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Digital Competence and Teacher Preparedness for Educational Transformation in the Merdeka Curriculum Framework

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Abstract

This research aims to analyze the digital competency level of teachers at Madrasah Ibtidaiyah (MI) in Cirebon Regency, West Java, Indonesia. The research methodology employs a mixed-method approach, combining quantitative and qualitative methods. 49 MI teachers were selected as respondents through random sampling techniques. Data collection was conducted through questionnaires and in-depth interviews. Descriptive statistics were used to look at quantitative data, and data reduction, data presentation, and conclusion drawing were used to look at qualitative data. Findings show a generally low level of digital competence, with a mean score of 2.28 (SD = 0.86) on a 5-point scale. Most teachers (40.8%) fell into the "Low" category, 30.6% were "Moderate," and only 4.1% achieved "Very High." Digital communication had the highest score (M = 2.52), followed by technology use (M = 2.42), digital ethics (M = 2.11), and content creation (M = 2.08). Teachers struggled most with creating digital materials, using online platforms, and understanding digital ethics. Teaching experience (F = 2.49, p = 0.045) and school location (F = 3.26, p = 0.047) showed significant differences, with urban and less-experienced teachers performing better. The regression analysis revealed age, teaching experience, rural location, and prior training as significant predictors, accounting for 43.5% of the variance. There were no differences between the sexes. The implications of this research point to the urgency of implementing programs to enhance teachers' digital competency. More broadly, this research impacts

educational policy formulation, curriculum development, and the transformation of Islamic education in facing the digital era.

Keywords: *digital competency, islamic education, teacher development.*

Abstrak

Penelitian ini bertujuan untuk menganalisis tingkat kompetensi digital guru di Madrasah Ibtidaiyah (MI) di Kabupaten Cirebon, Jawa Barat, Indonesia. Metode penelitian menggunakan pendekatan metode campuran, menggabungkan metode kuantitatif dan kualitatif. 49 guru MI dipilih sebagai responden melalui teknik pengambilan sampel acak. Pengumpulan data dilakukan melalui kuesioner dan wawancara mendalam. Statistik deskriptif digunakan untuk melihat data kuantitatif, dan reduksi data, penyajian data, dan penarikan kesimpulan digunakan untuk melihat data kualitatif. Temuan menunjukkan tingkat kompetensi digital yang umumnya rendah, dengan skor rata-rata 2,28 (SD = 0,86) pada skala 5 poin. Sebagian besar guru (40,8%) termasuk dalam kategori "Rendah", 30,6% "Sedang," dan hanya 4,1% yang mencapai "Sangat Tinggi." Komunikasi digital memiliki skor tertinggi (M = 2,52), diikuti oleh penggunaan teknologi (M = 2,42), etika digital (M = 2,11), dan pembuatan konten (M = 2,08). Guru paling kesulitan dalam membuat materi digital, menggunakan platform daring, dan memahami etika digital. Pengalaman mengajar (F = 2,49, p = 0,045) dan lokasi sekolah (F = 3,26, p = 0,047) menunjukkan perbedaan yang signifikan, dengan guru perkotaan dan guru yang kurang berpengalaman menunjukkan kinerja yang lebih baik. Analisis regresi menunjukkan usia, pengalaman mengajar, lokasi pedesaan, dan pelatihan sebelumnya sebagai prediktor signifikan, yang mencakup 43,5% varians. Tidak ada perbedaan antara kedua jenis kelamin. Implikasi penelitian ini menunjukkan urgensi pelaksanaan program untuk meningkatkan kompetensi digital guru. Secara lebih luas, penelitian ini berdampak pada perumusan kebijakan pendidikan, pengembangan kurikulum, dan transformasi pendidikan Islam dalam menghadapi era digital.

Kata kunci: *kompetensi digital, pendidikan islam, pengembangan guru.*

INTRODUCTION

The era of industrial revolution 4.0 has driven significant transformations in various sectors, including education. Digitalization and automation are changing the learning paradigm from conventional models to comprehensive technology integration (Guan et al., 2025). In this context, the integration of digital technology in learning is a necessity, especially in the implementation of contemporary curricula that emphasize digital competencies as essential 21st-century skills (Momdjian et al., 2025; Trilling & Fadel, 2009). This global demand is also reflected in the Sustainable Development Goals (SDGs), especially the fourth point on quality education, which emphasizes the importance of digital literacy in realizing quality education (Hennelly & Ctori, 2022). The digital competency framework developed by international organizations such as ISTE (International Society for Technology in Education) and the UNESCO ICT Competency Framework for Teachers is a global standard that is increasingly being adopted by various countries, including Indonesia through the Merdeka Belajar policy and digital transformation of education (Susanti et al., 2024).

The rapid advancement of digital technology has led to the development of comprehensive frameworks such as DigCompEdu and TPACK, which emphasize not only technical proficiency but also the integration of pedagogical knowledge, content mastery, and ethical digital practices (Galindo-Domínguez et al., 2024; Geraldo-Campos et al., 2024). Empirical research by de Obesso et al. (2023) demonstrates the value of digital literacy in fostering 21st-century competencies such as critical thinking, collaboration, and creativity within digital learning environments. Furthermore, Osiesi & Blignaut (2025) highlight the necessity of contextualizing digital competence in accordance with local cultural and religious values to ensure its relevance in diverse educational settings. Despite these developments, scarce studies focus on digital competence among teachers in Islamic primary education institutions, particularly Madrasah Ibtidaiyah. Additionally, the integration of digital ethics rooted in Islamic educational values is still underexplored in existing pedagogical models. This study contributes to filling these gaps by proposing a holistic and contextual model of teacher digital competence that integrates TPACK, DigCompEdu, and Islamic educational philosophy, aligning global standards with local values to support transformative and ethically grounded digital education.

