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The relationships of digital literacy, mathematics self-concept, mathematics literacy, and teacher competence

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ABSTRACT

Digital literacy among teachers remains a critical issue in mathematics education, particularly in supporting effective teaching practices in technology-enhanced learning environments. This study aimed to examine the structural relationships among teachers' digital literacy, mathematics self-concept, and teacher competence. A quantitative explanatory survey design was employed, involving 40 high school mathematics teachers from Subang and Ciamis Regencies, West Java, Indonesia. Participants were selected using purposive cluster sampling through local Mathematics Teachers' Working Groups (MGMP). Data were collected through an online questionnaire and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS. The findings indicate that teachers' digital literacy has a positive and significant effect on mathematics self-concept ($\beta = 0.570$, $p < 0.001$) and teacher competence ($\beta = 0.566$, $p < 0.001$). In contrast, mathematics self-concept does not have a significant direct effect on teacher competence ($\beta = 0.130$, $p = 0.411$). The structural model explains 32.4% of the variance in mathematics self-concept and 42.1% of the variance in teacher competence, indicating moderate explanatory power. These results suggest that digital literacy plays a central role in shaping both teachers' confidence in mathematics and their professional competence. The study highlights the importance of strengthening teachers' digital literacy through continuous professional development and technology-integrated pedagogical training. Future research should involve larger and more diverse samples to enhance the generalizability of the findings.

KEYWORDS

digital literacy; mathematics self-concept; mathematics teachers; PLS-SEM; teacher competence

INTRODUCTION

In the digital era, teachers are increasingly expected to possess strong digital literacy skills to design interactive, inclusive, and technology-enhanced learning environments. (Herlina & Istikomah, 2023). Despite substantial investments in educational technologies worldwide, the integration of digital tools into classroom practices remains inconsistent across educational systems. Previous studies have shown that many teachers continue to depend on traditional teaching methods and have not yet fully integrated emerging technologies into their teaching process (Omar et al., 2020). This limitation is often accompanied by a lack of confidence in utilizing technology effectively in instructional practices (Possaghi & Papavlasopoulou, 2024). As a result, technology is frequently used only as a supplementary tool rather than being meaningfully integrated into pedagogical practices. Several factors have been identified as barriers to effective technology integration, including limited professional development opportunities, insufficient institutional support, concerns regarding pedagogical effectiveness, and a lack of confidence in using digital technologies for teaching and learning.

These challenges are not limited to developing countries; they have also been reported in developed contexts. For instance, Possaghi & Papavlasopoulou (2024), in a study involving primary and middle school teachers in northern Italy, found that teachers experienced uneven digital competence, low confidence in using technology, difficulties in assessing digitally mediated learning, and tensions between institutional digitalization policies and classroom realities. In Morocco, Oumelaid et al. (2025) reported the growing use of digital classrooms in mathematics education and highlighted the continuing importance of equitable access to technology, adequate teacher training, and instructional quality in technology-enhanced learning environments. In the Indonesian context, although digitalization policies in education have been implemented, they have not been accompanied by a significant improvement in teachers' digital literacy. Previous studies indicate that teachers' digital literacy in Indonesia remains relatively low, particularly among older teachers (Soeparno & Ismaniati, 2022; Utomo et al., 2021). This situation highlights the continuing need to understand the factors associated with teachers' digital literacy and its potential contribution to other professional and psychological dimensions of teaching.

Digital literacy is a component of knowledge, skills, attitudes, and values that enable individuals to participate effectively, critically, and ethically in the digital world (Nogueira et al., 2022). It includes not just technical skills in operating digital media but also a critical comprehension of media content, awareness of the social context behind its use, and the capacity to participate ethically and effectively in digital environments (Mikkelsen & Chapagain, 2023). In educational fields, digital literacy comprises three fundamental domains: (1) digital initiative, which includes technological knowledge, skills, and active utilization techniques; (2) digital thinking, relating to practical reasoning and attitudes toward employing technology for educational and innovative purposes; and (3) digital humanity, emphasizing values, ethics, and social awareness within digital interactions (Wei, 2023). In mathematics education, digital literacy is essential for helping students engage with complex problem-solving and technology-driven learning environments (Yani et al., 2025). Using digital tools in mathematics requires both practical skills and higher-order thinking skills (HOTs), including analysis, evaluation, and creation. These skills enable learners to interpret data, solve mathematical problems, and make informed decisions in technology-enhanced learning environments, such as analyzing datasets in spreadsheets, exploring mathematical relationships with dynamic software, or evaluating information from digital sources. As a result, HOTs are regarded as indicators of digital literacy, with higher achievers demonstrating more advanced digital skills (Yanuarto et al., 2023).

