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Empowering Early Childhood Teachers through the Merdeka Mengajar Platform: Opportunities and Challenges in the Digital Era

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Abstract: The study aimed to analyze the utilization of the Merdeka Mengajar Platform (PMM) among Early Childhood Education (ECE) teachers in Semarang City and to identify factors influencing its adoption. A mixed-methods approach with a sequential explanatory design was employed, combining a quantitative survey of 100 teachers and qualitative interviews with 10 selected participants. Quantitative data were analyzed using descriptive and regression analyses, while qualitative data were examined through thematic analysis to explore teachers' experiences in depth. The results showed that PMM utilization was at a moderate-high level, with teachers primarily using the platform for accessing teaching resources and curriculum development. Regression analysis indicated that digital literacy ($\beta = 0.45$, $p < 0.001$) and infrastructure support ($\beta = 0.32$, $p = 0.003$) significantly influenced PMM utilization, explaining 52% of the variance. Qualitative findings revealed three dominant themes: empowerment through PMM, barriers to optimal use, and the need for continuous institutional support. The study concludes that effective PMM adoption requires not only technological readiness but also sustained digital mentoring and institutional facilitation. These findings contribute to strengthening teacher professionalism and digital competence within the framework of Indonesia's Merdeka Curriculum

Keywords: Digital literacy; Early childhood teachers; Educational infrastructure; Merdeka mengajar platform; Professional development

Introduction

The transformation of education in the Society 5.0 era has redefined learning paradigms across the world. Digital technology is no longer merely a supplementary tool but an integral part of modern education systems oriented toward collaborative, creative, and sustainable learning (Hasanudin et al., 2025; Sari, 2024). Teachers, as primary agents of change, are required to adapt to technological innovations to enhance instructional quality. The shift in roles positions teachers not only as transmitters of knowledge but also as facilitators and innovators who create meaningful learning experiences for students (Aditomo, 2023; Mulyani et al., 2024)

Indonesia's current educational policy focuses on implementing the Merdeka Curriculum, which emphasizes competency-based learning and teacher autonomy. The government, through the Ministry of Education, Culture, Research, and Technology, launched the Merdeka Mengajar Platform (PMM) as a digital medium to support teachers in accessing learning materials, participating in self-paced training, and documenting professional achievements (Kartika, 2024). PMM is expected to become a professional learning ecosystem that enables teachers to adapt to digital

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education dynamics and cultivate reflective practices in teaching (Hijriani et al., 2024).

Early Childhood Education (ECE) teachers hold a strategic role in shaping children's character, attitudes, and foundational abilities. Previous studies indicate that PMM utilization among ECE teachers remains relatively low compared with other education levels (Negara, 2024). Major barriers include limited digital literacy, insufficient technical training, and infrastructural challenges such as unstable internet access and inadequate devices (Alghifari, 2025; Safitri, 2024). These limitations hinder the optimal use of PMM for professional development, even though the platform has great potential to improve teacher quality and professionalism (Hasanudin et al., 2025).

The theoretical foundation of this study refers to Rogers (2003) Diffusion of Innovation theory, which explains that technology adoption is influenced by individual characteristics, environmental factors, and systemic support. Within the educational context, successful adoption of innovation depends largely on teacher readiness and institutional support (Astuti & Nugroho, 2022). The study also employs the Technological Pedagogical Content Knowledge (TPACK) framework by Mishra and Koehler (2006), which emphasizes the integration of technological, pedagogical, and content knowledge as the foundation for effective digital instruction (Rowsell, 2025).

Several empirical studies support the relevance of these theoretical perspectives. Mulyani et al. (2024) found that PMM effectively enhances teachers' professional competence through self-directed training. Hijriani et al. (2024) and Kartika (2024) reported that PMM use fosters teacher reflection and pedagogical innovation. Negara (2024) and Safitri (2024) confirmed that infrastructural barriers and low digital competence remain major obstacles to platform utilization. The diversity of these findings suggests that PMM adoption is context-dependent and strongly influenced by institutional conditions and teacher readiness.