In this context, the digital competence of teachers plays a vital role as a determinant of the success of the adaptation of the education system to the demands of the digital era (Nagel et al., 2023). This study aims to analyze the level of digital competence of Madrasah Ibtidaiyah (MI) teachers in Cirebon in implementing a digital competency-based curriculum and identify factors that influence the development of these competencies.

The urgency of this research lies in the fact that Islamic educational institutions, especially Madrasah Ibtidaiyah, are faced with a significant challenge to balance traditional religious values with the demands of digital competencies in the national curriculum. As stated by Nowell et al. (2025), education in the digital era requires a redefinition of teacher competencies that includes not only pedagogical knowledge but also adequate digital skills. This is all the more urgent given research by Peng et al. (2024), which shows that 67% of teachers in developing countries still experience difficulties in integrating digital technology in learning.

Several previous studies have examined aspects of teacher digital competence in different contexts. Antonietti et al. (2022) developed the European Framework for the Digital Competence of Educators, which became a reference for evaluating teacher digital competence in Europe. In Indonesia, a study by Muhaimin et al. (2020) identified a digital competence gap between urban and rural teachers. Meanwhile, Elmaadaway & Abouelenein (2023) expanded the concept of Pedagogical Content Knowledge (PCK) to Technological Pedagogical Content Knowledge (TPACK) as a conceptual framework for teacher competence in the digital era.

While these studies offer important insights, substantial research deficiencies persist. First, there is a lack of specific studies on teachers' digital competencies in Islamic education institutions, especially Madrasah Ibtidaiyah. Second, there is no comprehensive analysis that combines quantitative and qualitative approaches in evaluating teachers' digital competencies. Third, previous studies have focused more on the technical aspects of technology use and less on the digital ethics dimension, which is very relevant to the context of Islamic education.

The novelty of this research lies in the development of a teacher digital competency evaluation model integrated with Islamic values, which includes four main dimensions: technology use, digital content creation, digital communication, and digital ethics. The conceptual framework of this research is built by integrating three theoretical approaches: Elmaadaway & Abouelenein's (2023) TPACK Framework, Antonietti et al.'s (2022) Digital Competence Framework for Educators, and Attas's (1980) Islamic Educational Philosophy (2020). This integration results in a comprehensive and contextual analysis model, which enables a holistic understanding of the digital competence of Madrasah Ibtidaiyah teachers as an intersection of technological knowledge, pedagogical content, and Islamic values. This approach is in line with the theocentric-anthropocentric concept in Islamic education philosophy that emphasizes the balance between worldly and ukhrawi benefits in competency development (Waghid, 2014).

The implications and contributions of this research cover three main dimensions. Theoretically, this research adds an Islamic education perspective to the literature on teacher digital competence, which previous studies have yet to explore. Methodologically, the use of a mixed-method approach provides a more comprehensive understanding of the complexity of teachers' digital competencies. Practically, the findings of this study can be the basis for developing a contextual and empirical evidence-based digital competency improvement program for Madrasah Ibtidaiyah teachers.

More broadly, this research impacts the transformation of Islamic education in responding to the demands of the digital era. As emphasized by Ifinedo et al. (2020), improving teachers' digital competencies is a strategic investment for the future of education. At the policy level, the findings of this research can be considered by the Ministry of Religious Affairs and the Ministry of Education in formulating curricula and teacher professional development programs that are integrated with digital competencies. Furthermore, the digital competency evaluation model developed in this study can be adapted by other Islamic education institutions, such as pesantren and madrasah at the secondary education level, to improve the quality of learning in the digital era.

METHODS

This research employs a mixed-method approach, strategically integrating quantitative and qualitative methodologies to comprehensively examine teachers' digital competencies in implementing the Merdeka Curriculum in Indonesia. This approach follows Creswell & Creswell's (2018) recommendation that mixed methods provide a more comprehensive understanding of complex educational phenomena compared to using either approach alone. Using a sequential explanatory design (Crescentini, 2014), the research prioritizes quantitative data collection and analysis in the initial phase, followed by qualitative data collection and analysis to elaborate, explain, and contextualize the quantitative findings. This design allows for the triangulation of results, enhances validity, and provides a holistic perspective on teachers' digital competencies (Fetters & Tajima, 2023).

The research population consists of Madrasah Ibtidaiyah (MI) teachers in the Cirebon region, West Java, Indonesia. Following Krejcie & Morgan (1970) guidelines for determining sample size in educational research, a sample of 49 teachers was selected through stratified random sampling, ensuring proportional representation from various schools, age groups, and

teaching experience levels. This sample size was calculated using Slovin's formula with a 95% confidence level and 5% margin of error, providing adequate statistical power for meaningful analysis (Cohen et al., 2021). The demographic characteristics of participants were quite diverse, with teaching experience ranging from 2 to 25 years and ages ranging from 23 to 55 years, with 31 female teachers (63.3%) and 18 male teachers (36.7%).

