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Navigating Deep Learning Pedagogy in Rural Classrooms: A Qualitative Study on Teacher Readiness and Innovation in Indonesian Elementary Schools

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ABSTRACT

Purpose of the study: The integration of digital technology in primary education has become increasingly urgent in the era of 21st-century learning transformation. However, teachers' readiness to implement deep learning approaches and instructional innovation remains a challenge, particularly in non-urban areas such as Sumenep Regency.

Methodology: A qualitative descriptive approach was employed, involving six purposively selected teachers as primary data sources. Data were collected through classroom observations and structured interviews and then analyzed using the Miles and Huberman model, which includes data reduction, data display, and conclusion drawing.

Main Findings: The findings reveal that teachers' conceptual understanding of deep learning remains limited, and its classroom application has not reached a transformative level. Teacher readiness is influenced by insufficient training, inadequate infrastructure, weak institutional support, and varying levels of self-efficacy. Systemic barriers such as limited technological access and lack of supportive school policies hinder also implementation efforts.

Novelty/Originality of this study: This study uniquely examines teacher readiness for deep learning-oriented instruction in an underrepresented context—rural elementary schools in Indonesia. Unlike previous research that predominantly focuses on urban or secondary education settings, this study captures the real-world constraints and opportunities for digital transformation in low-resource environments. It also broadens the conceptual framing of "deep learning" beyond technology, integrating pedagogical depth and reflective teaching practices. The implications highlight the urgency of designing context-based, practice-oriented teacher training programs and developing supportive policies that enable sustainable digital pedagogy.

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1. INTRODUCTION

Elementary education plays a vital role in forming children's basic knowledge and skills and in their social development [1]. In Indonesia, elementary school is the first stage that prepares students to continue their education to a higher level [2]. Therefore, the quality of education at this level must continue to be improved to produce a competent generation ready to face global challenges [3]. A critical aspect of improving the quality of education is the application of technology in the learning process. In recent years, technological advances have

significantly changed how teaching and learning are carried out [4], especially with deep learning approaches and learning innovations increasingly adopted by various developed countries [5]. This approach, which uses sophisticated algorithms to analyze data and support decision-making in learning, promises to improve the effectiveness of teaching and learning in elementary schools. Although the great potential of this approach is clear, the biggest challenge in its implementation is the readiness of teachers to adopt and apply the technology in their classrooms [6].

Implementing deep learning and learning innovation in elementary schools faces several obstacles, especially regarding teacher readiness. This readiness covers various dimensions, ranging from knowledge of the technology used to the ability to integrate the technology into existing learning plans [7]. This study analyzes teacher readiness in facing this significant change to evaluate the extent to which teachers in elementary schools, especially in Sumenep Regency, are ready to implement the deep learning approach and innovation in learning. Education in this area has its challenges in terms of infrastructure, teaching quality, and technological skills educators possess.

According to data from the BPS of Sumenep Regency, around 60% of teachers in the area still feel unprepared to integrate technology into their learning process [8], [9]. This is exacerbated by limited access to adequate technological devices in many schools and the lack of adequate training for teachers in utilizing the latest learning technologies [10]–[12]. In East Java as a whole, data from the East Java Provincial Education Office shows that only around 45% of teachers have received training in the use of educational technology, and of that number, only a small proportion feel confident in implementing deep learning in their classrooms [13], [14]. This indicates a significant gap between the potential use of technology in the classroom and the readiness of teachers to implement it. Therefore, this study is critical to identify the challenges and obstacles teachers face in implementing this new technology and find solutions that can help improve their readiness.

This study aims to analyze the factors that influence teacher readiness in implementing deep learning and innovation in learning in elementary schools. Some factors that will be analyzed include the level of teacher knowledge about the technology, infrastructure readiness, and support received by teachers from the school and government. By understanding these factors, this study is expected to provide valuable insights for designing more effective training programs and policies that can support the implementation of technology in elementary schools. The primary focus of this study is to answer several important questions regarding teacher readiness, challenges faced in implementing technology, and how this technology can be utilized to improve the quality of education at the elementary level.

