IJORER : International Journal of Recent Educational Research
Homepage : https://journal.ia-education.com/index.php/ijorer
Email : ijorer@ia-education.com

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 6, No. 3, May 2025
Page 863-879


# A Phenomenological Study on Indonesian Teachers' Digital Competence in the Age of Education 4.0

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DOI: https://doi.org/10.46245/ijorer.v6i3.840

**Sections Info**

***Article history:***
Submitted: April 2, 2025
Final Revised: May 06, 2025
Accepted: May 08, 2025
Published: May 31, 2025

***Keywords:***
Teacher; Digital technology; Physical education; Teacher Training; Digital Implementation

**ABSTRACT**

**Objective**: This study examines teachers' digital competence in the technological era, its relevance to professional and educational contexts, and implications for educational development. Method: This research adopts a phenomenological approach to investigate and articulate the lived experiences of teachers regarding their digital competence in the era of technology. **Result**: The findings highlight four key dimensions of digital competence: (1) technological awareness, emphasizing the importance of technology in modern learning; (2) technical skills, encompassing mastery of digital tools and platforms; (3) digital collaboration, where informal learning enhances mutual support among teachers; and (4) adaptability, reflecting the ability to embrace new technologies. **Novelty**: A key novel finding is the critical role of informal learning in the workplace, which significantly contributes to enhancing teachers' digital competence. Effective strategies include continuous learning with mentorship, social support from colleagues and family, and leveraging digital media as a learning resource. Best practices such as workplace collaboration and family-supported learning foster holistic digital literacy development. Intrinsic motivation also drives successful technology adoption. This study recommends a holistic approach to developing teachers' digital competence through ongoing training, social support systems, and integrated technology use. Strengthening digital competencies promotes workforce readiness, enhances teaching quality, and improves student learning outcomes. In the context of Education 4.0, this development is pivotal for educational transformation and preparing the younger generation to thrive in the digital era.

## INTRODUCTION

In an era marked by rapid technological advancement, digital competency has become a foundational requirement across professions. This competency includes not only technical proficiency with digital tools but also the ability to think critically, communicate effectively, and navigate complex digital environments. As societies become increasingly digitized, the need to cultivate these skills across educational and professional settings has grown more urgent.

Numerous studies highlight the value of digital competence in various domains. Konttila et al. (2018) emphasize its importance in healthcare, where digital communication and technical literacy are critical. Vissenberg et al. (2022) expand this view by suggesting that digital literacy enhances personal well-being through informed engagement, while Wild and Heuling (2020) underscore the disparities in digital proficiency among vocational students, pointing to the need for differentiated support strategies.

The education sector plays a central role in developing these competencies. As Lindsay (2015) notes, the presence of digital tools alone does not ensure meaningful learning—educators must cultivate students' critical digital literacy. Delcker (2022) adds that digitalizing the curriculum is essential to preparing students for the future workforce. Bartolomé et al. (2021) further argue that promoting digital competence reduces the risk of social and labor exclusion, making it a matter of equity as well as employability.

In higher education, embedding digital skills into academic programs is increasingly seen as non-negotiable. Shouman (2023) advocates for incorporating digital literacy to meet the demands of the digital economy, and Zhan (2024) links improved digital competence with greater employability. Yet, Dobson et al. (2022) reveal wide discrepancies in skill levels among graduates, signaling the need for continued training and institutional support.

Teachers, in particular, serve as both facilitators and role models in the development of digital skills. Chen (2024) finds that teachers with higher digital literacy are more effective in their roles. Caena and Redecker (2019) argue that teacher competency frameworks must evolve to meet the demands of the digital age, while Muntu et al., (2023) stress that digital literacy spans various domains—such as media, communication, and information management—critical for effective instruction.

Beyond education, broader transformations are reshaping the workplace. Fonseca and Picoto (2020) describe how digital shifts present both challenges and opportunities, requiring adaptable, digitally literate professionals. He et al. (2023) suggest that digital skill development benefits from holistic approaches, integrating mental well-being and professional growth.

Education 4.0 represents a further evolution, integrating technologies like artificial intelligence, big data, and the Internet of Things. Udvaros et al. (2023) stress the importance of computational thinking in navigating these environments. In this context, teachers must not only adopt digital tools but also guide students in using them meaningfully. Porlán and Sánchez (2016)) highlight the need for relevant training programs, while Klochko and Prokopenko (2023) emphasize foundational skills such as information literacy and communication.

Despite this growing awareness, gaps remain in how educators, particularly teachers, are equipped to meet digital demands. These gaps highlight the need for more flexible, sustainable, and context-responsive approaches to digital competency development—especially through informal learning in the workplace, which offers an adaptive, self-directed path for teacher development outside formal training structures.

While the literature affirms the urgency of digital skill development, there is limited exploration of how informal, workplace-based learning can effectively empower teachers to develop digital competence in practice. This study addresses that gap by investigating how informal learning strategies can be leveraged to enhance educators' digital skills in alignment with the demands of Education 4.0.

