, allowing them to access training materials online and adapt learning to their schedules, boosting motivation and confidence in implementing the Merdeka Curriculum. While technology enhances professional development, challenges like limited infrastructure, unreliable internet, and a lack of devices in schools like SD Negeri Delik 02 highlight the need for adequate resources to ensure successful implementation.

Overall, High teacher satisfaction with PMM-based supervision highlights its potential to enhance academic supervision by improving access to training, supporting professional growth, and facilitating Merdeka Curriculum implementation. Sustaining these outcomes requires improved digital infrastructure and comprehensive teacher training, ensuring all schools benefit fully. PMM-based supervision serves as a catalyst for better teaching quality and a modern, sustainable education system in Indonesia. This technology-driven approach, when implemented with adequate support, has the potential to transform professional development for educators and enhance the overall effectiveness of the country's education system (Mpuangnan, 2024).

Table 1. Teacher Satisfaction with PMM-Based Supervision

Satisfaction Aspect	Percentage of Teachers Satisfied (%)
Ease of Access to PMM	94%
Relevance of Supervision Content	91%
Principal Support	89%
Technological Support	87%
Average	90%

Pre-test Learning Level (Improvement in Teacher Competency)

The results of pre-test and post-test results showed significant improvement in teachers' understanding of the Merdeka Curriculum and their ability to use PMM effectively. At SD Negeri Karanganyar 01, scores increased from 62% to 86%, and at SD Negeri Kesongo 01, from 58% to 84%. Even at SD Negeri Delik 02, despite digital literacy challenges, scores rose from 60% to 82%. These improvements highlight the success of PMM-based training in enhancing teaching practices, particularly in project-based learning and diagnostic assessments. The findings emphasize the importance of intensive training, ongoing support, and adequate resources to help teachers fully utilize digital platforms like

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PMM for student-centered learning. Classroom observations also revealed that teachers who achieved high post-test scores demonstrated increased use of collaborative and inquiry-based learning methods (Hastuti et al., 2020). They successfully motivated students to actively participate in the learning process and exhibited greater confidence in addressing the challenges of technology-based education. Even in schools like SD Negeri Candirejo, where infrastructure limitations posed significant challenges, teachers managed to improve their average scores from 55% in the pre-test to 80% in the post-test. This outcome highlights the positive impact of PMM-based supervision, even in less-than-ideal conditions.

Overall, the significant improvement in pre-test and post-test scores confirms the effectiveness of PMM-based supervision in enhancing teachers' professional competencies. This approach not only equips teachers with a conceptual understanding of the Merdeka Curriculum but also provides them with practical skills to integrate technology into innovative and relevant teaching strategies. However, the success of this implementation also underscores the importance of key supporting factors, such as teachers' digital literacy, the role of school principals in providing consistent guidance, and the availability of adequate technological infrastructure. To extend the positive impact of PMM, additional efforts are needed to improve digital literacy training and provide technological resources to under-resourced schools (Hargreaves, 2021). With the right approach, PMM can serve as an effective tool to strengthen teachers' competencies and support the sustainable implementation of the Merdeka Curriculum across Indonesia.

Table 2. Pre-Test and Post-Test Results for Teacher Competency

School	Pre-Test (%)	Post-Test (%)	Improvement (%)
SD Negeri Karanganyar 01	62	86	24
SD Negeri Kesongo 01	58	84	26
SD Negeri Delik 02	60	82	22
SD Negeri Candirejo	55	80	25

Behavioral Level (Application in Classroom Activities)