Recent studies further enrich this body of evidence by emphasizing the multifaceted impact of PMM on teacher professional growth and digital transformation in Indonesia. Supardi et al. (2024), demonstrated that PMM enhances pedagogical and professional competence through flexible, self-paced learning modules and online collaboration. Similarly, Makkiyah et al. (2024) found that PMM drives instructional innovation despite persistent infrastructural and digital literacy challenges. Empirical evidence from Riansyah et al. (2025) revealed overwhelmingly positive teacher sentiment toward PMM, although technical issues continue to hinder seamless adoption. The importance of leadership and institutional support is also underscored by Kustomo (2025) and Rahayu (2024), who observed that principal management and supervision via PMM significantly improve teacher performance and accountability. From a technological acceptance perspective, Aminah et al. (2024) and Syafruddin et al. (2025) confirmed that perceived ease of use and behavioral intention strongly predict teachers' engagement with PMM, aligning with the UTAUT framework. Moreover, Agustin et al. (2024) highlighted the platform's role in strengthening teacher learning communities, fostering collaboration and peer-driven reflection. However, Haeri et al. (2024) cautioned that excessive digital workloads and hierarchical communication patterns can limit teachers' intrinsic motivation to engage meaningfully with the platform. Collectively, these findings suggest that while PMM represents a promising vehicle for educational innovation and professional learning, its success remains contingent on robust institutional support, equitable infrastructure, and sustained capacity building.

The practical urgency of this study lies in strengthening ECE teachers' capacity to utilize PMM effectively as a sustainable platform for professional growth. Enhancing teachers' digital competence is crucial for ensuring the success of the Merdeka Curriculum, which emphasizes creativity, autonomy, and innovation in learning (Hasanudin et al., 2025; Ristianni et al., 2024) Technological readiness without sufficient human capacity may hinder the expected progress of educational digital transformation.

The phenomenon in the field shows that most ECE teachers are familiar with PMM but have not yet integrated it regularly into professional learning activities. Many teachers report a lack of confidence in using technology, while others face technical and institutional challenges (Negara, 2024). The effectiveness of digital education transformation depends on the balance between technological availability, teacher competence, and institutional culture that promotes innovation (Astuti & Nugroho, 2022). This study aims to analyze the level of PMM utilization among ECE teachers in Semarang City and to identify the influence of digital literacy and infrastructure support on its implementation. The findings are expected to contribute theoretically to strengthening teacher professionalism in the digital era and practically to informing policy improvements for digital training, infrastructure development, and institutional readiness in supporting sustainable educational innovation.

Method

Research Method

The research was conducted in Semarang City, Central Java, Indonesia, where the implementation of

the Merdeka Curriculum has been gradually introduced to early childhood education institutions. Data collection took place from March to July 2024, covering the academic semester in which teachers actively utilized the Merdeka Mengajar Platform (PMM) as part of their professional development activities. The city was selected as the research site due to its diverse early childhood education institutions and varying levels of digital literacy among teachers, which provided a representative context for this study.

This study applied a mixed methods approach with a sequential explanatory design, in which the quantitative phase was conducted first, followed by the qualitative phase. The mixed methods design was chosen to obtain a more comprehensive understanding of how early childhood education (ECE) teachers utilize the Merdeka Mengajar Platform (PMM) for professional development. The quantitative phase aimed to measure the level of PMM utilization, barriers, and influencing factors among teachers, while the qualitative phase explored teachers' lived experiences, challenges, and strategies related to PMM adoption. The integration of both data sets occurred during the interpretation stage, allowing qualitative findings to provide deeper insights into the quantitative results.

This study employs a mixed-methods research design, combining quantitative and qualitative approaches to gain a more comprehensive understanding of the phenomenon under investigation. This design was chosen because it allows the researcher not only to measure general tendencies through numerical data but also to explore in depth the lived experiences and emotional meanings of the participants. Consequently, the findings are expected to be both descriptive and reflective, providing a holistic view of the social and emotional context surrounding the issue.