The study aims to: (1) Define the multidimensional aspects of digital competency relevant to teachers and educational institutions; (2) Explore how informal learning in the workplace supports the development of these competencies; (3) Identify best practices and strategies for integrating digital literacy into teacher training and professional development; and (4) Assess the broader implications of digital competency development on teaching quality, student learning outcomes, and workforce readiness.

By articulating these objectives, this research seeks to contribute a practical and theoretical framework for fostering teacher digital competence through informal learning models that are adaptable, scalable, and sustainable in diverse educational settings.

Building upon the foundational discussion of digital competency, this study adopts the Technological Pedagogical Content Knowledge (TPACK) framework to analyze the integration of digital tools into teaching practice. As educational institutions adapt to the demands of Education 4.0, the intersection of content knowledge, pedagogical strategies, and technological proficiency becomes essential for effective instruction.

TPACK extends Shulman's original concept of Pedagogical Content Knowledge (PCK) by incorporating technological knowledge, emphasizing the complex interplay required to teach effectively with digital tools. Redmond and Lock (2019) identify seven interrelated domains within TPACK, each contributing to a teacher's ability to design meaningful, technology-enhanced learning experiences. Liang et al. (2013) reinforce this, framing TPACK as a useful theoretical lens through which teacher readiness for technology integration can be evaluated.

However, successful implementation of TPACK presents notable challenges. Valtonen et al. (2020) found that pre-service teachers often struggle to self-assess their competencies across TPACK dimensions, leading to uncertainty in using digital tools. Similarly, Agyei and Kafyulilo (2019) caution that generic assessments may fail to capture the nuanced, subject-specific knowledge needed for effective integration. These issues point to the need for targeted professional development and reflective practices that address specific digital competencies within disciplinary contexts.

In the broader context of digital transformation, teachers must engage in continuous learning to remain effective. Makovii et al. (2022) argue that digitalization in education enhances not only instructional delivery but also demands heightened levels of digital literacy from educators. This is especially critical amid the Fourth Industrial Revolution, which emphasizes skills such as critical thinking, creativity, and problem-solving. Lutfiana (2024) highlights that improving teachers' digital literacy directly correlates with increased confidence and effectiveness in using technology for pedagogical purposes.

Koehler et al. (2013) maintain that TPACK offers a practical model for preparing educators to operate within these evolving environments. Falloon (2020) adds that equipping teachers with digital capabilities in their initial training is a key component of preparing them to meet the expectations of Education 4.0.

The integration of technology into education brings significant pedagogical benefits. When used thoughtfully, digital tools can enhance engagement, support differentiated instruction, and expand access to resources. Behera (2023) shows that mobile and online learning environments significantly boost student motivation and interaction. Tamim et al. (2011) confirm this with a meta-analysis demonstrating moderate to positive impacts of technology on student achievement when embedded in effective instructional design.

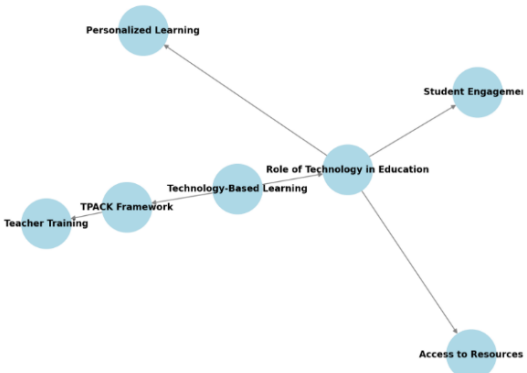


**Figure 1.** Theoretical Framework

Personalized learning, enabled by digital platforms, allows students to progress at their own pace and follow tailored learning pathways. Aşıksoy (2019) notes that environments supporting pedagogical and technical infrastructure—such as concept mapping software—can lead to deeper conceptual understanding. This is especially beneficial for accommodating diverse learning preferences and promoting learner autonomy. Moreover, mobile learning technologies expand the learning environment beyond traditional classrooms. Lai et al. (2014) and MacCallum et al. (2017) show how mobile tools support experiential and collaborative learning, fostering communication and critical engagement regardless of time or location. Such flexibility supports lifelong learning and improves access for students with varied needs and schedules.

Despite these benefits, technology integration is not a guaranteed solution. Goodchild and Speed (2018) argue that educational institutions must also evolve their cultural and pedagogical norms to fully capitalize on digital innovations. Teresevičienė et al. (2017) further emphasize the necessity for mindset shifts among educators, who must adapt traditional teaching practices to align with new technological realities. Furthermore, effective integration demands more than infrastructure—it requires intentional pedagogical design. Yılmaz (2021) and Asratie et al. (2023) highlight that thoughtfully designed digital learning environments can foster critical and creative thinking, as well as improve specific skills like public speaking. Meanwhile, Zhang (2024) and Criollo-C et al. (2021) discuss the importance of accessible digital platforms in democratizing access to high-quality educational content.