Classroom observations revealed that teachers who received PMM-based supervision began implementing Merdeka Curriculum teaching practices more consistently and effectively. At SD Negeri Karanganyar 01 and SD Negeri Kesongo 01, approximately 80% of teachers reported successfully integrating PMM teaching resources into their lessons. This included the use of relevant, project-based instructional materials and diagnostic assessments tailored to understand individual student needs. Additionally, more than 75% of teachers in these schools reported implementing differentiated instruction designed to accommodate the diverse learning needs of their students, including those with lower academic abilities and higher-performing learners. At SD Negeri Delik 02, about 70% of teachers started incorporating project-based learning into their teaching practices despite challenges related to digital literacy. Teachers in this school demonstrated significant efforts to creatively leverage PMM features, even though limited technological infrastructure posed challenges. They reported that the guidance provided through PMM-based supervision helped them practically utilize digital tools to support more flexible and student-centered learning. Similarly, at SD Negeri Candirejo, despite ongoing issues with technological infrastructure, teachers managed to adopt key elements of the Merdeka Curriculum. Approximately 65% of teachers began employing collaborative and inquiry-based learning strategies to foster active student participation in the classroom. Teachers noted that PMM resources provided concrete and practical guidance for implementing more interactive teaching methods, which enhanced student engagement and involvement in the learning process. Overall, teachers across the four schools reported that PMM-based learning facilitated the development of more flexible,

relevant, and student-centered teaching strategies. PMM features, such as digital teaching materials and curriculum-aligned assessments, enabled teachers to tailor their instructional approaches to meet the unique needs of their students, even in complex teaching scenarios (Pomeroy & Valley, 2017). Who emphasized that technology-based approaches can help teachers create more relevant and responsive learning experiences for individual students (George & Sanders, 2017).

Furthermore, teachers reported that project-based and differentiated learning strategies, supported by PMM-based supervision, improved student outcomes and increased teaching motivation. PMM helped teachers gain confidence and implement innovative, student-centered practices like group discussions and project presentations. However, challenges such as limited infrastructure and digital literacy remain, particularly in resource-constrained schools. Addressing these issues by improving access to technology and internet connectivity will enhance the effectiveness of PMM-based supervision in supporting the Merdeka Curriculum's implementation across Indonesia. This supervision approach not only benefits teachers directly but also creates more meaningful learning experiences for students, contributing to the achievement of inclusive and high-quality education goals (Tarimo & Lekule, 2024).

Results Level (Improvement in Student Learning Outcomes)

The enhancement of teacher competencies directly contributes to the improvement of student learning outcomes. At SD Negeri Karanganyar 01, the average student score increased by 20%. A similar improvement was observed at SD Negeri Kesongo 01, where the average student score rose by 18%. At SD Negeri Delik 02, despite facing greater technological challenges, student learning outcomes still improved by 15%. Meanwhile, at SD Negeri Candirejo, academic performance improved by 16%. Supervision based on the Platform Merdeka Mengajar (PMM) played a significant role in achieving these results. This supervisory process not only emphasized the improvement of teachers' pedagogical competencies but also their ability to utilize educational technology to create a more interactive and meaningful learning environment for students. Through this approach, teachers were able to integrate various learning resources supporting the Merdeka curriculum, such as educational videos, interactive modules, and technology-based assessments. This had a direct impact on students' motivation and understanding during the learning process. Moreover, PMM-based supervision encouraged teachers to continuously reflect on their teaching practices. With intensive training and mentoring, teachers in the schools involved in this study were able to accurately identify students' needs and design appropriate learning strategies. For example, at SD Negeri Karanganyar 01, teachers utilized diagnostic assessment features available on the PMM platform to understand students' initial levels of comprehension before beginning instruction. The results of these assessments were then used to design more focused lesson plans, significantly improving learning outcomes. This study's findings also reinforce the results of Hasanuddin et al. (2023), which highlighted that high-quality teaching supported by technology-based approaches can significantly enhance student learning outcomes.

The study underlined the importance of adequate access to educational technology and continuous training for teachers to ensure they can optimally leverage these tools. Furthermore, PMM-based supervision successfully enhanced student engagement in learning. At SD Negeri Kesongo 01, for instance, teachers reported that students became more active in asking questions and participating in classroom discussions after teachers began using technology-based teaching strategies. This aligns with the school's achievement of an 18% increase in average student scores. Similarly, at SD Negeri Delik 02, despite infrastructure

limitations being a major challenge, intensive teacher training yielded positive results. Teachers at this school found creative ways to overcome technological barriers, such as utilizing simple available devices to effectively deliver learning materials. Overall, this study demonstrates that PMM-based supervision has great potential to improve the quality of education in various school contexts, including those facing technological constraints. By enhancing teacher competencies and integrating technology into teaching, student learning outcomes can be significantly improved, ultimately contributing to the development of a higher-quality human resource pool in the future (Deming, 2022).