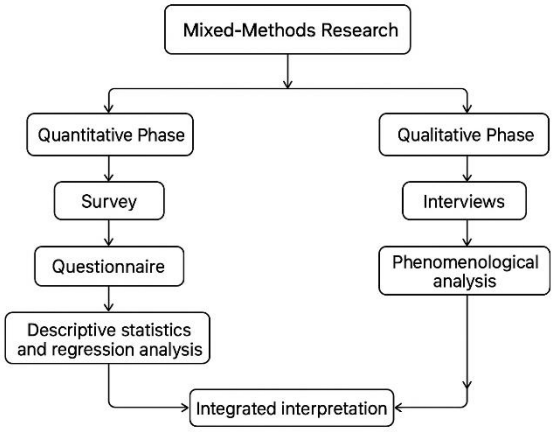

Figure 1. Mixed-methods research design framework

The diagram above illustrates the flow of a mixed-methods research design that integrates both quantitative and qualitative approaches. Through stages of surveys and statistical analysis followed by interviews and phenomenological analysis, this study produces an integrated interpretation that provides a more comprehensive understanding of the phenomenon under investigation.

Population and Sample

The population of this study comprised Early Childhood Education (ECE) teachers in Semarang City who were registered in the implementation of the Merdeka Curriculum. To determine the sample size, Slovin's formula was applied with a margin of error of 10%. Based on the total population of ECE teachers in Semarang, the calculation resulted in a sample size of 100 teachers for the quantitative phase. The respondents were selected using proportional random sampling, ensuring representation from different institutions and sub-districts across the city.

For the qualitative phase, purposive sampling was employed to select participants from among the survey respondents. The selection criteria included teaching experience, frequency of PMM use, and level of digital literacy, in order to obtain diverse and representative perspectives for in-depth interviews.

The research instrument was developed in the form of a questionnaire using a five-point Likert scale to measure ECE teachers' perceptions and experiences in utilizing the Merdeka Mengajar Platform (PMM). The scale applied was: 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neutral (N), 4 = Agree (A), and 5 = Strongly Agree (SA).

Research Variables

This study investigates the utilization of the Merdeka Mengajar Platform (PMM) by Early Childhood Education (ECE) teachers, focusing on three main groups of variables:

Independent Variables. Several factors are expected to influence teachers' engagement with PMM, including: (a) Digital literacy: teachers' ability to operate digital devices, access online learning resources, and integrate technology into their teaching practices. (b) Infrastructural support: availability and stability of internet connectivity, adequacy of devices, and institutional provision of technological facilities. (c) Training and mentoring: participation in structured professional development programs and ongoing guidance in using PMM effectively. (d) Teacher motivation and self-regulation: intrinsic drive and ability to manage one's own learning, adapt to challenges, and sustain professional growth. (e) Institutional and policy support: organizational encouragement, leadership involvement, and alignment with educational policy frameworks.

Dependent Variable. The central outcome of this study is teachers' utilization of PMM. This is measured not only by the frequency of use but also by the depth of engagement across different PMM features, such as: (a) Accessing teaching modules and digital resources. (b) Participating in self-paced training. (c) Documenting professional achievements (d) Integrating PMM resources into classroom practices. (e) Intervening Variables In line with the theoretical assumption, PMM utilization is hypothesized to contribute to broader educational outcomes through: Teacher professionalism, which encompasses pedagogical, professional, social, and personal competencies, and Readiness to implement the Merdeka Curriculum, particularly in adopting student-centered, technology-supported, and deep learning approaches.

Theoretically, the independent variables (digital literacy, infrastructural support, training, motivation, and institutional backing) directly affect the level of PMM utilization (dependent variable). In turn, this utilization serves as a mechanism that strengthens teacher professionalism and enhances readiness to implement the Merdeka Curriculum (intervening variables). By examining these relationships, the study seeks to generate empirical evidence on how digital platforms can support sustainable teacher development in the context of the Society 5.0 era.

Research Instruments

The research instrument was developed in the form of a questionnaire using a five-point Likert scale to measure ECE teachers' perceptions and experiences in utilizing the Merdeka Mengajar Platform (PMM). The scale applied was: 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neutral (N), 4 = Agree (A), and 5 = Strongly Agree (SA).