This study applies the TPACK framework to understand how informal workplace learning contributes to the development of digital competencies among educators. Focusing on teachers at SMA Negeri 1 Ciranjang in Cianjur, West Java, this research draws on in-depth interviews to explore how teachers navigate the demands of Education 4.0 through informal, self-directed professional learning. By doing so, it bridges the theoretical underpinnings of digital pedagogy with real-world practices in Indonesian secondary education.

## RESEARCH METHOD

This study employs a phenomenological qualitative approach to explore and describe the lived experiences of teachers regarding their digital competence in the technological era. The phenomenological design is chosen to uncover the essence of these experiences from the participants' subjective perspectives, aligning with the study's goal of understanding how teachers perceive and navigate digital integration in their teaching.

Phenomenology, grounded in Edmund Husserl's philosophy, prioritizes understanding the "what" and "how" of lived experience rather than explaining the "why" (Creswell, 2013). This study follows the descriptive phenomenological tradition to delve into teachers' direct experiences with digital technologies.

A central concept in phenomenological inquiry is bracketing or *epoché*, which involves suspending the researcher's own assumptions to focus purely on participants' viewpoints. As Moustakas (1994) explains, this practice allows researchers to "enter the world of the participant" without bias. In this study, bracketing was maintained throughout data collection and analysis by keeping a reflexive journal and consistently revisiting researcher assumptions.

Data were collected from three secondary school teachers at SMA Negeri 1 Ciranjang, Cianjur, West Java, selected through purposive sampling. Selection criteria included active involvement in digital teaching practices and a minimum of five years of

teaching experience. This ensured participants had sufficient exposure to digital tools and pedagogical shifts in the Education 4.0 era.

The primary data collection method consisted of in-depth, semi-structured interviews. Interviews lasted between 45 to 75 minutes and were conducted face-to-face in a quiet setting within the school environment. All interviews were audio-recorded with consent and subsequently transcribed verbatim. While Van Manen (1990) describes interviews as "the most direct way to approach the meaning of lived experience," this study goes further by connecting that notion to the participants' digital realities. The interview questions were designed to evoke narratives of daily challenges, adaptation processes, and perceived benefits of using digital technologies in the classroom.

The data analysis followed phenomenological reduction, guided by (Giorgi, 2009) steps:

1) Reading transcripts holistically
2) Identifying meaning units
3) Transforming meaning units into psychological expressions
4) Synthesizing themes into a coherent structure

To ensure analytical rigor and traceability, the researcher used manual coding alongside NVivo software to organize and manage codes, themes, and participant quotes systematically. The final stage involved synthesizing the codes into major themes and subthemes that encapsulated the lived experience of digital competence. Trustworthiness was ensured through: (1) Member checking (participants reviewed transcripts and summaries); (2) Peer debriefing with fellow qualitative researchers; (3) Audit trail of coding decisions and memo writing.

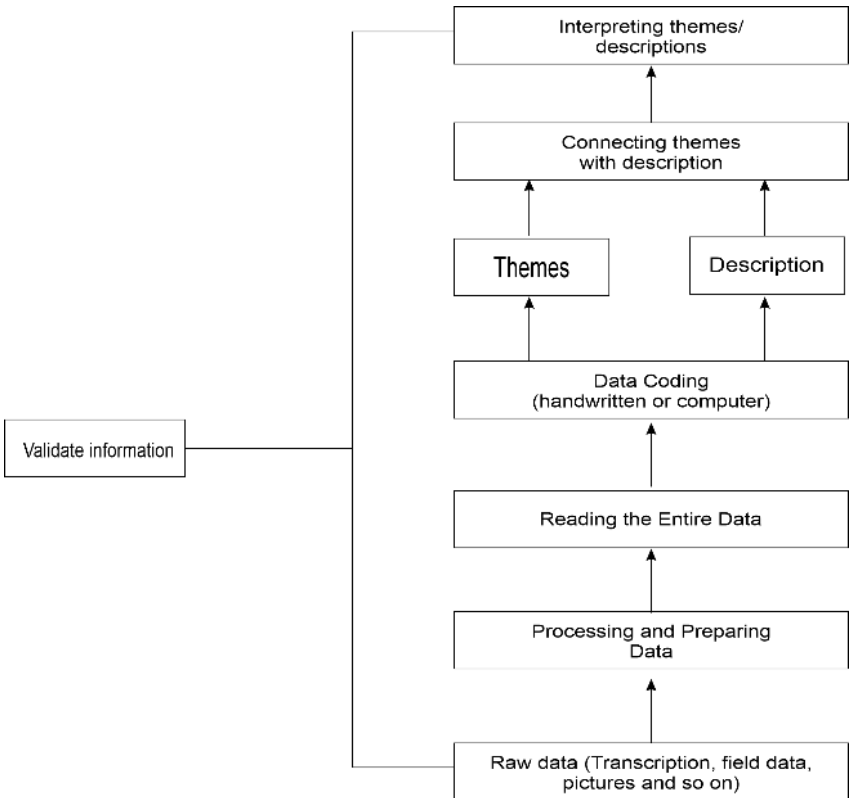


**Figure 2.** Data Analysis in Qualitative Research Cresswell

Figure 2 illustrates the cyclical nature of qualitative data analysis, beginning with raw data and culminating in interpretation and theme development. This model was adapted and followed in analyzing interview transcripts for this study.