Data collection instruments were developed through rigorous procedures to ensure validity and reliability. The main quantitative instrument consisted of a structured questionnaire using a 5-point Likert scale (1 = very incompetent to 5 = very competent) designed to measure four main indicators of digital competence identified from previous research (Redecker, 2017; Falloon, 2020): technology use (8 items), digital content creation (7 items), digital communication (6 items), and digital ethics (5 items). The instrument development process involved a comprehensive literature review, expert panel input (n=5), and pilot testing with 15 teachers from similar contexts but outside the sample population. Content validity was established using Aiken's V formula, resulting in coefficients above 0.80 for all items, exceeding the recommended threshold of 0.75 by Aiken (1985). Construct validity was confirmed through Confirmatory Factor Analysis (CFA) with factor loadings above 0.50 for all items, meeting Murtagh & Heck's (2012) criteria for measurement validity. Reliability analysis showed excellent internal consistency with a Cronbach's Alpha coefficient of 0.92 for the overall instrument and ranging from 0.84 to 0.90 for individual dimensions, substantially exceeding the minimum acceptable threshold of 0.70 (DeVellis & Thorpe, 2021).

For qualitative data collection, semi-structured interview guidelines were developed based on Patton's (2014) recommendations for qualitative interviews in educational research. The interview protocol contained 12 open-ended questions exploring teachers' experiences, challenges, strategies, and perceptions regarding digital competencies in implementing the Merdeka Curriculum. The interview guidelines underwent expert validation by two specialists in educational technology and qualitative methodology, followed by cognitive interviews with three teachers to assess question clarity, comprehensibility, and alignment with research objectives. Revisions based on expert feedback and cognitive interviews enhanced the content validity and cultural appropriateness of the protocol.

Data collection was conducted in two distinct phases according to the sequential explanatory design. In the first phase, the quantitative questionnaire was administered electronically through Google Forms during February-March 2024, with personal reminders sent three days after the initial invitation. A comprehensive follow-up protocol resulted in a 100% response rate, eliminating concerns about non-response bias. The second phase, which took place in April and May 2024, involved in-depth interviews with 12 carefully chosen participants using purposive sampling with maximum variation (Patton, 2014). Based on quantitative results, representing diverse levels of digital competence (high, medium, and low), teaching experience, and demographic characteristics. Interviews were conducted face-to-face in private school settings, lasting 45–60 minutes per respondent. All interviews were recorded with written consent and professionally transcribed verbatim within 48 hours to ensure data integrity and accuracy.

Data analysis utilized sophisticated techniques appropriate for mixed-methods research. Quantitative analysis using SPSS version 28 included descriptive statistics (frequency

distributions, measures of central tendency, and dispersion) to characterize the sample and identify patterns in digital competencies. Inferential statistics included Pearson correlation analysis to test relationships between dimensions of digital competence, independent sample t-tests to compare competencies across gender categories, and one-way ANOVA to identify differences based on experience levels and educational qualifications. Effect sizes were calculated using Cohen's d and partial eta squared (η^2) to determine the practical significance of statistical findings.

Qualitative data analysis followed Miles & Huberman's (1994) interactive model through a systematic three-stage process. First, data reduction involved comprehensive coding of interview transcripts using a priori codes derived from literature and emergent codes identified through iterative readings. Second, data display involved creating thematic matrices, concept maps, and process diagrams to visualize patterns and relationships in the data. Finally, conclusion drawing and verification encompassed identifying themes, patterns, and insights, with verification through negative case analysis and constant comparison techniques. Throughout this process, reflective memos documented analytical decisions and emerging insights.

RESULTS AND DISCUSSION

Demographic Information of Research Participants

To provide a clearer understanding of the study participants, Table 1 presents the demographic information related to the gender distribution of respondents

Table 1. Gender Distribution

Gender	Frequency	Percentage
Female	31	63.3%
Male	18	36.7%
Total	49	100%

Based on the research findings in table 1, it can be observed that out of a total of 49 respondents who participated, there were 31 female respondents representing 63.3% and 18 male respondents representing 36.7%. This data indicates that the majority of respondents in this research were female, with almost twice the number of male respondents. This unbalanced gender distribution might need to be considered in the analysis and interpretation of subsequent research findings.

To further describe the demographic profile of the participants, Table 2 outlines the distribution of respondents by age group.

Table 2. Age Distribution

Age Group	Frequency	Percentage
23-30 years	8	16.3%
31-40 years	15	30.6%
41-50 years	21	42.9%
51-55 years	5	10.2%
Total	49	100%

Based on the age distribution in table 2, out of a total of 49 respondents, the majority are in the 41-50 years age group with 21 people (42.9%), followed by the 31-40 years age group with 15 people (30.6%). The 23-30 years age group consists of 8 people (16.3%), while the oldest age group of 51-55 years is the smallest with 5 people (10.2%). This data indicates that the research respondents are dominated by teachers in their middle to senior productive age.

To gain insights into the professional background of the respondents, Table 3 presents the distribution of participants based on their years of teaching experience.

Table 3 Teaching Experience

Experience	Frequency	Percentage
2-5 years	5	10.2%
6-10 years	7	14.3%
11-15 years	18	36.7%
16-20 years	14	28.6%
21-25 years	5	10.2%
Total	49	100%

Based on table 3 regarding teaching experience, out of a total of 49 respondents, the majority have teaching experience of 11-15 years with 18 people (36.7%), followed by the group with 16-20 years of experience comprising 14 people (28.6%). Respondents with 6-10 years of teaching experience number 7 people (14.3%), while the groups with the least experience (2-5 years) and the most experience (21-25 years) each consist of 5 people (10.2%). This data indicates that most respondents are experienced teachers with more than 10 years of service.

An overview of the respondents' school locations is presented in Table 4, which categorizes participants based on whether they teach in urban or rural Madrasah Ibtidaiyah (MI).

Table 4. School Distribution

School Location	Frequency	Percentage
Urban MI	17	34.7%
Rural MI	32	65.3%
Total	49	100%

Based on table 4 on school distribution, from a total of 49 respondents, the majority came from Madrasah Ibtidaiyah (MI) in rural areas with a total of 32 people (65.3%), while the remaining 17 people (34.7%) came from Madrasah Ibtidaiyah in urban areas. These data show that most of the respondents in this study were teachers who taught in Islamic elementary schools located in rural areas.