Table 1. Research Instrument (Questionnaire)

Variable	Indicator	Question Item	Scale (1–5)
Utilization of PMM	Access to teaching resources	I use PMM to find teaching resources (modules, lesson plans, learning materials).	1–5
	Self-paced training	I participate in self-paced training provided by PMM.	1–5
	Professional portfolio	I upload my teaching practices or professional work to PMM.	1–5
	Curriculum development	I find PMM useful in designing the PAUD (ECE) curriculum.	1–5
Digital Literacy	Basic ICT skills	I can operate digital devices (smartphone/laptop) to access PMM.	1–5
	Technical ability in PMM	I am able to use PMM features independently.	1–5
	Confidence	I feel confident using digital technology in early childhood education.	1–5
Infrastructure Barriers	Internet access	I have a stable internet connection to use PMM.	1–5
	Technological devices	I have adequate devices (smartphone/laptop) to access PMM.	1–5
	Institutional support	My school/institution provides facilities to support PMM utilization.	1–5
Support & Motivation	External support	My principal/colleagues support me in using PMM.	1–5
	Intrinsic motivation	I am motivated to improve my competence through PMM.	1–5
	Relevance	I find PMM features relevant to my needs as an ECE teacher.	1–5
Benefits & Satisfaction	Professional competence	PMM helps me improve my professional competence as an ECE teacher.	1–5
	Teaching innovation	PMM inspires me to develop innovative teaching practices.	1–5
	Feature satisfaction	I am satisfied with the features and services provided by PMM.	1–5

Table 2. Research Instrument (Interview Guide)

Aspect	Guiding Question
Utilization of PMM	How do you use PMM for teaching resources, training, or professional portfolios?
Barriers	What challenges do you face when using PMM (e.g., internet, devices, skills)?
Digital Literacy	How would you describe your ability to access and operate PMM? Any particular difficulties?
Support & Motivation	What kind of support do you receive from your school or colleagues? What motivates you to use PMM?
Benefits & Impact	In your opinion, how has PMM influenced your teaching and curriculum development in ECE?
Expectations	What improvements would you suggest to make PMM more beneficial for ECE teachers?

Data Collection Techniques

Survey questionnaire: developed using a Likert scale to assess PMM utilization, barriers, and supporting factors. The instrument was validated by expert judgment and piloted prior to distribution. In-depth interviews: conducted using a semi-structured interview guide, allowing participants to elaborate on their experiences and perceptions. All interviews were recorded, transcribed, and thematically analyzed.

Data Analysis

Quantitative data were analyzed using descriptive statistics (frequency, percentage, mean) to describe the level of PMM utilization and inferential statistics (correlation and regression analysis) to examine relationships between digital literacy, infrastructure, and PMM adoption. Qualitative data were analyzed using a phenomenological approach, involving coding, categorization, and theme development. Integration of data occurred at the discussion stage, where qualitative insights were used to enrich and interpret the quantitative findings.

The validity of the questionnaire was ensured through expert review, while reliability was tested using Cronbach's Alpha. The credibility of qualitative data was maintained through triangulation, member checking, and peer debriefing. This study adhered to research ethics, including informed consent, voluntary participation, confidentiality of participants' identities, and the use of data strictly for academic purposes.

Result and Discussion

Result

A total of 100 Early Childhood Education (ECE) teachers in Semarang City participated in the survey. The demographic characteristics of the respondents are summarized in Table 3, providing an overview of their background profiles. The table includes information on gender, age, education level, teaching experience, and frequency of using the Merdeka Mengajar Platform (PMM). Understanding these demographic characteristics is essential to interpret the research findings, as factors such as teaching experience and digital literacy may influence teachers' adoption and utilization of PMM in their professional activities.

Table 3 shows that the majority of respondents were female (87%), which reflects the general trend in early childhood education where teaching positions are predominantly occupied by women. This gender distribution aligns with the demographic characteristics of early childhood education (ECE) teachers in Indonesia, as previous studies have shown that the profession is predominantly female-dominated (Hidayati, 2019; Rohman & Mulyana, 2023; Wulandari, 2016). In terms of teaching experience, most respondents had between five and ten years of experience (42%), followed by those with more than ten years (30%), and fewer with less than five years (28%). This distribution suggests that the majority of participants possessed adequate teaching experience to provide informed perspectives on the use of the Merdeka Mengajar Platform (PMM). Regarding educational background, most teachers held a bachelor's degree (65%), while smaller proportions had diploma (25%) and master's (10%) qualifications. The dominance of bachelor-level educators indicates that the respondents have met the minimum professional requirements for early childhood education teachers in Indonesia. Overall, these demographic characteristics show that the participants represent a mature and professionally diverse group, making their responses reliable for analyzing factors influencing PMM adoption and digital literacy development.