## RESULTS AND DISCUSSION

### *Results*

The results of this study reveal a multifaceted understanding of teacher digital competence in the technological era, highlighting its critical role in enhancing educational practices. The analysis uncovers significant patterns, such as the varying levels of proficiency among teachers in utilizing digital tools, influenced by factors like access, prior experience, and institutional support.

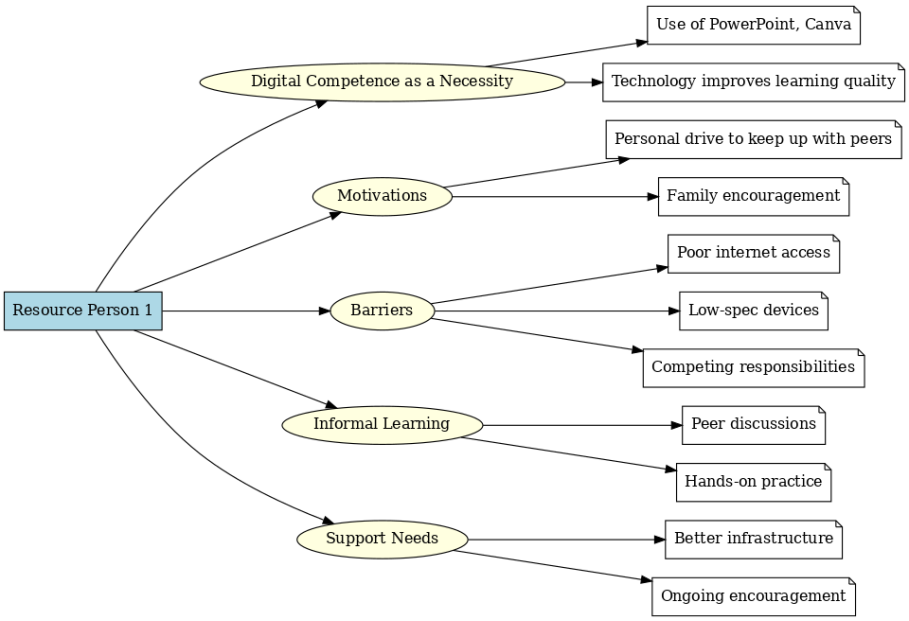


**Figure 3.** Coding of Resource Person 1

In the interview, Resource Person 1 said that digital technology competence is very important for teachers in this modern era. He emphasized that the demands of the times make the use of technology in learning a must. Adapting to technological developments is a step that needs to be taken so that the teaching and learning process can run more effectively. Teachers must be able to utilize various digital media to support the delivery of materials, so that they can help students more easily access various learning resources.

Resource person 1 also explained that the use of digital technology has a number of significant benefits, including time efficiency in delivering materials and improving the quality of learning. Media such as PowerPoint and Canva, for example, are considered capable of making learning more interesting and interactive. In addition, the use of technology allows students to be more independent in finding and understanding materials, which were previously difficult to achieve with conventional learning methods.

However, Resource Person 1 acknowledged that not all teachers, especially those he called "old products," have adequate digital skills. This challenge actually motivated him to continue learning so as not to be left behind by younger colleagues, who are generally more familiar with technology. The encouragement to master digital technology also came from various sources, both internal and external. Internally, he felt the need to improve his competence to support learning. Externally, the support of family and colleagues also encouraged him to continue learning and adapting.

However, Resource Person 1 did not turn a blind eye to the obstacles faced. He revealed that limited infrastructure, such as internet access in remote areas where he lives, is a major obstacle. In addition, inadequate equipment, such as low-spec mobile phones or computers, also hinders the process of learning technology. Other obstacles

are work, family responsibilities, and laziness that sometimes arises because of feeling far behind in terms of technological mastery.

To overcome these obstacles, Resource Person 1 relies on informal learning as the main solution. He often discusses and shares knowledge with colleagues on how to use digital technology. In addition, he believes that direct practice is very helpful in understanding and mastering new technologies. Resource Person 1 also suggested that the government be more serious about providing equal internet access, especially in remote areas, so that teachers can easily improve their digital competence.

Overall, Resource Person 1 believes that mastery of digital technology is very important to improve the quality of learning. With the right support and high enthusiasm for learning, he is optimistic that all teachers, including senior ones, can develop their competencies according to the demands of the times.