Furthermore, effective mathematics teaching is influenced not only by cognitive competencies, such as higher-order thinking skills (HOTs), but also by affective factors, particularly mathematics self-concept. Mathematics self-concept refers to an individual's perception of their competence in mathematics and reflects the extent to which they feel confident in understanding mathematical concepts, solving mathematical problems, and performing mathematics-related tasks (Arens et al., 2022; Passiatore et al., 2024). For teachers, mathematics self-concept may influence how they approach mathematical tasks, evaluate their own capabilities, and make instructional decisions in the classroom. Teachers with a stronger mathematics self-concept are generally more confident in explaining mathematical concepts, facilitating students' learning, and adopting innovative teaching practices, including integrating digital technologies into instruction. In addition, mathematics self-concept can shape teachers' professional attitudes, persistence in the face of instructional challenges, and willingness to engage in continuous professional development. Previous studies have also shown that self-concept plays an important role in shaping individuals' academic and career-related decisions (Ding et al., 2024; Gaspard et al., 2020). Despite its importance, research on mathematics self-concept has predominantly focused on students (Li et al., 2020; Steinberg et al., 2024; Vasalampi et al., 2020), with relatively limited attention given to mathematics teachers. This gap is noteworthy because teachers' perceptions of their own mathematical competence may influence not only their professional competence but also their ability to create effective learning environments and meaningfully integrate digital technologies into mathematics instruction.

In the digital era, effective technology integration in mathematics classrooms depends largely on teachers' ability to select, adapt, and implement digital technologies in ways that support pedagogical goals. Consequently, teacher competence plays a vital role in fostering students' digital literacy and advanced thinking skills. Teacher competence in implementing learning in the digital era requires the ability to integrate digital technology into classroom practices (Uribe-Banda et al., 2021). Moreover, teacher competence has been shown to affect students' mathematics literacy positively (Franklin & Chang, 2025; Papic & Papic, 2026). Nevertheless, many teachers still encounter obstacles when integrating digital technologies into classroom practices. These challenges include limited digital skills, insufficient professional training, a lack of confidence in using technology for instructional purposes, inadequate technological infrastructure, and restricted access to digital resources (Possaghi & Papavlasopoulou, 2024; Uribe-Banda et al., 2021). In addition, some teachers struggle to align digital tools with pedagogical objectives, leading to technology being used primarily for administrative or supplementary purposes rather than as an integral part of learning (Biber et al., 2022; Raveh et al., 2025). These barriers may hinder the effective implementation of technology-enhanced instruction and limit the educational benefits that digital technologies can offer.

Despite these challenges, rapid advances in information technology require teachers to take a more proactive role in preparing students with the competencies needed for the future. Teachers with strong digital capabilities are better able to design, evaluate, and continuously update digital learning resources, thereby making learning more engaging and relevant (Serezhkina, 2021). In this study, teachers' digital competence is understood as a construct that includes three main components: (1) skills in utilizing digital technology to solve various learning problems, (2) attitudes towards the use of digital technology as a means to achieve learning objectives, and (3) knowledge related to digital technology acquired through formal education, work experience, and various professional development activities (Hämäläinen et al., 2021). Thus, teachers' digital literacy can be viewed as a fundamental prerequisite for effective technology integration in mathematics classrooms.

Effective mathematics teaching in the digital era requires not only strong content knowledge but also the ability to integrate technology and maintain positive beliefs about one's mathematical capabilities. Effective mathematics instruction requires teachers to integrate pedagogical knowledge, mathematical content knowledge, and digital technologies to support students' conceptual understanding and active participation in learning (Priyanda et al., 2025). Moreover, mathematics teachers are instrumental in helping students develop a deep understanding of mathematical concepts and explore complex mathematical ideas through meaningful learning experiences (Oumelaid et al., 2025). Among these factors, digital literacy enables teachers to utilize technological resources to support learning. At the same time, mathematics self-concept reflects teachers' confidence in their ability to understand, communicate, and teach mathematical ideas. Previous studies have examined these constructs separately, often focusing either on digital literacy, mathematics self-concept, or teacher competence. However, limited attention has been given to how these factors interact to influence teachers' competence. Understanding these relationships is particularly important in contemporary mathematics education, where teachers are expected to combine pedagogical expertise, technological proficiency, and confidence in mathematics to meet the demands of digital-era learning.