Several significant issues must be addressed in implementing deep learning and innovation in learning. One of the main issues is teachers' readiness to use the technology. Although this technology offers much potential to improve the quality of learning, the reality is that many teachers do not have adequate skills or knowledge to use it effectively [15], [16]. This problem is related to various factors, including lack of proper training, limited access to technological devices, and low teacher confidence in integrating new technology into their curriculum [17], [18]. In addition, there are also challenges related to teachers' understanding of how to use technology to support innovative teaching methods, which focus on increasing student creativity and engagement. Another problem is how schools and the government can provide adequate infrastructure to support the implementation of this technology. Most schools in areas such as Sumenep Regency do not yet have sufficient technological devices to support implementing deep learning [19], [20]. In many schools, computers and other hardware are not available in sufficient numbers, and the internet is often unstable, which hinders the maximum use of technology. These factors must be identified and analyzed to find appropriate solutions to improve teacher readiness and improve existing infrastructure [21], [22].

The urgency of this research can be seen from two sides. First, the need to improve the quality of education in Indonesia, especially in elementary schools, is very urgent. Amid the rapid development of global technology, if Indonesia does not immediately adopt and integrate technology in education, the gap between the quality of education in Indonesia and developed countries will widen [23], [24]. Second, at the local level, Sumenep Regency and East Java have specific challenges related to implementing technology in education. In Sumenep, many teachers have not been exposed to modern technology training, which results in low levels of technology use in teaching. This research will provide essential insights into how teachers in the area can be supported to be better prepared to face the challenges of technology in education. In addition, the urgency of this research is also related to the role of technology in improving the effectiveness of learning. Deep learning and learning innovation can help create a more interactive and adaptive learning environment. However, the success of implementing this technology is highly dependent on the readiness and competence of teachers. Therefore, this research is very important to identify factors that influence teacher readiness, as well as to develop recommendations that can help improve the effectiveness of implementing technology in education.

While numerous studies have examined teachers' use of educational technology, the majority focus on urban schools, secondary education, or general ICT integration. There is a lack of empirical research addressing teacher readiness to implement deep learning pedagogies in rural elementary schools, where contextual challenges such as poor infrastructure, limited training access, and low technological literacy are prevalent. This

study addresses this critical gap by exploring the specific conditions and barriers teachers face in Sumenep Regency—one of Indonesia's less-developed regions. This study identifies the current level of teacher readiness and explores the underlying factors that influence it, from pedagogical knowledge and self-efficacy to institutional support and infrastructure. By uncovering these dynamics, the study offers actionable insights for policymakers, school leaders, and teacher training institutions in designing context-sensitive interventions.

This study focuses on the following questions: What factors influence teacher readiness in implementing deep learning approaches in elementary schools? To what extent are teachers prepared to face the use of new technologies and intense learning in the learning process in elementary schools? What are the challenges teachers face in integrating this technology into their learning? How does the existing school infrastructure affect the application of technology in learning? What efforts must be made to improve teacher readiness to use technology in learning? The objectives of this study are to Analyze the level of teacher readiness in implementing deep learning and innovation in learning in elementary schools. Identify factors that influence teacher readiness in implementing this technology, including knowledge, skills, and support received. Identify the main challenges faced by teachers in integrating technology into learning. Provide policy and training recommendations to improve teacher readiness and overcome existing challenges.

Research on the application of technology in education has been widely conducted, but most of it focuses on higher education levels. The application of technology in education requires teacher readiness in terms of technological knowledge and skills and support from school management [25]. In addition, research by Samsonova et al, also shows that factors such as teachers' attitudes toward technology, their level of knowledge, and the availability of resources greatly influence the success of implementing technology in learning [26]. More specific research on the application of deep learning in elementary education is still limited, but a study by Sølvik and Glenna shows that deep learning can increase personalization in learning, allowing students to learn according to their pace and learning style [27]. This shows the importance of teacher readiness in using this technology to optimize its benefits in the learning process.

Although there are several studies on teacher readiness in using technology in education, many gaps still need further research, especially in the context of elementary schools in areas such as Sumenep Regency. Previous studies have focused more on higher education levels or general educational technology. Meanwhile, the application of deep learning and innovation in learning at the elementary level requires a more specific approach. This study will fill this gap by focusing on teacher readiness in elementary schools and the factors that influence the application of this technology in a local context. This study provides a new contribution to the education literature by focusing on teacher readiness to apply deep learning and innovation in elementary schools. This study also provides a deeper perspective on teachers' challenges in less developed areas, such as Sumenep Regency. The justification for this study lies in the importance of preparing teachers to face the era of technology-based education, which will be a significant challenge in the future.