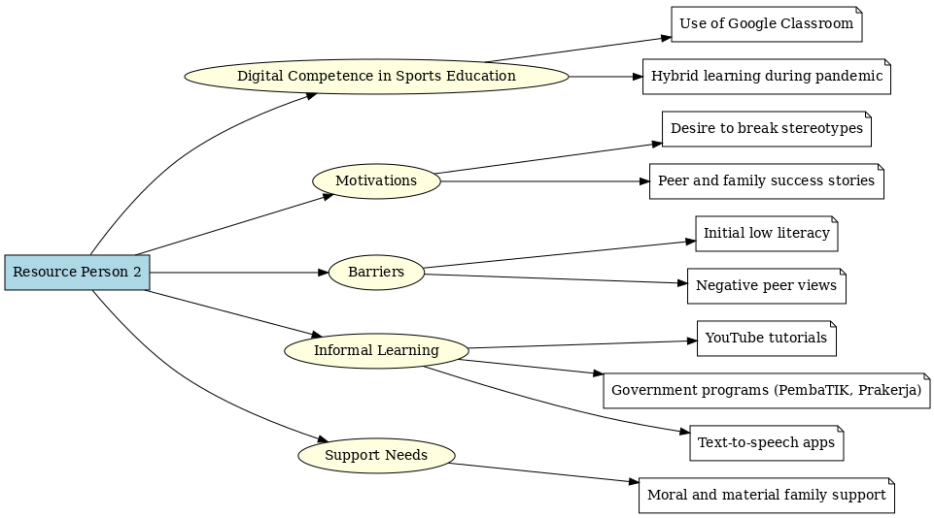


**Figure 4.** Coding of Resource Person 2

Resource person 2, a sports teacher with more than eight years of experience, expressed the importance of mastering digital technology in supporting the learning process, including in sports subjects. He explained that although there is a general assumption that sports teachers rarely use digital technology, he is very interested in digitalization and strives to continue to improve his competence.

As part of his motivation to learn technology, Resource Person 2 said that he started learning independently through platforms such as YouTube and participating in government programs, such as Kartu Prakerja and ICT-Based Learning (PembaTIK). These programs not only provide digital training but also open up opportunities for him to get certification and improve his skills, including in creating simple applications for learning.

During the covid-19 pandemic, Resource Person 2 adapted digital-based learning through a hybrid approach. He utilized Google Classroom to provide materials to students before the practicum meeting, so that students had a better initial understanding. In this way, learning in the field became more focused and interactive, where students were prepared in advance.

The main motivation of Resource Person 2 in developing digital competence comes from the desire to prove that sports teachers are not only limited to teaching roles in the field, but can also contribute in other areas, such as curriculum and supervision. This motivation is supported by internal and external factors. Internally, he was inspired by the success of his peers who had pursued higher education or achieved success in their respective fields. Meanwhile, moral support from family and colleagues also played an

important role. He said that his family was very supportive, both morally and materially, in every effort to improve his competence.

However, Interviewee 2 also faced a number of obstacles along the way. One of the main challenges was his initial lack of digital literacy, which he admitted was due to his dislike of reading books. To overcome this, he used an application that could convert text into audio, making the learning process easier. In addition, inconsistent motivation in the past was also an obstacle, although he has managed to overcome this through continuous effort.

From the external side, he mentioned that negative views from a small number of colleagues were sometimes a challenge. However, he managed to turn this into motivation to keep moving forward. Regarding facilities, Resource Person 2 assessed that even though there were limitations on certain devices, he was able to maximize the use of smartphones and platforms such as Google Classroom to support learning.

Overall, Resource Person 2 assessed that mastery of digital technology is an important step to improve the quality of learning, including in the field of sports. With a high spirit of learning and support from various parties, he is optimistic that sports teachers can be on par with teachers from other fields in terms of technology utilization.