Table 3. Respondents' Demographic Characteristics (N=100)

Characteristic	Category	Frequency	Percentage
Gender	Female	87	87%
	Male	13	13%
Teaching Experience	< 5 years	28	28%
	5–10 years	42	42%
	> 10 years	30	30%
Education Level	Diploma (D2/D3)	25	25%
	Bachelor (S1)	65	65%
	Master (S2)	10	10%

Utilization of PMM

Respondents' utilization of the Merdeka Mengajar Platform (PMM) was assessed through four main indicators, namely frequency of platform access, participation in training modules, use of teaching resources, and completion of professional portfolios. These indicators were designed to capture teachers' engagement and interaction with PMM as a digital platform for professional development. Table 4 presents the descriptive results of PMM utilization among Early Childhood Education (ECE) teachers in Semarang City, illustrating the extent to which teachers have integrated the platform into their daily teaching and learning practices. Understanding the level of PMM utilization is essential for identifying patterns of engagement, potential challenges, and opportunities for improving teachers' digital competence and professional growth.

Table 4 shows that the overall utilization of the Merdeka Mengajar Platform (PMM) among Early Childhood Education (ECE) teachers in Semarang City falls within the moderate-high category (M = 3.73, SD = 0.72). Among the four indicators, access to teaching resources recorded the highest mean score (M = 4.10),

indicating that most teachers frequently use PMM to obtain instructional materials that support classroom learning. Curriculum development also achieved a relatively high level of utilization (M = 3.85), reflecting teachers' engagement in aligning lesson activities with the Merdeka Curriculum framework. Participation in self-paced training was rated moderate-high (M = 3.75), suggesting that teachers are increasingly aware of the benefits of online professional learning but may still face constraints related to time, motivation, or digital familiarity. Uploading professional portfolios had the lowest mean score (M = 3.20), which implies that teachers are less consistent in documenting their professional achievements through the platform. These findings indicate that while PMM is generally well-received and utilized for instructional support, its reflective and evaluative features, such as portfolio submission, remain underused. The pattern suggests that targeted mentoring and institutional encouragement are needed to strengthen teachers' habits of self-reflection and professional documentation through PMM.

Table 4. Utilization of PMM

Indicator	Mean	Std. Dev.	Interpretation
Access to teaching resources	4.10	0.65	High
Participation in self-paced training	3.75	0.72	Moderate-High
Uploading professional portfolios	3.20	0.80	Moderate
Curriculum development	3.85	0.70	Moderate-High
Overall Utilization	3.73	0.72	Moderate-High

Digital Literacy of Teachers

Digital literacy and infrastructural readiness play a crucial role in supporting teachers' effective use of the Merdeka Mengajar Platform (PMM). In this study, infrastructure and institutional support were evaluated based on three key indicators: internet access, device availability, and institutional support. These indicators were designed to assess the external conditions that enable or hinder teachers in engaging with PMM for professional learning. Table 5 presents the mean scores of each indicator, providing an overview of the level of infrastructure and support available to Early Childhood Education (ECE) teachers in Semarang City.

Table 5. Infrastructure and Support

Indicator	Mean	Interpretation
Internet access	3.40	Moderate
Device availability	3.75	Moderate-High
Institutional support	3.50	Moderate
Overall Infrastructure & Support	3.55	Moderate

Table 5 reveals that the overall level of infrastructure and support for PMM utilization among ECE teachers is categorized as moderate (M = 3.55). The availability of technological devices scored relatively high (M = 3.75), suggesting that most teachers already possess or have access to digital tools such as laptops or smartphones for instructional purposes. However, internet access remains moderate (M = 3.40), indicating that unstable connectivity continues to hinder teachers' ability to engage consistently with PMM. Institutional support also received a moderate score (M = 3.50), reflecting that while schools encourage PMM use, structured assistance or ongoing mentoring is still limited. The pattern implies that external factors, rather than teacher motivation alone, significantly affect PMM adoption.