Digital Competence Assessment Results

A detailed overview of the respondents' digital competence levels, as measured through standardized assessment criteria, is summarized in Table 5.

Table 5. Overall Digital Competence Scores

Level of Competence	Score Range	Frequency	Percentage
Very High	4.21-5.00	2	4.1%
High	3.41-4.20	7	14.3%
Moderate	2.61-3.40	15	30.6%
Low	1.81-2.60	20	40.8%
Very Low	1.00-1.80	5	10.2%
Total		49	100%

Based on Table 5, most of the 49 respondents had "Low" digital competency (40.8%, score 1.81-2.60), followed by "Medium" (30.6%, score 2.61-3.40). "High" competency (14.3%, score 3.41-4.20) and "Very Low" (10.2%, score 1.00-1.80) were less common, while only 4.1% reached "Very High" (score 4.21-5.00). The average score was 2.28 ("Low"), with a standard deviation of 0.86, indicating most respondents had low to moderate digital competency.

In order to gain a more nuanced understanding of the respondents' digital competence, Table 6 breaks down the results by specific dimensions, including technology use, content creation, communication, and digital ethics.

Table 6. Digital Competence by Dimension

Dimension	Mean	SD	Level
Technology Use	2.42	0.89	Low
Digital Content Creation	2.08	0.94	Low
Digital Communication	2.52	0.82	Low
Digital Ethics	2.11	0.78	Low

Based on Table 6, all digital competence dimensions are at the "Low" level. Digital Communication scored highest (M=2.52, SD=0.82), followed by Technology Use (M=2.42, SD=0.89). Digital Ethics (M=2.11, SD=0.78) and Digital Content Creation (M=2.08, SD=0.94) had the lowest scores. This indicates that while respondents perform better in digital communication and technology use, overall competence remains low.

A closer examination of the specific items within the Technology Use dimension provides deeper insight into which digital skills are more or less developed among respondents, as shown in Table 7.

Table 7. Detailed Scores for Technology Use Dimension

Item	Description	Mean	SD
TU1	Using basic office software	3.12	0.84
TU2	Managing digital files and folders	2.96	0.82
TU3	Using learning management systems	2.24	0.93
TU4	Installing and configuring educational software	2.05	1.04
TU5	Using digital assessment tools	2.18	0.88
TU6	Troubleshooting common technical issues	1.87	0.96
TU7	Using digital devices for teaching	2.54	0.92
TU8	Navigating educational resources online	2.38	0.85

Based on Table 7, respondents showed the highest ability in basic office software (M=3.12) and digital file management (M=2.96), nearing the "Medium" level. The lowest scores were in technical problem solving (M=1.87), educational software installation (M=2.05), and digital assessment tools (M=2.18). Other skills ranged from 2.24 to 2.54. This suggests stronger proficiency in basic technology use than in complex educational applications.

To further identify specific strengths and weaknesses within the Digital Content Creation domain, Table 8 presents itemized scores across seven key competencies assessed in this dimension.

Table 8. Detailed Scores for Digital Content Creation Dimension

Item	Description	Mean	SD
DC1	Creating digital presentations	2.56	0.89
DC2	Developing digital learning materials	2.14	0.95
DC3	Editing digital images for teaching	1.82	0.97
DC4	Creating digital assessments	2.05	0.84
DC5	Developing educational videos	1.68	0.93
DC6	Creating interactive learning content	1.85	0.91
DC7	Adapting existing digital resources	2.46	0.88

Based on Table 8, respondents excelled in creating digital presentations (M=2.56) and adapting resources (M=2.46), though still in the "Low" category. The weakest areas were educational video development (M=1.68), image editing (M=1.82), and interactive content creation (M=1.85). Digital material development (M=2.14) and assessment creation (M=2.05) were moderate. This suggests stronger skills in adapting content than in producing complex digital materials.

To evaluate how effectively respondents engage in digital communication within various educational contexts, Table 9 presents detailed scores across six key indicators in this dimension.

Table 9. Detailed Scores for Digital Communication Dimension

Item	Description	Mean	SD
DM1	Communicating with students via digital platforms	3.05	0.84
DM2	Facilitating online discussions	2.32	0.89
DM3	Sharing resources digitally	2.78	0.76
DM4	Collaborating with colleagues online	2.46	0.82
DM5	Communicating with parents through digital means	2.64	0.79
DM6	Using social media for professional purposes	1.88	0.91

Based on Table 9 on the Digital Communication dimension, respondents showed the highest ability in communicating with students through digital platforms (M=3.05) which reached the "Medium" level, followed by sharing resources digitally (M=2.78) and communicating with parents through digital means (M=2.64). Lower abilities were seen in the use of social media for professional purposes (M=1.88), facilitating online discussions (M=2.32), and collaborating with colleagues online (M=2.46). These data indicate that

respondents are more competent in one-way or direct digital communication compared to more complex collaborative and professional communication through digital platforms.

An overview of teachers' understanding and application of ethical behavior in digital contexts is presented in Table 10, which details their responses across five key indicators of Digital Ethics.