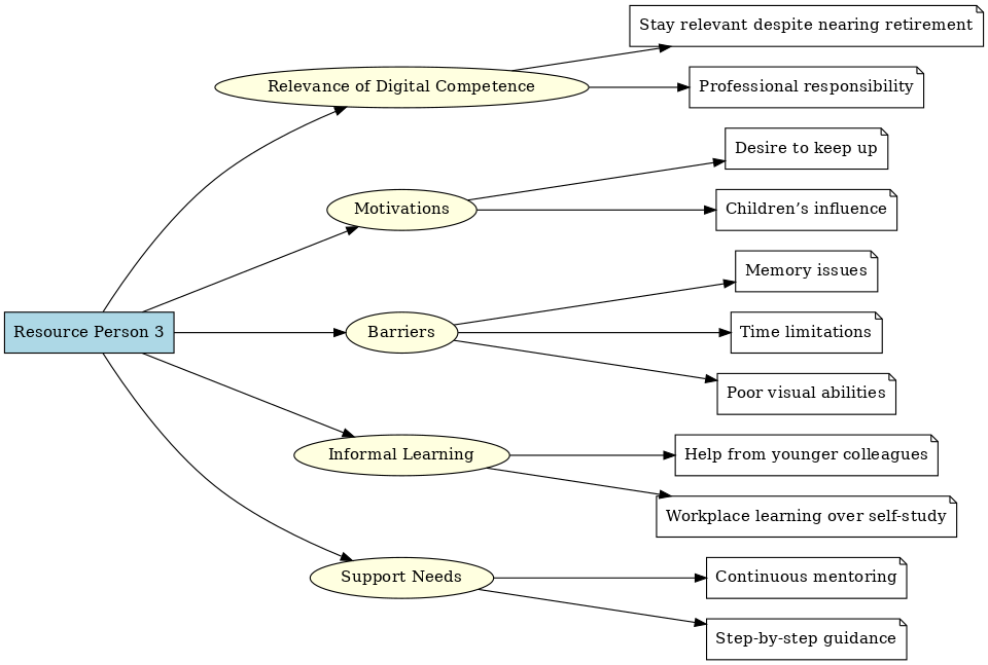


**Figure 5.** Coding of Resource Person 3

Resource person 3, a teacher approaching retirement, shared his views on the importance of mastering digital technology in learning. Although he finds it difficult to keep up with technological developments due to his age, he remains committed to adapting to the demands of the times. For him, mastering digital technology is urgent so as not to be left behind by more advanced colleagues.

The internal motivation of Interviewee 3 to learn digital technology comes from his desire to stay relevant in the modern era. He feels it is important to keep up with the development of his colleagues and ensure that he is not left behind. In addition, external motivation also comes from family support, especially his children who often help provide understanding regarding the use of technology. He said that his children, although still in school, have better digital skills and are often the place to ask questions.

In her learning process, Resource Person 3 uses a learning approach with family and utilizes support from friends in the work environment. When she has difficulty

understanding certain steps in using a device or application, she does not hesitate to ask her colleagues, including younger teachers. However, she admits that learning independently through platforms such as YouTube is often difficult due to limited visual abilities and technical constraints, such as understanding the functions of a laptop or certain applications.

Support from the work environment is also a significant factor in improving his competence. Colleagues often provide motivation by convincing him that he is still able to learn despite his age limitations. Interviewee 3 also feels that learning in the workplace, with direct interaction with friends, is more effective than learning independently through digital media.

However, Resource Person 3 faced various obstacles in his learning journey. One of the main obstacles was the difficulty in remembering the technical steps to be followed, especially when the steps were complex and time-consuming. Another obstacle was the limited time, both from himself and from his colleagues who were busy with their respective tasks. Nevertheless, he tried to make optimal use of the available time, both by asking friends again and trying to solve the problem independently.

In his view, an effective training pattern should be continuous, with intensive mentoring so that participants can repeat and understand the material well. He feels that this approach is more suitable than short and independent training.

Resource person 3 showed a high enthusiasm for learning despite facing various challenges. With the support of family, colleagues, and personal determination, he is optimistic that he can continue to improve his digital technology competence, even in his retirement period. For him, the ability to adapt to technology is a form of professional responsibility as an educator in the digital era.

**Thematic Analysis**

This study presents the lived experiences of three teachers, each revealing distinct yet interrelated aspects of digital competence in the technological era. Through narrative case studies and coding analysis (Figures 3–5), several overarching themes emerged:

**Theme 1: Digital Competence as a Necessity**

All three teachers emphasized the importance of mastering digital technology to remain relevant in the classroom. Resource Person 1 described it as a *"must"* in the current era, pointing out the efficiency and interactivity digital tools offer in delivering content. Similarly, Resource Person 2 countered the stereotype that sports teachers are disconnected from digital practices by integrating tools like Google Classroom into his lessons. Resource Person 3, nearing retirement, saw digital competence as a way to keep pace with his peers and stay engaged with students.

"Teachers must adapt to technological developments to make learning more effective." — *Resource Person 1.*

**Theme 2: Motivations for Learning Technology**

Both internal and external motivations drive teachers to enhance their digital skills. Internal motivations included professional pride, a desire to avoid being left behind, and aspirations to contribute beyond classroom instruction. External motivators included support from family, colleagues, and exposure to training opportunities.

1) Resource Person 2 mentioned, "*Seeing friends succeed motivated me to improve myself*".
2) Resource Person 3 was inspired by his children's fluency in technology, stating, "*My kids are still in school, but they already know more than I do*".

**Theme 3: Barriers to Digital Adaptation**

Barriers appeared across all cases and included:

1) Technological infrastructure (limited internet, outdated devices)
2) Age-related limitations (especially for Resource Person 3)
3) Low prior exposure or digital literacy
4) Time constraints and family/work responsibilities

"Sometimes I feel lazy because I'm too far behind, but I keep trying." — *Resource Person 1*

**Theme 4: Informal Learning as a Strategy**

In the absence of formal support, all teachers relied heavily on informal learning. They watched tutorials, consulted peers, and learned through trial and error. Resource Person 1 emphasized peer discussions, while Resource Person 2 used text-to-speech apps to overcome reading difficulties. Resource Person 3 preferred learning through direct interaction at the workplace rather than independent study.