2. RESEARCH METHOD

This study employed a qualitative descriptive research design to explore elementary school teachers' readiness in implementing deep learning approaches and instructional innovation. The qualitative approach was chosen because it allows for an in-depth exploration of teachers' experiences, perceptions, and contextual challenges, which are often overlooked in quantitative methods [28], [29]. Qualitative allows researchers to explore teachers' experiences, perceptions, and challenges in more detail, which cannot be achieved through a quantitative approach. The descriptive approach was chosen to describe the existing conditions, namely teacher readiness to adopt deep learning technology and the challenges and obstacles they face [30]. This approach also allows for a clear picture of the current situation without any intervention or changes made by the researcher.

The primary data source in this study was six teachers who teach at SDN Pajagalan 2, Sumenep Regency. The selection of this school was based on its representative characteristics for elementary schools in areas with challenges in implementing technology. The teachers involved in this study were selected using a purposive sampling technique, which aims to select informants with relevant knowledge and experience regarding the research topic. The selection of six teachers was based on the need to obtain a sufficiently deep understanding of the individual perspectives of the teachers without burdening the data analysis process with too much complexity. The research procedure began with initial observations and initial interviews with teachers to understand the context and challenges they face in implementing technology in the classroom. These observations help obtain a general picture of teachers' interactions with technology and how they prepare technology-based learning materials.

This study used a structured interview technique to collect data. Structured interviews were chosen because this technique allows researchers to collect more consistent and systematic data from all respondents. Structured interviews provide predetermined questions, making the data collected easier to analyze qualitatively. In addition, this technique also ensures that each teacher interviewed will answer the same questions, allowing for easier comparison between answers from one respondent and another. Given that the focus of the study was

to explore teachers' understanding, experiences, and challenges in detail, structured interviews provided the clarity and depth needed to analyze teachers' readiness to implement deep learning and innovation in learning.

Table 1. Structured Interview Indicators

No.	Indicator	Question	Purpose
1.	Understanding of deep learning technology	How do you understand deep learning in the context of primary school education?	To assess the teacher's understanding of deep learning concepts and their potential application in primary education.
2.	Experience with using technology in teaching	Have you used technology in your teaching? What type of technology do you use?	To evaluate the teacher's practical experience in using technology in the classroom, and how frequently technology is incorporated into lessons.
3.	Teacher's readiness level	To what extent do you feel ready to implement deep learning in your teaching?	To measure the teacher's self-confidence and readiness in integrating deep learning technologies into their teaching methods.
4.	Factors influencing teacher readiness	What factors affect your readiness to use technology in teaching?	To identify personal and external factors, such as knowledge, skills, confidence, and support from the school or training, that influence the teacher's readiness.
5.	Training and support received	Have you received training or support to use technology in your teaching? If yes, how was your experience?	To assess the quality and adequacy of the training and support that the teacher has received regarding educational technology.
6.	Availability of technological infrastructure	Does your school have the necessary infrastructure to support the use of technology in teaching, such as computers, software, or internet connectivity?	To evaluate the current state of the school's infrastructure in supporting the implementation of technology in teaching.
7.	Impact of technology on teaching	What do you think is the greatest benefit of using technology in teaching?	To explore the teacher's perception of how technology, particularly deep learning, enhances the teaching process and student engagement.
8.	Challenges faced in using technology	What are the main challenges you face in using technology in teaching?	To identify practical barriers that teachers face, such as limited access to devices, lack of training, or insufficient technological support.
9.	Student reception of technology	How do students respond to the use of technology in teaching?	To assess how students react to the integration of technology in the classroom and whether it increases their motivation and interest in learning.
10.	Integration of innovation in lesson plans	How do you integrate technology, such as deep learning, into your lesson plans?	To understand how teachers incorporate new technologies into their lesson plans and adapt teaching methods to foster innovation in the classroom.
11.	Required changes for better implementation	What changes do you think need to be made at your school to enable more effective use of technology?	To identify recommendations for systemic improvements in the school that would better support the implementation of technology.
12.	Expectations for technology development at school	What are your expectations for the development of educational technology at your school?	To gather insights from the teacher about their expectations regarding future developments in educational technology and the support needed to improve teaching.