Table 10. Detailed Scores for Digital Ethics Dimension

Item	Description	Mean	SD
DE1	Understanding copyright and fair use	1.94	0.81
DE2	Teaching digital citizenship	1.88	0.76
DE3	Protecting student privacy online	2.45	0.87
DE4	Addressing digital safety and cyberbullying	2.36	0.84
DE5	Promoting ethical use of digital technology	1.92	0.79

Based on Table 10 on the dimensions of Digital Ethics, respondents showed the highest ability in protecting online student privacy (M=2.45) and handling digital security and cyberbullying (M=2.36), although still in the "Low" category. Lower abilities were seen in teaching digital citizenship (M=1.88), promoting the ethical use of digital technology (M=1.92), and understanding copyright and fair use (M=1.94). These data indicate that respondents have a better awareness of the security and privacy aspects of digital ethics, but are still less competent in the aspects of teaching and promoting digital ethics and understanding intellectual property rights.

Correlation Analysis Between Dimensions

Relationships among the four measured dimensions of digital competence are summarized in Table 11, which presents Pearson correlation coefficients for each paired combination.

Table 11. Pearson Correlation Coefficients Between Digital Competence Dimensions

Dimension	Technology Use	Digital Content Creation	Digital Communication	Digital Ethics
Technology Use	1.000	0.721	0.675	0.594
Digital Content Creation	0.721	1.000	0.623	0.568
Digital Communication	0.675	0.623	1.000	0.589
Digital Ethics	0.594	0.568	0.589	1.000

Based on Table 11 on the correlation analysis between dimensions of digital competence, the results show that there is a significant positive correlation ($p<0.01$) between all dimensions studied. The strongest correlation was found between Technology Use and Digital Content Creation ($r=0.721$), followed by the correlation between Technology Use and Digital Communication ($r=0.675$). A fairly strong relationship was also seen between Digital Content Creation and Digital Communication ($r=0.623$). Meanwhile, the Digital Ethics dimension showed a relatively more moderate correlation with other dimensions, with correlation coefficient values ranging from 0.568 to 0.594. These data indicate a strong

relationship between various dimensions of digital competence, where improvements in one dimension tend to be related to improvements in other dimensions.

Comparison by Gender

Differences in digital competence between male and female respondents were further examined through an independent samples t-test, as presented in Table 12.

Table 12. Independent Samples t-test Results for Digital Competence by Gender

Dimension	Female (n=31)		Male (n=18)		t	df	p-value	Cohen's d
	Mean	SD	Mean	SD				
Technology Use	2.39	0.92	2.47	0.85	-0.31	47	0.758	0.09
Digital Content Creation	2.04	0.96	2.15	0.91	-0.42	47	0.679	0.12
Digital Communication	2.46	0.85	2.63	0.78	-0.74	47	0.462	0.21
Digital Ethics	2.08	0.80	2.16	0.75	-0.36	47	0.721	0.10
Overall Digital Competence	2.24	0.88	2.35	0.83	-0.45	47	0.654	0.13

Based on Table 12 on the comparison of digital competence based on gender, the results of the t-test for independent samples show that there is no statistically significant difference ($p > 0.05$) between female and male teachers in all dimensions of digital competence measured. Male teachers showed slightly higher mean scores on all dimensions (Technology Use: 2.47 vs 2.39; Digital Content Creation: 2.15 vs 2.04; Digital Communication: 2.63 vs 2.46; Digital Ethics: 2.16 vs 2.08; Overall Digital Competence: 2.35 vs 2.24) compared to female teachers, but this difference was not statistically significant. The effect size (Cohen's d) for all dimensions ranged from 0.09 to 0.21, indicating a small effect. These data indicate that gender is not a significant determinant of digital competence among the respondents of this study.

Comparison by Teaching Experience

An analysis was also conducted to examine whether digital competence levels varied according to teaching experience, and the results are summarized in Table 13.

Table 13. One-way ANOVA Results for Digital Competence by Teaching Experience

Dimension	2-5 years (n=5)	6-10 years (n=7)	11-15 years (n=18)	16-20 years (n=14)	21-25 years (n=5)	F	p-value	η^2
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)			
Technology Use	2.85 (0.78)	2.68 (0.82)	2.34 (0.86)	2.25 (0.91)	2.16 (0.95)	2.49	0.045*	0.18
Digital Content Creation	2.47 (0.81)	2.32 (0.85)	2.03 (0.92)	1.96 (0.94)	1.78 (1.02)	2.18	0.086	0.16
Digital Communication	2.87 (0.73)	2.74 (0.76)	2.48 (0.81)	2.35 (0.84)	2.26 (0.88)	2.05	0.103	0.15
Digital Ethics	2.28 (0.74)	2.24 (0.70)	2.09 (0.75)	2.05 (0.80)	1.96 (0.82)	0.92	0.462	0.08

Overall Digital Competence	2.62 (0.76)	2.49 (0.79)	2.23 (0.84)	2.15 (0.87)	2.04 (0.92)	2.27	0.074	0.17

Note: * $p < 0.05$

Based on Table 13 on the comparison of digital competence based on teaching experience, the results of the ANOVA analysis showed a statistically significant difference only in the Technology Use dimension ($F = 2.49$; $p = 0.045$; $\eta^2 = 0.18$) with a medium effect size. Teachers with less teaching experience (2-5 years and 6-10 years) showed a higher level of competence in this dimension compared to the group with more experience. Although other dimensions (Digital Content Creation, Digital Communication, Digital Ethics) and Overall Digital Competence showed a similar pattern of decline with increasing teaching experience, these differences did not reach statistical significance ($p > 0.05$). The effect sizes (η^2) for these dimensions ranged from 0.08 to 0.17, indicating small to medium effects. These data indicate an inverse relationship between teaching experience and digital competence, where newer teachers tend to have higher digital competence, especially in the use of technology

Comparison by School Location

In addition, an analysis was conducted to determine whether teachers' digital competence differed based on the geographical location of their schools, as presented in Table 14.