**Theme 5: Institutional and Social Support**

Support networks played a crucial role in teacher empowerment. Families encouraged persistence, while colleagues provided hands-on help. However, institutional support was seen as uneven. All participants highlighted the need for continuous mentoring and equal access to infrastructure, especially in rural areas.

The findings are visually represented in Figures 3 to 5, which show the coding maps of each resource person. These figures have been refined to correspond directly to the thematic categories discussed above.

1) Figure 3 illustrates Resource Person 1's emphasis on peer learning, infrastructure challenges, and self-motivation.
2) Figure 4 reflects Resource Person 2's progression from self-learning to hybrid instruction and the use of government programs.
3) Figure 5 highlights Resource Person 3's reliance on social support and need for step-by-step mentoring.

Figures 3–5 are coding maps derived from NVivo analysis, visualizing the frequency and co-occurrence of major themes and subthemes from each narrative.

These findings demonstrate the complex and individualized pathways through which teachers navigate digital competence. Although each participant faced distinct barriers, all converged on the necessity of adaptation and the empowering role of informal, peer-based learning in overcoming challenges. This thematic framework lays the foundation for the discussion in the next section, which will further analyze the implications for professional development, policy, and teacher empowerment in digital contexts.

## *Discussion*

**Digital Competence of Indonesian Teachers in the Context of Education 4.0**

Based on interviews with three sources, teachers' digital competence includes several main dimensions that are relevant to the professional and educational context, namely:

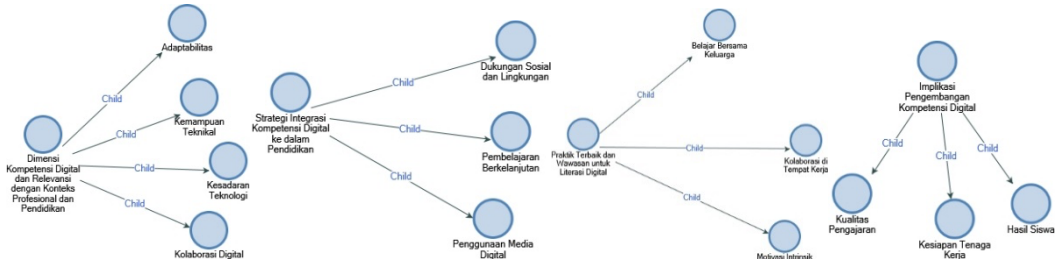


**Figure 6.** Dimensions of Digital Competence and Relevance to Professional and Educational Contexts

**The Multidimensional Nature of Teachers' Digital Competence**

The concept of digital competence in educators is increasingly recognized as multifaceted and dynamic. The European Framework for the Digital Competence of Educators (DigCompEdu) provides a comprehensive structure that defines what it means for educators to be digitally competent. This framework organizes 22 competences across six areas, addressing professional tasks, pedagogical strategies, and learner-focused practices (Eroupean Commission, 2021). Our research findings, drawn from in-depth interviews, reinforce this multidimensional perspective, highlighting four distinct but interrelated dimensions of digital competence among teachers.

The first of these is Technology Awareness and Context Understanding. For instance, Teacher 3, despite nearing retirement, demonstrated a strong awareness of the importance of digital technology in modern education. Her attitude illustrates the foundational layer of digital competence: a conscious understanding of why digital skills matter in teaching. This echoes Cabero-Almenara et al. (2023), who emphasize that teachers must first acquire a mindset geared toward digital integration before they can successfully implement it.

The second dimension involves Operational Technical Skills, where teachers face the practical challenge of using digital tools effectively. Respondents 1 and 3 expressed difficulties in using software, indicating that technical fluency remains a barrier for many educators. This supports the findings of Feng S. (2023), who assert that digital competence must include the ability to practically engage with digital resources to enhance educational delivery.

Another key dimension is Digital Collaboration Capacity. Several teachers underscored the value of learning from peers. This peer-to-peer support system enhances competence and confidence, validating the research of Tejedor et al. (2020), who found strong correlations between teacher networks, collaborative projects, and student digital competence outcomes.

Lastly, Adaptive Professional Practice surfaced as a critical aspect. All participants reflected on their varying ability to adapt to digital change. This flexibility is essential for thriving in today's constantly evolving educational landscape, aligning with Lapina A. (2019) concept of "advanced digital competencies" that position educators as proactive agents in digital education reform.

Together, these dimensions do not stand in isolation but function as an interconnected system. Progress in one area often supports development in others. This interplay reflects the TPACK framework developed by Mishra and Koehler (2006), which stresses the synergy between technological, pedagogical, and content knowledge in successful digital integration.