Despite growing interest in teachers' digital literacy, mathematics self-concept, and teachers' competence, limited research has examined how these constructs interact within a single structural model. Previous studies have typically investigated digital literacy, self-concept, and teacher competence independently, resulting in a fragmented understanding of the factors that contribute to effective mathematics teaching in the digital era. This highlights a gap in the literature regarding the extent to which teachers' digital literacy and mathematics self-concept are associated with their professional competence. To address this gap, this study aims to test a hypothesized structural model that explains how teachers' digital literacy and mathematics self-concept contribute to teachers' competence in technology-enhanced mathematics education. Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to examine the relationships among these latent constructs. Unlike previous studies that focus on isolated variables, this study provides a more comprehensive analysis by investigating their simultaneous relationships within a single model. The significance of this study lies in its integration of psychological factors, particularly mathematics self-concept, with professional factors such as digital literacy and teacher competence, thereby contributing to a broader understanding of teacher development in technology-enhanced mathematics education.

This addresses the following research questions:

RQ1: To what extent does digital literacy influence teachers' mathematics self-concept?
RQ2: To what extent does digital literacy influence teacher competence?
RQ3: To what extent does teachers' mathematics self-concept influence teacher competence?

To address the research questions, a hypothesized structural model was developed based on the literature reviewed in the preceding sections. The model specifies three hypothesized relationships among the latent constructs: digital literacy, mathematics self-concept, and teacher competence. Figure 1 presents the proposed research model and the corresponding hypotheses (H1–H3) derived from RQ1–RQ3.

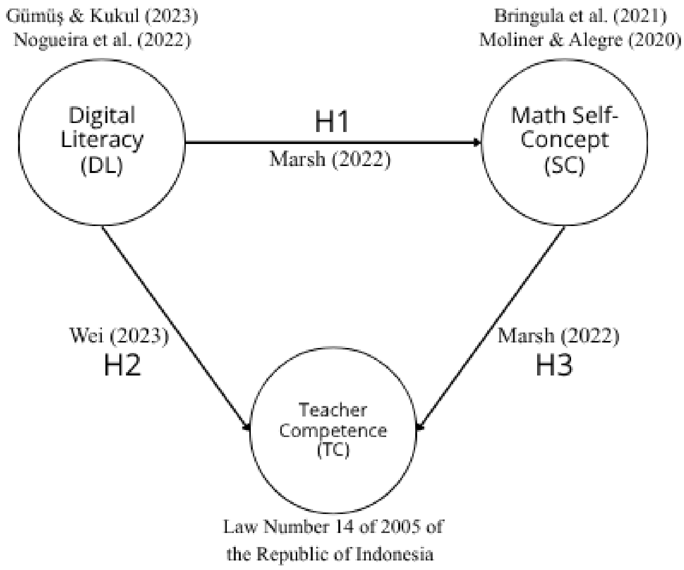

Figure 1. The Research Hypothesis

METHODS

This study employed a quantitative explanatory survey design to examine relationships among teachers' mathematics self-concept, digital literacy, and teacher competence, without manipulating participants' conditions. The study was positioned as a predictive investigation aimed at explaining the structural relationships among the latent variables. To achieve this objective, Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed using SmartPLS software. PLS-SEM was selected instead of covariance-based SEM (CB-SEM) for several reasons. First, the primary objective of this study was to predict and explain relationships among constructs rather than to confirm a well-established theory. Second, the sample size was relatively small (n = 40), whereas PLS-SEM has been shown to provide robust parameter estimates with small samples (Jhantasana, 2023; Kock & Hadaya, 2018). Third, PLS-SEM does not require multivariate normality and can produce reliable estimates even when data distributions deviate from normality assumptions (Cahyawati et al., 2023). The latent variables (constructs) analyzed in this study include mathematics self-concept (SC), digital literacy (DL), and teacher competence (TC), each with a reflective measurement model (see Figure 2). The complete list of questionnaire items and their corresponding indicators is available in the Supplementary File.