After the data was collected, the data analysis technique used was the Miles and Huberman approach, which involves three main stages: data collection, data reduction, and data presentation. This analysis technique was chosen because of its systematic and flexible nature in analyzing qualitative data and its ability to organize complex information into clear and understandable findings. This approach allows researchers to identify key patterns that emerge from the data and provide an in-depth picture of teachers' experiences and perceptions of

technology in learning. In the first stage, data was collected through observation and structured interviews. The collected data was then reduced by organizing it into categories that were relevant to the research topic. After that, the data presentation stage was carried out by describing the main findings obtained from interviews and observations and analyzing them to conclude teachers' readiness to implement technology in their classrooms. This approach is beneficial because it allows researchers to dig deeper into the meaning of the data collected while ensuring that the analysis remains focused and relevant to the research objectives. By using the Miles and Huberman approach, this study can provide a clearer understanding of teacher readiness and the challenges they face in implementing deep learning and innovation in learning in elementary schools, as well as provide more targeted recommendations to improve the implementation of educational technology in areas that still face obstacles in access and training.

3. RESULTS AND DICUSSION

This study analyzes teacher readiness in implementing the deep learning approach and learning innovation in elementary schools. Data were collected through structured interviews with six teachers at Elementary School Pajagalan 2, Sumenep Regency, East Java. The data analysis process used the Miles and Huberman approach, which included data reduction, data presentation, and concluding/verification. The research findings show that teacher readiness is diverse and influenced by internal factors (knowledge, skills, motivation) and external factors (infrastructure support, school policies, and training). To strengthen the results, the data were compared with previous research findings.

Teachers' Understanding of the Concept of Deep Learning and Learning Innovation

Teachers' understanding of the concept of deep learning and learning innovation is the initial foundation that greatly determines the success of technology integration in the learning process in elementary schools. This study found that most teachers at Elementary School Pajagalan 2, Sumenep Regency, still have a limited understanding of the true meaning of deep learning. Through structured interviews conducted with six teachers, it was revealed that five of them associated the term "deep learning" only as a form of using digital tools such as computers and the internet in learning. For example, Teacher A stated, "I think deep learning means using a computer to learn, like when we search for material on Google or use Zoom for online classes." This statement shows that understanding is still on the surface or that the practical use of technology is not linked to a more profound and transformative pedagogical approach. The only teacher who showed a relatively better understanding was Teacher D, who said that deep learning can be interpreted as "an effort to make students not only memorize but understand and apply concepts in everyday life." Although still simple, this understanding reflects an initial awareness of a learning approach emphasizing conceptual understanding and higher-order thinking skills. However, interviews generally showed that teachers had not yet associated deep learning with problem-based, project-based, or contextual learning strategies that encourage students to think reflectively and deeply.

This finding aligns with a study conducted by Zhao, which stated that teachers' understanding of educational technology is often limited to using visual aids or online communication without understanding its pedagogical implications [31]. The lack of technological pedagogical literacy makes it difficult for teachers to transform technology into an integral part of a meaningful teaching and learning process. In the context of elementary school Pajagalan 2, this limited understanding is also exacerbated by the lack of training oriented towards integrating pedagogy and technology. Teacher B admitted, "So far if there is training, it is more about how to use the application, not how to teach it." This shows that the available training has not been able to bridge the gap in understanding between technology as a tool and as part of a learning strategy. One of the causes of this low understanding is the absence of literature or teaching materials that systematically discuss applying the deep learning approach in elementary education. Teacher C added, "We have never been given a module or book on how to teach with a concept like that. So, we are confused about where to start." This situation indicates that teachers need references appropriate to their context in terms of language, content, and relevance to learning conditions in the area.