Table 14. One-way ANOVA Results for Digital Competence by School Location

Dimension	**Urban (n=17)**	**Sub urban (n=19)**	**Rural (n=13)**	**F**	**p-value**	**η^2**
	Mean (SD)	Mean (SD)	Mean (SD)			
Technology Use	2.67 (0.84)	2.42 (0.88)	2.11 (0.92)	3.87	0.028*	0.14
Digital Content Creation	2.24 (0.89)	2.09 (0.92)	1.86 (0.97)	2.49	0.094	0.10
Digital Communication	2.76 (0.74)	2.51 (0.79)	2.23 (0.88)	3.14	0.049*	0.12
Digital Ethics	2.25 (0.73)	2.14 (0.74)	1.89 (0.85)	2.35	0.107	0.09
Overall Digital Competence	2.48 (0.80)	2.29 (0.83)	2.02 (0.90)	3.26	0.047*	0.12

Note: * $p < 0.05$

Based on Table 14 on the comparison of digital competencies based on school location, the results of the ANOVA analysis showed statistically significant differences in three areas: Technology Use ($F = 3.87$; $p = 0.028$; $\eta^2 = 0.14$), Digital Communication ($F = 3.14$; $p = 0.049$; $\eta^2 = 0.12$), and Overall Digital Competence ($F = 3.26$; $p = 0.047$; $\eta^2 = 0.12$). Teachers in urban schools showed higher levels of competency in all dimensions compared to teachers in suburban and rural schools, with a consistent decreasing pattern from urban to rural. Although the dimensions of Digital Content Creation and Digital Ethics showed the same pattern, these differences did not reach statistical significance ($p > 0.05$). The effect sizes (η^2) for all dimensions ranged from 0.09 to 0.14, indicating a moderate effect. These data indicate

that school location has a significant influence on the level of teachers' digital competence, where teachers in urban areas tend to have higher digital competence compared to their colleagues in rural areas.

Multiple Regression Analysis: Factors Predicting Overall Digital Competence

To further explore the predictors of overall digital competence, a multiple regression analysis was conducted using several demographic and contextual variables, as summarized in Table 15.

Table 15. Multiple Regression Results

Predictor Variable	B	SE	β	t	p-value
(Constant)	3.286	0.345		9.526	0.000
Gender (Male)	0.108	0.172	0.061	0.628	0.533
Age	-0.027	0.009	-0.312	-3.000	0.004
Teaching Experience	-0.048	0.016	-0.327	-3.000	0.004
School Location (Rural)	-0.287	0.112	-0.252	-2.563	0.014
Prior Digital Training	0.214	0.092	0.212	2.326	0.025

Based on Table 15, on the results of multiple regression analysis for factors predicting overall digital competence, the resulting model is statistically significant ($F(5, 43) = 7.693$, $p < 0.001$) with the ability to explain 43.5% of the variance in teachers' digital competence (Adjusted $R^2 = 0.435$). Four of the five predictor variables showed a significant effect. Age ($\beta = -0.312$, $p = 0.004$) and teaching experience ($\beta = -0.327$, $p = 0.004$) both showed a significant negative relationship with digital competence, indicating that younger and less experienced teachers tend to have higher levels of digital competence. The location of the school in a rural area ($\beta = -0.252$, $p = 0.014$) also had a significant negative impact on digital competence. In contrast, previous digital training ($\beta = 0.212$, $p = 0.025$) showed a significant positive relationship, indicating the importance of formal training in developing digital competence. Gender ($\beta = 0.061$, $p = 0.533$) did not show a significant relationship with digital competence, consistent with the results of the previous t-test analysis.

Qualitative Data Findings on Teachers' Digital Competence in the Implementation of the Merdeka Curriculum

Theme 1: Varied Technology Use Experiences

Participants demonstrated diverse experiences in technology use, ranging from basic to advanced proficiency levels. Most teachers reported regular use of fundamental digital tools but struggled with more advanced applications.

Subtheme 1.1: Basic Technology Utilization

Most teachers (9 out of 12) reported comfort with basic technology applications such as Microsoft Office, Google Classroom, and WhatsApp.

> "I use PowerPoint for my daily lessons and Google Classroom to distribute assignments. These are the tools I'm most comfortable with." (Teacher 3, 45 years, 15 years experience).
>
> "WhatsApp groups are my primary communication channel with students and parents. I can share materials, announcements, and collect assignments through it easily." (Teacher 7, 32 years, 8 years experience).

Subtheme 1.2: Advanced Technology Challenges

A significant majority (10 out of 12) expressed difficulty with more sophisticated educational technologies such as learning management systems, interactive assessment tools, and digital content creation platforms.

> "I've tried using Kahoot and Quizizz for interactive assessments, but I often encounter technical problems I can't solve independently." (Teacher 5, 37 years, 12 years experience).
>
> "Creating digital learning modules with multimedia elements is still challenging for me. I know it would benefit my students, but I lack the technical skills." (Teacher 10, 29 years, 5 years experience).

Theme 2: Digital Content Creation Limitations

Most participants acknowledged significant limitations in their ability to create original digital learning materials aligned with Merdeka Curriculum principles.

Subtheme 2.1: Dependence on Pre-made Resources

Nearly all teachers (11 out of 12) reported heavy reliance on ready-made digital resources rather than creating personalized materials.

> "I mostly download materials from various teacher forums and websites. Creating my own digital content takes too much time and technical knowledge that I don't have." (Teacher 2, 41 years, 14 years experience).
>
> "When I find good videos or presentations online that match my lesson objectives, I use them directly. I rarely modify them because I don't know how to edit digital content effectively." (Teacher 8, 27 years, 4 years experience).