The study involved 40 high school mathematics teachers from Subang and Ciamis Regencies, West Java, Indonesia. Participants were selected using purposive cluster sampling. First, the sampling clusters were defined by geographical region: Subang and Ciamis. Subsequently, teachers were purposively recruited through local Mathematics Teachers' Working Groups (MGMP) according to the following inclusion criteria: (1) actively teaching mathematics at the senior high school level, (2) participating in MGMP activities, and (3) being between 25 and 50 years of age. This approach ensured that the participants had relevant professional experience and engagement in mathematics teaching communities. Data were collected through an online questionnaire administered using Google Forms. Instrument validity and reliability were evaluated as part of the PLS-SEM measurement model assessment using SmartPLS. Convergent validity was examined through outer loadings and average variance extracted (AVE), while internal consistency reliability was assessed using composite reliability (CR). Discriminant validity was evaluated using the heterotrait-monotrait ratio (HTMT). Indicators with outer loadings above 0.70, AVE values above 0.50, CR values above 0.70, and HTMT values below 0.90 were considered acceptable (Hair et al., 2017).

Mathematics self-concept is defined as an individual's perception of their competence in mathematics, including their confidence in understanding mathematical concepts, solving mathematical problems, and performing mathematics-related tasks successfully (Bringula et al., 2021). In this study, the construct was measured using three dimensions: (1) Mathematics ability (SC1), confidence in one's own ability to understand, perform, and complete math tasks; (2) Perceived mathematics performance (SC2) refers to teachers' evaluations of their own mathematical competence and performance in mathematics-related activities; (3) Mathematics interest (SC3), measuring interest and enjoyment in learning mathematics (Bringula et al., 2021; Moliner & Alegre, 2020). Each dimension was measured with two reflective indicators, yielding a total of 6 questionnaire items.

Digital literacy in this study is defined as the teacher's ability to master, adapt, and integrate technology into the learning process in accordance with learning objectives and students' needs (Serezhkina, 2021). Indicators for measuring teachers' digital literacy include: (1) Data literacy (DL1), the ability to search, evaluate, and effectively use digital data or information; (2) Digital content creation (DL2), the ability to design, develop, and modify digital content for learning purposes; (3) Problem solving (DL3), the ability to solve problems that arise in the use of technology and adapt to digital innovations; (4) Communication and collaboration (DL4), the ability to use digital tools to work together, participate, and communicate professionally; (5) Safety and ethics (DL5), the ability to maintain digital security, privacy, and protect personal and student data from online risks, as well as the ability to understand and apply ethical principles in using, sharing, and creating digital content

(Gümüş & Kukul, 2023; Nogueira et al., 2022). The digital literacy construct was measured using nine reflective indicators distributed across the five dimensions: three indicators for data literacy (DL1), one indicator for digital content creation (DL2), two indicators for problem solving (DL3), two indicators for communication and collaboration (DL4), and one indicator for safety and ethics (DL5).

Teacher competence in this study refers to the knowledge, skills, and professional behaviors that teachers must possess, internalize, and demonstrate in carrying out their educational responsibilities, as stipulated in Law Number 14 of 2005 of the Republic of Indonesia concerning Teachers and Lecturers. The construct was operationalized through four dimensions: (1) Professional competence (TC1), the ability to master subject matter broadly and deeply; (2) Pedagogical competence (TC2), the ability to manage learning; (3) Social competence (TC3), the ability of teachers to communicate and interact effectively and efficiently with students, fellow teachers, parents, and the surrounding community; (4) Personality competence (TC4), the ability to have a stable personality, noble character, wise, authoritative, and serve as a role model for students. The teacher competence construct was measured using 22 reflective indicators distributed across four dimensions: five indicators for professional competence (TC1), five for pedagogical competence (TC2), eight for social competence (TC3), and four for personality competence (TC4).