These results align with previous studies indicating that infrastructural readiness and administrative support are decisive for teachers' participation in digital learning platforms. For example, Nurhikmah et al. (2024) found that infrastructure and management support significantly affect teachers' readiness for online learning, while Sawiji (2024), highlighted that facilitating conditions and institutional backing play crucial roles in teachers' intention to adopt web-based e-learning. Strengthening network accessibility and institutional facilitation is therefore essential to optimize the implementation of PMM in early childhood education settings.

Inferential Analysis

A regression analysis was performed to examine the extent to which digital literacy and infrastructure support influence the utilization of the Merdeka Mengajar Platform (PMM) among Early Childhood Education (ECE) teachers. The analysis aimed to identify which predictor variables contributed most strongly to teachers' engagement with PMM. Digital literacy was hypothesized to directly enhance teachers' ability to navigate and benefit from the platform, while infrastructure and institutional support were expected to facilitate accessibility and sustained use. Table 6 summarizes the results of the multiple regression analysis, presenting the coefficients, t-values, and significance levels for each predictor variable.

Table 6 indicates that both digital literacy and infrastructure support significantly influence PMM utilization. Digital literacy emerged as the strongest

predictor ($\beta = 0.45$, $p < 0.001$), suggesting that teachers with higher levels of digital competence are more capable of exploring and benefiting from PMM features for professional development. Infrastructure and support also showed a significant positive effect ($\beta = 0.32$, $p = 0.003$), demonstrating that adequate access to technology and institutional encouragement are key external enablers of platform use. The regression model accounted for 52% of the variance in PMM utilization ($R^2 = 0.52$, $F(2.97) = 26.35$, $p < 0.001$), indicating a strong explanatory power. These findings are consistent with previous studies by Hijriani et al. (2024), which emphasized that digital competence and institutional support jointly determine teachers' readiness for digital transformation. The results also align with Rogers, (2003) Diffusion of Innovation theory, affirming that both individual and environmental factors shape technology adoption behaviors.

Table 6. Regression Analysis

Predictor	B (Coefficient)	t-value	Sig. (p)
Digital Literacy	0.45	4.20	0.000
Infrastructure & Support	0.32	3.10	0.003
Constant	1.25	2.50	0.014
$R^2 = 0.52$; $F(2,97) = 26.35$; $p < 0.001$			

The qualitative findings further reinforce the quantitative results, providing deeper insight into teachers' lived experiences with PMM. Three major themes emerged from in-depth interviews with ten selected teachers. The first theme, Empowerment through PMM, highlights that teachers felt more confident and creative after accessing diverse teaching resources and online training opportunities. The second theme, Barriers to Optimal Use, reveals that unstable internet connections and limited training remain major obstacles to consistent engagement with PMM. The third theme, need for Continuous Support, emphasizes the importance of sustained institutional guidance, peer collaboration, and mentoring to maintain teachers' motivation in using PMM. These qualitative insights validate the statistical results and illustrate how digital literacy and support systems interact in influencing the success of digital-based professional learning.

Discussion

Utilization of the Merdeka Mengajar Platform (PMM)

The study found that the overall utilization of the Merdeka Mengajar Platform (PMM) among Early Childhood Education (ECE) teachers in Semarang City was moderate-high. Teachers primarily accessed PMM to obtain teaching resources and align classroom practices with the Merdeka Curriculum framework. This result aligns with Mulyani et al. (2024), who reported that PMM serves as a practical tool for teachers to access digital teaching materials. Similarly, Kartika (2024), observed that PMM encourages teacher autonomy in curriculum implementation through its resource-sharing and self-training features. The finding also supports Rohman et al. (2023), who emphasized that PMM provides opportunities for self-directed professional development.