**Strategies for Developing Digital Competence**

Our study reveals that the development of digital competence is best supported by intentional strategies that combine formal training with informal learning

opportunities. One of the strongest themes to emerge was the role of Continuous Professional Development. For example, Teacher 3 emphasized the importance of having a mentor to navigate new technologies. This mirrors Ifenthaler (2018) argument that digital technologies can act as bridges between theory and practice in the professional learning space.

In addition, Social Learning Environments play a crucial role. Teachers 1 and 3 both mentioned turning to colleagues and even family members for support. These informal learning moments are consistent with Casquero et al. (2020), who point out that inter-professional communities—especially those that use digital tools—can strengthen teachers' pedagogical innovation.

While Teacher 3 expressed difficulties learning independently from platforms like YouTube, the experience underscores the value of Blended Learning Approaches. Structured learning, when complemented by informal self-directed exploration, can lead to more robust competence development. (Heidari et al., 2021) emphasize that informal digital learning enhances professional engagement by supporting both pedagogical and technological growth.

Another important strategy involves Self-Reflective Practice. The range of digital confidence observed in our respondents highlights the importance of self-assessment tools. These allow educators to identify their current competence levels and create targeted development plans. As noted by Ghomi C. (2019), DigCompEdu supports this through a structured self-assessment process.

**Effective Practices for Digital Literacy Development**

Our research also identified several specific practices that effectively support digital competence. Intergenerational Learning surfaced as a unique and powerful strategy. Teacher 3 shared how learning from her children helped her grasp digital tools, validating the approach described by Martínez-Piñeiro Delgado-Benito V. and Gewerc A. (2022), who advocate for frameworks that embrace diverse roles and relationships in learning ecosystems. Equally important are Professional Learning Communities. Teachers 2 and 3 frequently relied on colleagues for guidance and feedback, a practice that aligns with the insights of (Newel, 2025), who highlights the value of video-sharing and peer review in professional growth.

Moreover, Purpose-Driven Learning emerged as a key motivator. Teacher 3's intrinsic belief in the importance of digital competence drove her willingness to learn. This supports (Garzón Artacho et al., 2020), who argue that digital competence is foundational for creating innovative and meaningful teaching environments.

**Broader Implications for Education**

The ripple effects of teachers' digital competence extend far beyond their individual practice. One clear implication is for Workforce Preparation. Several interviewees recognized that digitally competent teachers are better able to prepare students for the demands of a technology-centric workforce. This aligns with research by (García-Vandewalle García et al., 2023), who argue that investing in teacher training contributes to students' educational and socioeconomic success.

There is also potential for Educational Quality Transformation. Respondents acknowledged how digital competence enhances the quality of learning experiences. Frameworks like CDCFT help identify areas that need strengthening, enabling schools to foster continuous improvement (García-Vandewalle García et al., 2023).

At a systemic level, Systemic Educational Evolution becomes possible when teacher development is prioritized. As Caena and Redecker (2019) note, digital competence can support transformation not just at the level of individual practice, but

also at the meso-level of institutional governance. Schools can evolve into learning organizations where innovation and collaboration are embedded in the culture.

Our research demonstrates that developing teachers' digital competence requires a comprehensive approach that recognizes its multidimensional nature and leverages both formal and informal learning opportunities. As Mishra and Koehler (2006) note, teaching is "an example of an ill-structured discipline, requiring teachers to apply complex knowledge structures across different cases and contexts" in increasingly "dynamic classroom contexts," making integrated digital competence development essential.

The findings suggest that effective development strategies must integrate formal training with informal workplace learning, create supportive collaborative environments, and foster intrinsic motivation. This reflects how frameworks like DigCompEdu are "articulated around six differentiated competency areas that teachers must possess to promote effective, inclusive and innovative learning strategies, using digital tools" (Cabero-Almenara & Palacios-Rodríguez, 2021).

In the context of Education 4.0, investing in teachers' digital competence development enhances not only teaching quality but also prepares students for the technological demands of future workplaces. As (Althubyani, 2024) indicates, "digital transformation opens up multiple opportunities for educators to achieve the continuity of learning through life" and "prepare them for the digital age" by using technology "to deepen students' learning experiences."

## CONCLUSION

**Fundamental Finding**: The results of this study indicate that teachers' digital competence is an important element in supporting educational transformation in the technological era. This competence consists of several main dimensions, namely technological awareness, technical ability, digital collaboration, and adaptability. Awareness of the importance of technology encourages teachers to remain relevant in a professional context, while technical ability ensures they are able to utilize various digital devices and platforms. Digital collaboration strengthens learning through social support, and adaptability helps teachers face new technological challenges. **Implications**: the implications of this study include improving the quality of teaching through technology integration, teacher readiness to meet the demands of Education 4.0, and contributing to better student learning outcomes. **Limitation:** to support the development of holistic digital competence, continuous training is needed with an approach that includes social support, the use of digital media, and relevant learning strategies. **Future Research : t**eachers' digital competence not only improves the quality of education but also strengthens the competitiveness of the workforce in the future.

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