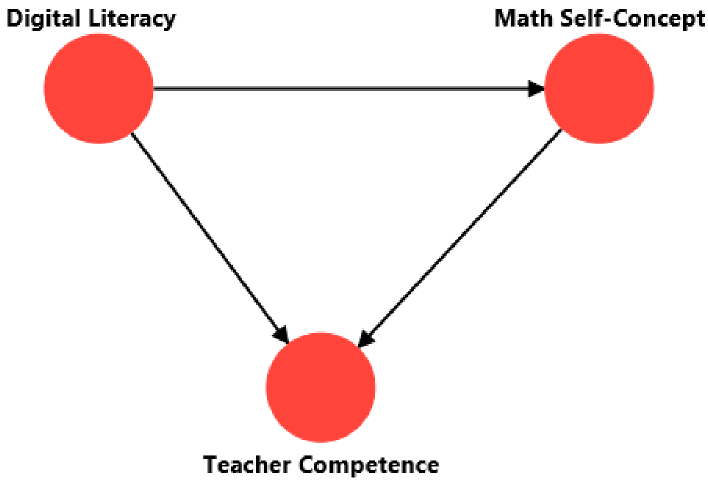

Figure 2. The Initial Measurement Model

RESULT AND DISCUSSION

To ensure that the indicators within a single construct truly have a high correlation and collectively reflect the same construct consistently, a convergent validity test is conducted using three main values in SmartPLS, namely outer loading, composite reliability (CR), and average variance extracted (AVE) (Jhantasana, 2023). The results of the convergent validity analysis are presented in Table 1.

Table 1. Convergent validity of the latent variable

No	Variable	Indicator	Total Item	Outer Loading	CR	AVE
1	Mathematics self-concept (SC)	SC1	2	0.902	0.924	0.803
		SC2	2	0.849		
		SC3	2	0.935		
2	Digital Literacy (DL)	DL1	3	0.950	0.958	0.819
		DL2	1	0.891		
		DL3	2	0.892		
		DL4	2	0.938		
		DL5	1	0.849		

3	Teacher Competence (TC)	TC1	5	0.909	0.972	0.896
		TC2	5	0.966		
		TC3	8	0.956		
		TC4	4	0.954		

Based on Table 1, all constructs satisfy the recommended criteria for convergent validity. All outer loading values exceed 0.70, while the composite reliability (CR) and average variance extracted (AVE) values are above the recommended thresholds of 0.70 and 0.50, respectively (Hair et al., 2017). These findings indicate that the indicators adequately capture their intended latent constructs and exhibit satisfactory reliability and convergent validity. Notably, Teacher Competence demonstrated the strongest measurement properties (CR = 0.972; AVE = 0.896), followed by Digital Literacy (CR = 0.958; AVE = 0.819) and Mathematics Self-Concept (CR = 0.924; AVE = 0.803). Therefore, the measurement model is considered robust and suitable for evaluating the structural relationships among the constructs (see Figure 3).

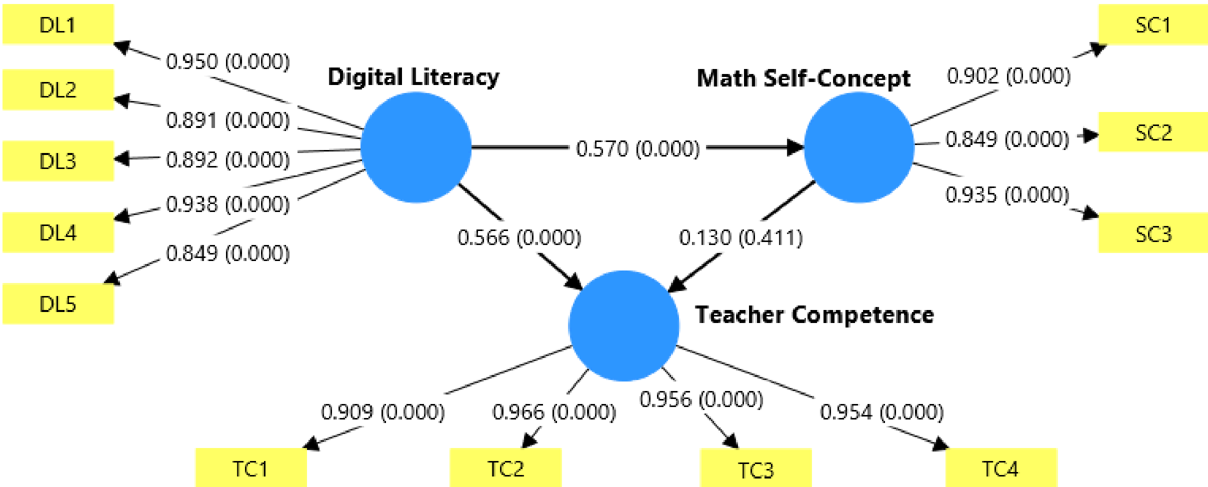

Figure 3. The Measurement Model of 3 Latent Variables

To ensure that each variable is unique and non-overlapping, a discriminant validity test was conducted between the variables of mathematics self-concept, digital literacy, and teacher competence. The discriminant validity test, conducted using the Heterotrait–Monotrait Ratio (HTMT) method via SmartPLS, is presented in Table 2.