Interestingly, despite not fully understanding the concept of deep learning, all teachers showed a positive and open attitude toward using technology in learning. Teacher E's statement shows, "I'm happy if there is technology that can help children learn, as long as I can also learn how to use it." This attitude is essential in increasing teacher capacity because openness to change is the initial key to educational transformation. However, without appropriate intervention in training, mentoring, and provision of relevant learning resources, this potential is feared to be hampered by conceptual confusion and methodological ignorance. In a broader context, teachers' understanding of deep learning cannot be separated from school curriculum policies and learning culture. If the national curriculum and school policies do not provide space and incentives for implementing innovative learning approaches, teachers' motivation to explore concepts such as deep learning will be very low. Teacher F complained, "Sometimes we want to try new things, but they are not supported. The

lesson plan must be by the format; the time is also tight, so we use the old way." This shows that changes in the learning paradigm cannot only be imposed on individual teachers but must be supported by a broader education system.

Based on these findings, teachers' understanding of deep learning and learning innovation is minimal and technical-operational. Most teachers identify technology only as a visual aid, not as a transformative pedagogical approach. However, there is a positive attitude towards technology-based learning that can be used to develop teacher capacity in the future. Therefore, increasing conceptual and pedagogical understanding of deep learning needs to be a priority in teacher training, with a contextual and collaborative approach. Continuous mentoring, provision of applicable learning modules, and support from school leaders and education policies are essential to ensure that this understanding transformation runs systematically and sustainably.

Teacher Readiness in Implementing Technology and Learning Innovation

Teacher readiness is a fundamental component in the success of educational technology integration, including deep learning approaches and learning innovations in elementary schools. Based on the results of interviews with six teachers at elementary school Pajagalan 2, Sumenep Regency, it was found that teacher readiness in implementing technology is still quite diverse, ranging from very limited to basic levels. This readiness aspect is analyzed from three main dimensions, namely: (1) teacher knowledge and understanding of technology, (2) skills in using it in the classroom, and (3) attitudes or psychological dispositions towards technology-based pedagogical changes.

Regarding knowledge, only two teachers admitted to having participated in learning technology training in the last five years. One teacher said, "During the pandemic, I participated in online training from the Education Office, but only once. After that, there was no more. So, the knowledge is just as it is." This shows that the sustainability of teacher competency development programs in technology is not well structured. Another teacher added, "We really want to learn, but time is limited and sometimes the material is too technical, even though we need something that is applicable." This statement indicates that although teachers intend to improve their knowledge, no relevant and contextual training facilities meet their needs in the field. This is in accordance with research by Araujo, which emphasizes the importance of context-based teacher training and direct practice so that the results can effectively improve teachers' professional readiness in dealing with educational technology [32].

Regarding technical skills, most teachers are only familiar with using simple devices such as laptops and projectors. Two teachers stated they are accustomed to using YouTube to show learning videos, while one teacher uses PowerPoint as a visual medium. However, none mentioned using Learning Management Systems (LMS), online quiz platforms such as Kahoot, or artificial intelligence-based applications in the learning process. This indicates that teachers' skills in utilizing technology are still at a basic level (substitution in the SAMR model), not reaching the level of modification or redefinition of learning. A teacher named Mrs. R (initials) explained, "I usually just play videos on YouTube, then students write summaries. It hasn't gotten to interactive or using applications. They're confused about how to use them." This shows that technology is still seen as a secondary tool, not as a core component in designing student learning experiences. On the other hand, time constraints and administrative burdens are also obstacles. Teacher Mrs. S said, "We want to try out applications but to be honest, sometimes the lesson plans are too tight for them. Where does the time come from if we have to learn a new application?" This statement emphasizes that teacher readiness is not only a matter of competence but also related to time management, workload, and administrative pressures teachers at the elementary level face.

Psychologically, teachers' attitudes towards innovation and technology appear quite positive but are accompanied by feelings of anxiety or lack of confidence. Several teachers expressed concerns about technical errors when using technology, which could disrupt the learning process. Teacher Mr. D said, "I once tried using Zoom for a combined class during the pandemic, but the connection was intermittent at that time. Ultimately, I was stressed, and the students were also confused. Since then, I have been careful about using technology." This shows that previous experiences greatly influence teachers' psychological readiness, and if the experience is bad or frustrating, it will hurt teachers' motivation to try new things. In this context, [33] self-efficacy theory becomes relevant, where teachers' perceptions of their abilities play a crucial role in adopting new behaviors such as technology-based learning. Previous studies by [34] showed that internal factors such as self-confidence, self-efficacy, and belief in the effectiveness of technology are the main determinants of teacher readiness in ICT (Information and Communication Technology) integration. When teachers feel insecure or do not see the direct benefits of technology on student learning outcomes, they are unlikely to take the initiative to adopt it in their learning. This finding is also reflected in the current study, where teachers tend to "play it safe" with conventional teaching methods because they feel they are more proficient in these methods, even though they are open to the idea of technology and innovation.