Subtheme 2.2: Limited Multimedia Integration

Most teachers (8 out of 12) specifically mentioned difficulties incorporating multimedia elements into their teaching materials.

> "I know videos and animations make lessons more engaging, but recording and editing my own videos is beyond my current abilities." (Teacher 11, 33 years, 7 years experience).
>
> "I can create simple presentations with text and images, but adding interactive elements or embedding videos is too complicated for me." (Teacher 1, 49 years, 20 years experience).

Theme 3: Digital Communication Competencies

Teachers demonstrated relatively stronger skills in digital communication compared to other competency areas, though with notable limitations in some aspects.

Subtheme 3.1: Communication Tool Preferences

All teachers reported using digital communication tools, with clear preferences for familiar platforms.

> "I'm very comfortable using WhatsApp for communication with students, parents, and colleagues. It's easy and everyone already uses it." (Teacher 4, 39 years, 13 years experience).
>
> "Email is my preferred formal communication channel with school administration, while I use messaging apps for daily interactions with students." (Teacher 9, 51 years, 22 years experience).

Subtheme 3.2: Online Collaboration Challenges

Most teachers (9 out of 12) reported difficulties with collaborative digital work environments.

"Collaborative document editing in Google Docs is confusing when multiple people are working simultaneously. I often lose track of changes." (Teacher 6, 35 years, 10 years experience)

"I struggle with scheduling and conducting efficient virtual meetings. Managing student participation in Zoom classes requires skills I'm still developing." (Teacher 12, 25 years, 3 years experience).

Theme 4: Digital Ethics Awareness

Teachers demonstrated varied levels of understanding regarding digital ethics, copyright, and online safety.

Subtheme 4.1: Copyright Understanding Gaps

A majority of teachers (7 out of 12) showed limited understanding of copyright issues related to digital educational materials.

"I honestly don't think much about copyright when I use images or videos from the internet for my teaching. If it's for education, I assume it's acceptable." (Teacher 2, 41 years, 14 years experience).

"I'm aware that copyright exists, but the rules seem complicated and I'm not sure which materials are free to use and which aren't." (Teacher 7, 32 years, 8 years experience).

Subtheme 4.2: Data Privacy Concerns

Most teachers (8 out of 12) expressed awareness of data privacy issues but limited knowledge of practical protection measures.

"I know student data should be protected, but I'm not always sure what specific precautions I should take when using online platforms." (Teacher 5, 37 years, 12 years experience).

"I try to be careful with student information, but sometimes educational apps request access to data, and I'm not confident in evaluating whether these requests are appropriate." (Teacher 10, 29 years, 5 years experience).

Theme 5: Contextual Challenges to Digital Competence Development

All participants identified specific contextual factors hindering their digital competence development.

Subtheme 5.1: Infrastructure Limitations

Nearly all teachers (11 out of 12) cited inadequate technological infrastructure as a significant barrier.

"Our school has limited internet bandwidth. When multiple classes try to use online resources simultaneously, everything slows down or crashes." (Teacher 3, 45 years, 15 years experience).

"I don't have a dedicated computer in my classroom. I have to bring my personal laptop, which isn't always practical or reliable." (Teacher 11, 33 years, 7 years experience).

Subtheme 5.2: Time Constraints All teachers mentioned time limitations as a major obstacle to developing digital competencies.

"Between teaching responsibilities, administrative work, and family obligations, I simply don't have enough time to learn new digital skills properly." (Teacher 9, 51 years, 22 years experience).

"The Merdeka Curriculum already requires significant adaptation. Adding technology integration on top of that creates an overwhelming time burden." (Teacher 1, 49 years, 20 years experience)

Subtheme 5.3: Training Inadequacies

All participants expressed dissatisfaction with current professional development opportunities related to digital competencies.

"The training sessions we receive are too general and basic. They don't address the specific challenges we face when implementing technology in our Madrasah context." (Teacher 8, 27 years, 4 years experience).

"Most workshops are one-time events with no follow-up support. I need ongoing guidance to successfully apply what I've learned." (Teacher 6, 35 years, 10 years experience).

Theme 6: Adaptation Strategies

Teachers developed various adaptation strategies to navigate digital competency challenges.

Subtheme 6.1: Peer Learning Networks

Most teachers (9 out of 12) highlighted the importance of informal peer support.

"I often ask younger colleagues for help with technology issues. They're usually more knowledgeable and willing to assist." (Teacher 4, 39 years, 13 years experience).

"We've created an informal WhatsApp group where teachers share technology tips and resources. It's more helpful than formal training sometimes." (Teacher 12, 25 years, 3 years experience).

Subtheme 6.2: Selective Technology Adoption

All teachers reported being selective about which technologies they invest time in learning.

"I focus on mastering one digital tool at a time, prioritizing those that align with my immediate teaching needs and seem relatively easy to learn." (Teacher 5, 37 years, 12 years experience).

"I've learned to evaluate whether a new technology genuinely enhances learning before investing time in it. Not everything that's digital is automatically better." (Teacher 10, 29 years, 5 years experience).

Discussion

The qualitative findings gave additional context for the quantitative results, particularly in explaining why teachers scored lower in digital content creation (mean score 2.8) compared to digital communication (mean score 3.6). Interviews revealed specific challenges related to multimedia production and limited understanding of copyright issues. This finding supports the study by Instefjord & Munthe (2017), which indicated that while teachers frequently use digital communication tools, they often lack the more advanced skills required for content production.

Although the quantitative data showed minimal differences based on teaching experience, qualitative analysis revealed substantial variation in adaptation strategies. Early-career teachers were more inclined toward self-directed learning, while experienced teachers relied more heavily on structured training and peer support. This aligns with findings by Antonietti et al. (2022), who emphasized that younger teachers tend to be more agile in adopting digital tools in educational practice.