Table 2. Heterotrait-monotrait ratio between latent variables

The relation between the latent variable	HTMT Ratio
Math Self-Concept - Digital Literacy	0.628
Teacher Competence - Digital Literacy	0.669
Teacher Competence - Math Self-Concept	0.483

All HTMT values shown in Table 2 are below 0.90, which means that all constructs used in the measurement model are truly distinct and do not overlap (Hair et al., 2017).

Hypothesis testing H1, H2, and H3 was conducted through structural model evaluation, including the following stages: (1) collinearity testing (VIF-inner model), (2) significance testing of structural model relationships (path coefficient), and (3) effect size measurement (f^2), (4) coefficient of determination measurement (R^2), and (5) predictive relevance measurement (Q^2) (Hair et al., 2017).

Table 3. Evaluation of the structural model

The latent variable	VIF	Model path coefficient		f^2	R^2	Q^2
		Path coefficient (β)	p-value			
Digital Literacy → Math Self-Concept	1.000	0.570	0.000	0.480		
Digital Literacy → Teacher Competence	1.480	0.566	0.000	0.374		
Math Self-Concept → Teacher Competence	1.480	0.130	0.468	0.020		
Math Self-Concept					0.324	0.287
Teacher Competence					0.421	0.370

Table 3 shows that all VIF values are less than 5, indicating no collinearity among the latent variables, and the structural model is suitable for further analysis (Hair et al., 2017). The strong effect of digital literacy on both mathematics self-concept ($\beta = 0.570,\ p < 0.001,\ f^2 = 0.480$) and teacher competence ($\beta = 0.566,\ p < 0.001,\ f^2 = 0.374$) highlights its central role within the model. These results validate H1 and H2, indicating that teachers with higher digital literacy tend to show greater confidence in their math skills and possess greater professional competence. In contemporary education, digital literacy extends beyond technical proficiency and serves as an essential resource for designing, implementing, and evaluating technology-enhanced learning environments. The digital literacy of teachers is very important in designing lesson plans, choosing instructional strategies, and using technology to enhance student engagement (Priyanda et al., 2025).

This finding suggests that enhancing teachers' digital literacy can have a substantial impact on their mathematics self-concept and teacher competence. Theoretically, these results support the view that the digital era necessitates the integration of ICT in education, enabling the mathematics learning process to be effective and relevant (Novitasari et al., 2020). A teacher with high digital literacy can effectively use technology to understand, teach, and reflect on mathematical concepts (Basilotta-Gómez-Pablos et al., 2022), thereby enhancing their mathematics self-concept. Additionally, strong digital literacy enhances teacher competence by strengthening their pedagogical and professional abilities to design innovative, interactive, and technology-based learning experiences.

This study indicates that mathematics self-concept does not have a significant direct effect on teacher competence ($\beta = 0.130,\ p = 0.468, f^2 = 0.020$). This indicates that teachers' confidence in their mathematics skills alone does not directly improve their competence in teaching practices. The multidimensional nature of teacher competence may explain this result. Internal beliefs influence teacher competence but are also shaped by external and contextual factors, including professional training, teaching experience, institutional support, and access to educational resources. Therefore, even if teachers possess a positive mathematics self-concept, these external factors may play a more dominant role in determining their overall competence.

In line with previous studies by Marsh (2022) and Sorjonen et al. (2024), self-concept is more closely associated with motivational constructs, such as effort, persistence, and engagement. These motivational factors may act as mediators that translate self-belief into actual teaching competence. Mathematics self-concept belongs to the affective domain, reflecting individuals' perceptions and beliefs about their abilities. In contrast, teacher competence encompasses cognitive and behavioral dimensions, including pedagogical knowledge, instructional skills, and professional practices. The distinction between these domains may limit the strength of their direct relationship within the structural model. Finally, this result highlights that improving teacher competence requires more than strengthening psychological factors such as self-concept. It requires integrated efforts that combine internal factors (e.g., beliefs and motivation) with external support (e.g., professional development programs, institutional policies, and collaborative learning environments).