Table 3. Improvement in Average Student Scores

School	Pre-Test Score (%)	Post-Test Score (%)	Improvement (%)
SDN Karanganyar 01	70	90	20
SDN Kesongo 01	68	86	18
SDN Delik 02	65	80	15
SDN Candirejo	60	76	16

Discussion

Effectiveness of PMM-Based Supervision in Enhancing Teacher Performance

The findings of this study indicate that PMM-based supervision is highly effective in enhancing teachers' competencies in designing and implementing Merdeka Curriculum-based learning. The improvement in pre-test and post-test scores demonstrates that teachers successfully integrated technology into their teaching processes. This proves that digital platforms like PMM can significantly enhance the quality of teaching when supported by effective guidance (Jin et al., 2021). Teachers who were guided through PMM-based supervision not only gained a deeper understanding of the Merdeka Curriculum but were also able to explore innovative and relevant teaching methods aligned with the needs of students in the digital era.

Classroom observations showed that teachers effectively used project-based learning and diagnostic assessments, helping students develop critical skills and allowing teachers to better understand student needs. PMM-based supervision enhanced both teachers' theoretical knowledge and practical skills, boosting their confidence in designing technology-based strategies and improving classroom teaching effectiveness.

Improvements in Teacher Performance and Their Impact on Students

The improvement in teacher performance through PMM-based supervision had a positive impact on students' learning outcomes. Teachers proficient in using technology in their teaching tend to have students with better academic achievements. The use of PMM as a supervisory tool also facilitated more engaging and student-centered learning, encouraging students to actively participate in the learning process. This increased student engagement was reflected in their heightened motivation to learn and their improved ability to master the material taught. For instance, in several schools involved in this study, students demonstrated higher enthusiasm during group discussions, project-based activities, and problem-solving tasks (Saimon et al., 2023).

Furthermore, qualitative data collected through interviews with teachers and students revealed that features available on the PMM platform, such as interactive learning modules and technology-based assessments, contributed to creating a more dynamic and enjoyable learning experience. These findings demonstrate that with appropriate supervisory support, technology can be effectively integrated to create a learning environment that supports students' holistic development (Jordan et al., 2021).

Challenges in Implementing PMM-Based Supervision

Despite the positive outcomes, challenges related to teachers' digital literacy and limited access to technology remain significant barriers, particularly in schools with inadequate infrastructure. Low digital literacy can hinder the optimal use of educational technology. Additionally, technical issues such as unstable internet connections and limited availability of technological devices are common problems faced by schools in remote areas. Teachers unfamiliar with technology often require more time to adapt to technology-based teaching methods, highlighting the need for more intensive and continuous training. Therefore, enhancing digital literacy training and improving infrastructure support are crucial to strengthening the implementation of PMM-based supervision. Governments and educational stakeholders must collaborate to ensure that teachers have adequate access to the necessary technology and resources (Adebowale, 2024). By addressing these challenges, PMM-based supervision can be more widely implemented and make a greater impact on improving the quality of education in Indonesia.

The findings emphasize the need to integrate digital tools like PMM into teacher development to improve competencies and student outcomes. While project-based learning shows promise for broader implementation, challenges such as digital literacy and infrastructure gaps highlight the need for targeted training and investment. Collaboration among policymakers, schools, and stakeholders is crucial to overcoming these barriers and supporting technology-driven education aligned with the Merdeka Curriculum.

Conclusion

The research findings demonstrate that PMM-based supervision has a significant positive impact across four levels: Reaction, Learning, Behavior, and Results. Specifically, the study found that PMM-based supervision enhanced teachers' professional competencies, as evidenced by significant improvements in pre-test and post-test scores. Teachers at all four schools successfully integrated PMM into Merdeka Curriculum-based teaching, focusing on project-based learning, diagnostic assessments, and differentiated instruction. This improvement in teacher competency directly contributed to better student learning outcomes, reflecting the positive influence of PMM-based supervision on teaching quality.