Compared with previous studies, the current results show that ECE teachers use PMM mainly for instructional rather than reflective purposes. While Aditomo (2023) and Hijriani et al. (2024) found that PMM facilitates teachers' self-evaluation and portfolio building, this study identified that uploading professional portfolios remains the least utilized feature. This discrepancy could be attributed to the limited digital literacy levels among ECE teachers and the lack of institutional motivation to maintain online portfolios. Unlike Hasanudin et al. (2025), who documented high PMM engagement among primary teachers, ECE teachers in this study demonstrated selective use of features, focusing primarily on those directly linked to daily teaching needs.

The moderate-high utilization level reflects both progress and limitation. Teachers demonstrate awareness of PMM's potential but still encounter technical and motivational barriers. This duality echoes findings by Maulana et al. (2016), who argued that consistent digital engagement depends not only on access but also on intrinsic motivation. The present study therefore extends earlier findings by highlighting the contextual challenges specific to ECE settings. Improving mentoring programs and institutional incentives could enhance teachers' reflective engagement with PMM, ultimately advancing professional quality in early education.

Digital Literacy and Teachers' Competence

Digital literacy emerged as a critical factor influencing PMM utilization. Teachers with strong ICT skills and confidence in using digital platforms were more active in accessing training modules and teaching resources. This finding corroborates Hijriani et al. (2024), who found that digital competence directly affects teachers' capacity for independent professional development. Similarly, Hasanudin et al. (2025) and Sari (2024) emphasized that digital literacy is a prerequisite for meaningful technology integration in learning environments. The results are also consistent with Purnomo et al. (2024), who reported that teachers with higher digital awareness adapt better to educational innovations.

Despite alignment with prior research, differences also exist. While Wulandari (2016) found uniform digital competence among teachers in urban schools, this study

revealed disparities in ECE teachers' abilities across districts. These differences mirror findings by Negara (2024), who noted uneven access to digital training opportunities among educators. Moreover, Astuti & Nugroho (2022) indicated that contextual factors, such as institutional culture and administrative support, often moderate the impact of digital literacy on technology use. This study reinforces that notion by showing how ECE teachers' digital skills interact with infrastructural realities to shape PMM engagement.

Overall, the findings suggest that strengthening digital competence requires more than one-time training. Consistent with the TPACK framework proposed by Mishra et al. (2006), professional development must integrate technological, pedagogical, and content knowledge. Supporting programs should prioritize hands-on mentoring, peer learning, and reflective practice, as recommended by Rowsell (2025), Enhancing these components will ensure that digital literacy development is continuous, contextually relevant, and transformative.

Infrastructure and Institutional Support

Infrastructure and institutional support significantly affected teachers' engagement with PMM. Although most respondents reported having access to digital devices, unstable internet connections and limited administrative support were major barriers. These findings are consistent with Safitri (2024) and Negara (2024), who documented that inadequate technological infrastructure limits the adoption of digital platforms in early education settings. Similarly, Hijriani et al. (2024) emphasized that continuous institutional support is necessary to sustain teachers' online learning participation.

However, the results differ slightly from Mulyani et al. (2024), who found that schools with well-established ICT environments show higher PMM adoption regardless of location. This study revealed that even with available devices, inconsistent internet and lack of structured facilitation hinder effective utilization. The findings also contrast with Alghifari (2025), who reported that infrastructural readiness in urban areas fully supports digital transformation. The present study suggests that readiness alone is insufficient without consistent administrative commitment and teacher assistance.

These findings support Astuti et al. (2022), who argued that organizational readiness and leadership support are crucial for innovation diffusion. They also reinforce the view of Rowsell (2025), who stated that digital transformation succeeds only when infrastructure, institutional culture, and user competence are developed in harmony. Strengthening school-level policies, improving connectivity, and providing ongoing technical support will be critical steps toward optimizing PMM implementation in ECE institutions.