The coefficient of determination indicates that the mathematics self-concept variable accounts for 32.4% of the variance in teachers' mathematics self-concept ($R^2 = 0.324$). This value falls into the moderate level of determination category (Hair et al., 2017). These findings indicate that teachers' digital literacy significantly influences mathematics self-concept. Teachers who are more skilled with digital devices tend to feel more capable of exploring mathematical materials by accessing a range of digital resources. That can strengthen their mathematics self-concept. The moderate level of this correlation suggests that mathematics self-concept is a complex construct and can be influenced by factors beyond digital literacy. Teachers' prior mathematical knowledge, teaching experience, and institutional support are likely to contribute significantly to shaping teachers' mathematics self-concept.

The predictive relevance value indicates that the model has moderate predictive ability for the mathematics self-concept variable ($Q^2 = 0.287$). Furthermore, the model shows a fairly strong predictive relevance for teacher competency ($Q^2 = 0.370$), indicating that the structural relationship proposed in this study is quite effective in predicting this construct. Specifically, the significant role of digital literacy in this model underscores its importance in enhancing teachers' professional capacity, especially in technology-based learning. Teachers with strong digital literacy tend to be better able to design interactive learning experiences, use digital learning resources effectively, and adapt to the ever-evolving demands of education.

However, teacher competence is influenced not only by individual capabilities but also by professional learning experiences and contextual conditions within schools and educational systems (OECD, 2017). Teacher competence is a multidimensional construct shaped by teachers' knowledge, beliefs, motivation, and contextual factors that influence professional performance (Blömeke et al., 2015). Teaching experience, pedagogical knowledge, institutional support, and other variables not yet accounted for in this model can also make equally important contributions. Digital literacy plays a significant role, but it is not the sole determining factor; it works alongside other contextual factors. Teachers' ability to use technology can strengthen their self-concept and increase their readiness to adopt classroom learning innovations. These findings also have practical implications, as efforts are needed to improve teachers' digital literacy to directly promote the quality of teaching and learning in the classroom.

Several limitations should be acknowledged. First, the study involved a relatively small sample of only 40 mathematics teachers, which may limit the statistical generalizability of the findings. Second, all participants were drawn exclusively from the Subang and Ciamis regions of West Java, Indonesia. Consequently, the findings may reflect local educational contexts and may not be fully representative of mathematics teachers in other regions or countries. Third, participants were limited to teachers aged 25-50 years who were actively involved in Mathematics Teachers' Working Groups (MGMP). As a result, the sample may represent teachers who are relatively more engaged in professional development activities and potentially more familiar with digital technologies than the broader teacher population. Therefore, caution should be exercised when generalizing the findings to teachers with different demographic and professional characteristics, particularly older teachers or those with limited participation in professional learning communities. Future studies should employ larger and more diverse samples to enhance the generalizability of the structural model and provide a more comprehensive understanding of the relationships among digital literacy, mathematics self-concept, and teacher competence.

CONCLUSION

This study examined the relationships among teachers' digital literacy, mathematics self-concept, and teacher competence using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings indicate that digital literacy is a significant predictor of both mathematics self-concept and teacher competence. Teachers with higher levels of digital literacy tend to demonstrate greater confidence in their mathematical abilities and higher levels of professional competence. These results highlight the importance of digital literacy not only as a technical skill but also as a factor that supports teachers' psychological and professional development in technology-enhanced mathematics education.

In contrast, mathematics self-concept did not have a significant direct effect on teacher competence. This finding suggests that confidence in one's mathematical ability alone is insufficient to enhance professional competence, which is influenced by a broader combination of pedagogical, professional, social, and personal factors. Consequently, efforts to improve teacher competence should not focus solely on strengthening teachers' self-perceptions, but also on developing digital literacy and other professional capacities. Therefore, professional development programs should prioritize enhancing teachers' digital literacy through continuous training, technology-integrated pedagogical practices, and participation in professional learning communities.

Overall, the structural model demonstrates moderate explanatory and predictive power, indicating that digital literacy plays a central role in shaping both teachers' mathematics self-concept and professional competence. These findings contribute to the growing body of literature on teacher development in the digital era by demonstrating the importance of integrating psychological and technological dimensions in supporting effective mathematics teaching. Future research should involve larger, more diverse samples from diverse educational contexts to further validate and extend the proposed model.

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