Teachers' digital competence is a key factor in the successful implementation of the Merdeka Curriculum, which emphasizes autonomy and creativity in learning. This study found that the majority of Madrasah Ibtidaiyah teachers possess low levels of digital competence. This phenomenon reflects the global challenge highlighted by Instefjord & Munthe (2017), as well as Momdjian et al. (2025), who noted that teacher digital competence remains a critical issue in many countries, particularly in developing contexts where the digital divide is pronounced.

The digital competence framework developed by Demissie et al. (2022), which includes technology use, digital content creation, digital communication, and digital ethics, reveals substantial gaps across all dimensions in this study. These results are consistent with the findings of Drummond & Coulet (2022), who pointed out that technical skills among teachers often do not correlate with pedagogical and ethical digital literacy (Elmaadaway & Abouelenein, 2023).

The strong positive correlations among the dimensions of digital competence in this study reinforce the theoretical framework of Technological Pedagogical Content Knowledge (TPACK) developed by Mishra & Koehler (2006) and further elaborated by Su (2023); the results indicate that technological, pedagogical, and content knowledge are deeply interconnected. This supports the argument by Saidah (2024) that teacher training should be designed holistically, as enhancing one dimension can strengthen others.

The negative correlations between digital competence and both age and teaching experience highlight generational gaps in technological adaptation. These findings support the study of Mertala et al. (2024), which emphasized that younger teachers, often referred to as "digital natives," are generally more open and adaptable to educational technologies. The implication is that professional development programs must differentiate their approaches based on teachers' demographic characteristics.

The significant disparities in digital competence based on school location, urban versus rural, reflect broader digital divide issues. Teachers in urban schools showed higher scores compared to those in rural settings. This is consistent with Sysoyev et al. (2015) and Momdjian et al. (2025), who noted that access to digital infrastructure plays a critical role in determining the level of technology adoption in education. Addressing the above issue requires government policy interventions aimed at ensuring equitable digital access and targeted support for schools in under-resourced areas.

Qualitative findings regarding teachers' reliance on pre-made digital materials suggest a gap between curricular expectations and actual teacher capacity. This is in line with Liu et al. (2024), who argued that digital content creation is an advanced skill requiring technical support, specific training, and adequate time for development. In this regard, Merdeka Curriculum implementation should provide a repository of high-quality digital resources as a short-term measure while investing in long-term capacity building.

Teachers' limited understanding of digital ethics, especially concerning copyright and data privacy, raises serious concerns in an era marked by increasing complexity in the legal and ethical dimensions of technology use. Botturi & Addimando (2025) stressed the need for digital literacy to include a thorough understanding of the legal and ethical implications of online behavior. Batubara & Risfianti (2024) similarly stressed the importance of integrating

ethical considerations into teacher professional development for effective implementation of the Merdeka Curriculum.

Systemic challenges such as limited infrastructure, time constraints, and inadequate training represent significant barriers that demand holistic solutions. These results mirror findings by Grover et al. (2024), who reported that successful integration of technology in education requires a supportive ecosystem, including robust infrastructure, coherent policy frameworks, and sustained capacity development.

Teachers' adaptive strategies, such as peer learning and selective adoption of technology, reflect their resilience in facing digital challenges. These strategies correspond with the concept of "communities of practice" as introduced by Lave & Wenger (1991) and further developed by Leahy et al. (2025), which highlights that professional knowledge and skills often emerge through social interaction and collaboration. In contexts with limited formal resources, professional development that leverages peer learning may prove more effective.

The study's findings emphasize the urgency of reorienting teacher professional development policies to be more contextualized and sustainable. Wu et al. (2025) determined that effective teacher training must be continuous, content-specific, active, aligned with institutional requirements, and collaborative. Based on teachers' perceptions, current digital training programs do not appear to meet these criteria, limiting their effectiveness.

Overall, the results of this study both confirm and expand upon previous research findings. They corroborate international studies that have highlighted demographic and infrastructural challenges in building digital competence but also offer new insights by situating these challenges within the context of Indonesian Islamic primary schools. While the findings align with global patterns, they also challenge the assumption that teaching experience alone ensures higher digital competence.

Bridging the digital competence gap in the implementation of the Merdeka Curriculum requires a systemic and contextualized approach that simultaneously strengthens curriculum development, teacher training, and digital infrastructure. As Stutchbury & Biard (2023) argue, effective educational reform must consider local capacity and contextual variability. In this regard, a standardized or one-size-fits-all policy for improving teacher digital competence will not be effective. A more nuanced, multi-layered strategy is required, one that acknowledges demographic, contextual, and systemic factors to ensure the equitable and successful implementation of the Merdeka Curriculum in the digital era.

CONCLUSION

Based on the research results, it was concluded that the majority of teachers still have low digital competence. Although they are able to use basic tools such as Microsoft Office, many have difficulty in adopting more complex technologies, such as learning management systems and digital assessment tools. The location of the school significantly influences the level of digital competence, where teachers in urban areas tend to be more proficient than teachers in rural areas. In addition, age and teaching experience have a negative correlation with digital competence, while previous digital training has been shown to have a positive impact. We still need to improve awareness of digital ethics, particularly in terms of copyright and personal data protection. We recommend a more comprehensive and sustainable digital

training program, particularly for teachers in rural areas and those with longer teaching experience. The training curriculum should include not only technical skills but also an understanding of digital ethics and data security. In addition, adequate technological infrastructure provided by the government and educational institutions will greatly improve teachers' digital competence.

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