Influence of Digital Literacy and Infrastructure on PMM Utilization

The regression analysis demonstrated that digital literacy and infrastructure support jointly explained 52% of the variance in PMM utilization ($R^2 = 0.52$, $p < 0.001$). Digital literacy was the strongest predictor, consistent with Rogers (2003), Diffusion of Innovation theory , which posits that individual readiness accelerates technology adoption. The findings are consistent with studies by Hijriani et al. (2024) and Consistent with previous research, teachers' digital competencies play a crucial role in determining the depth of their engagement with professional learning platforms. Studies have shown that digital competence training enhances teachers' professional engagement, collaboration, and the effective use of digital tools in teaching and learning contexts (Reisoglu, 2021). Likewise, the use of digital learning platforms such as Google Classroom has been found to significantly improve instructional design skills and foster higher levels of cognitive, behavioral, and social engagement among pre-service teachers (Gameil & Al-Abdullatif, 2023). Reflective digital learning approaches have also been shown to help teachers transfer newly acquired digital competences into classroom practice, deepening their professional involvement with technology-enhanced learning environments (Fessl et al., 2023). Mulyani et al. (2024), also highlighted that digital competence fosters self-efficacy, motivating teachers to explore PMM features independently.

While the results align with previous studies, this research also identifies nuances. Alghifari (2025), found that infrastructural factors alone explain little variance in technology adoption, while this study demonstrates their significant contribution when combined with digital literacy. The finding suggests that external support acts as a catalyst that enhances the effectiveness of digital competence. Similarly, Makkiyah et al. (2024), observed that integration between personal skills and institutional systems determines the sustainability of digital practices among educators. The interplay between these variables underscores that PMM adoption requires both internal readiness and systemic reinforcement.

The results strengthen the argument of Hasanudin et al. (2025), who noted that digital innovation in education must be approached holistically, addressing human and structural dimensions simultaneously. They also expand on the work of Rohman et al. (2023), which found that teacher motivation alone cannot sustain digital participation without environmental facilitation.

Therefore, capacity-building programs should not only enhance individual digital literacy but also ensure that institutional and infrastructural systems are capable of supporting long-term engagement with PMM.

Qualitative Insights on Teachers' Experiences

Qualitative data enriched the quantitative findings by uncovering the lived experiences of teachers in adopting PMM. The theme of empowerment through PMM illustrates how teachers gained confidence, creativity, and pedagogical flexibility after accessing digital training and teaching materials. This aligns with Ristianni et al. (2024) and Consistent with previous research, online learning platforms have been found to empower teachers to experiment with innovative instructional methods and enhance their engagement in digital learning environments (Gameil & Al-Abdullatif, 2023). Similar to Rowsell (2025), the current findings confirm that digital tools foster collaboration and self-reflection among educators. The results also resonate with Hijriani et al. (2024), who reported that PMM facilitates the development of reflective professional identity among Indonesian teachers.

Despite these positive outcomes, barriers to optimal use persist. Teachers described unstable internet connections and insufficient training as major limitations, confirming earlier observations by Safitri, (2024) and Negara (2024). Unlike Mulyani et al. (2024), who observed strong institutional involvement in supporting PMM adoption, this study found that most ECE institutions still provide minimal assistance. The discrepancy highlights the contextual challenges of early childhood settings, where resources and digital mentoring are often lacking.

The theme of continuous support underscores the importance of sustained institutional engagement. Consistent with Astuti et al. (2022), the study emphasizes that long-term success in digital transformation depends on regular mentoring and peer collaboration. The findings also extend Hasanudin et al. (2025), who proposed that communities of practice serve as effective vehicles for sustaining teacher engagement with digital innovation. Strengthening institutional mentoring frameworks and peer learning networks is therefore essential to ensure that PMM functions as a truly empowering platform for teacher professional growth.

Conclusion

This study demonstrated that the utilization of the Merdeka Mengajar Platform (PMM) among Early Childhood Education (ECE) teachers in Semarang City is at a moderate-high level, with teachers actively using the platform for accessing instructional materials and curriculum development. The regression results confirmed that digital literacy and infrastructure support significantly influence PMM utilization, explaining more than half of its variance. Teachers with stronger digital competence and better access to technological resources were more consistent in using PMM features for professional development. Qualitative findings further revealed that teachers experienced empowerment through PMM, yet their engagement was constrained by limited internet access, inconsistent institutional support, and insufficient digital mentoring. These results highlight that successful digital transformation in education requires not only technological readiness but also continuous institutional encouragement and teacher capacity building.

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