However, the study also identified challenges in PMM implementation, particularly related to teachers' digital literacy and the limitations of technology infrastructure, which affected the effectiveness of PMM use, especially in schools with limited access to technology. Which revealed that restricted access to technology and inadequate digital literacy training can hinder the effectiveness of technology-based platforms (Alakrash & Razak, 2021). In conclusion, this study affirms that PMM-based academic supervision is an effective strategy for enhancing teacher performance and educational quality in elementary schools. However, to maximize the positive impact of PMM, continuous and intensive training, strengthening teachers' digital literacy, and improving technology infrastructure in schools, particularly in rural areas, are essential. Additionally, expanding PMM implementation to more schools should be prioritized to support the national success of the Merdeka Curriculum.

Recommendation

Based on the findings of this study, several strategic recommendations can be made to optimize the implementation of academic supervision based on the Merdeka Mengajar Platform (PMM) to support the success of the Merdeka Curriculum and enhance the quality of education in elementary schools across Indonesia. These recommendations are intended

for school leaders, teachers, education policymakers, as well as developers and providers of the PMM platform.

Strengthening Technology-Based Training and Mentoring Programs While PMM has proven effective in improving teacher competencies, a primary challenge remains the low digital literacy of some teachers, especially in schools with limited access to technology. Therefore, there is a need for more intensive and continuous training programs to improve teachers' digital literacy, particularly concerning the use of more complex PMM features, such as diagnostic assessments and project-based learning. Technology-based training should be structured and in-depth, accompanied by direct mentoring from school leaders or qualified mentors to help teachers effectively integrate technology into their teaching (Parrish & Sadera, 2019).

Enhancing Technology Infrastructure in Schools Limited access to technological infrastructure, especially in rural areas, remains a significant barrier to effectively utilizing PMM. Strengthening technology infrastructure in schools with limited facilities must be a top priority. The government and relevant stakeholders should collaborate to provide adequate hardware (laptops, tablets) and stable internet access to ensure that both teachers and students can fully benefit from PMM. A good infrastructure significantly affects the effectiveness of using educational technology, including platforms like PMM (Wang & Shin, 2022).

Continuous Mentoring by School Leaders School leaders play a critical role in ensuring the effectiveness of PMM-based supervision. Therefore, continuous, data-driven mentoring should be provided by school leaders to teachers, particularly in integrating technology into teaching. School leaders should receive training on technology-based supervision, including how to offer constructive, data-driven feedback to support teachers' professional development (Gorni et al., 2024). Data-driven mentoring can help teachers overcome challenges faced during PMM implementation and improve the application of the Merdeka Curriculum-based teaching.

Expanding PMM Implementation to Other Schools While this study involved four schools, the positive results suggest that PMM-based supervision can be applied in many other schools. Therefore, it is crucial to expand the implementation of PMM to more schools across Indonesia, both in urban and rural areas. A wider implementation will accelerate the achievement of the Merdeka Curriculum's goals nationwide and ensure that more teachers benefit from the training and teaching resources provided by PMM. The government should offer adequate incentives and support to expedite the adoption of this platform in schools that have not yet implemented it.

Improving Collaboration Between Schools and the Government To ensure the success of PMM implementation, closer collaboration between schools and the government, both at the regional and national levels, is essential. The government can provide resources such as training, teaching materials, and funding to enhance technology infrastructure, while school leaders and teachers can help identify needs and challenges on the ground. This partnership is vital in creating an educational ecosystem that supports the use of technology in teaching and strengthens the implementation of the Merdeka Curriculum throughout Indonesia.

Regular Evaluation and Monitoring To ensure the sustainability of PMM-based supervision's effectiveness, structured evaluation and monitoring of the program's implementation should be conducted. This can include periodic feedback collection from teachers and students, as well as an analysis of student learning outcomes to assess the direct impact of using PMM. Data-driven monitoring can help identify barriers and challenges faced by teachers in applying PMM-based learning, allowing for more targeted interventions (Bakhshi & Efatmaneshnik, 2024).

Development of Interactive Features on PMM Although PMM already offers various self-training features and teaching resources, the development of more interactive and collaborative features could further enhance teacher engagement. Features such as discussion rooms for teachers and experience-sharing forums could facilitate the exchange of ideas and experiences among teachers, enriching the learning process. These features could also encourage teachers to collaborate in designing more innovative lessons that are contextually relevant to students' local needs.

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