Furthermore, the readiness aspect is also influenced by institutional support, including support from the principal, colleagues, and school policies. Five out of six teachers stated that no specific policies in their schools

encouraged the use of technology or digital-based innovation in learning. Teacher Mrs. L said, "If there was a program from the school or a special time for routine training, maybe we could be more prepared. But now it all comes back to each individual's efforts." This emphasizes the importance of transformational leadership at the school level in building collective teacher readiness. Teachers struggle to develop without a support system, even with high personal motivation. Thus, teacher readiness in this study is on the low to medium spectrum, with the main determinants including limited knowledge and skills, low exposure to relevant technology training, and lack of system support and innovative climate at the school level. This readiness is multidimensional and mutually influencing; the overall readiness is also hampered when one aspect is weak. Therefore, improving teacher readiness requires a holistic approach, from individual interventions through targeted professional training to improving institutional policies and culture in elementary schools. This study reinforces the importance of transformation from the technological side and from the readiness of human resources, the leading actors in 21st-century learning.

Barriers to Implementing Deep Learning and Learning Innovation in Elementary Schools

Barriers to implementing learning technology, especially the deep learning approach in elementary schools, are significant findings that emerged in this study. Based on interviews with six teachers at elementary school Pajagalan 2, Sumenep Regency, it was found that the obstacles faced were technical, systemic, and cultural. These obstacles include a lack of infrastructure, low-quality internet connectivity, limited human resources, high teacher workloads, and minimal school policies that support innovation.

Technically, the five teachers complained about the limited support facilities. At the school, only one projector is used alternately; not all classes have access to computers, and the internet connection is often unstable. Teacher Mrs. L said, "If you want to use a projector, you must schedule it because there is only one. If the WiFi is slow or dead, the learning plan is all messed up." This shows that the available technology is not proportional to the needs of teachers to innovate. One of the main requirements for starting a profound learning-based learning transformation is the availability of hardware that supports the integration of digital content and interactivity. Lai and Chen's (2011) research confirms that the availability of infrastructure is an absolute prerequisite for the success of technology integration in elementary schools.

The next obstacle is the low quality of internet connectivity. The researcher noted that the school's internet signal was often lost during the observation, even during crucial learning hours. Teacher Mr. D shared his experience, "I had prepared a Google Form for the quiz that day, but the internet couldn't be used. The students had to wait long, so I canceled the quiz." This incident directly impacted the effectiveness of the teaching and learning process and eroded teachers' trust in technology. This supports a study by Wijnen, which states that the low digital infrastructure in rural schools is a significant cause of the failure of educational technology programs, especially in developing countries [35]. Systemic barriers are also very real. All teachers stated that there had never been an ongoing internal or external training program to integrate technology into learning. The absence of school policies that support the use of technology makes teachers feel that their efforts to innovate are running alone without institutional support. Teacher Mrs. R said, "We want regular training or at least mentoring from the office. But until now, there has been no such policy." This shows weak change management at the school level. In fact, according to Celik, the success of educational innovation is greatly influenced by the school's ability to manage change and provide a sustainable support system for teachers [36].

Cultural and psychological aspects are also obstacles. Teachers are afraid of failure when trying new technologies. Technical failures in front of students can reduce their credibility. Mrs. S said, "I once pressed the wrong button when showing a video, and what came out was an inappropriate YouTube ad video. Since then, I've been afraid to try." This shows that teachers face technical challenges and social and psychological pressures in the classroom without training and system control. This fear creates an avoidance of technology and encourages teachers to return to traditional teaching patterns that they consider safer. From the overall results, it can be concluded that the obstacles to the implementation of deep learning and learning innovation at elementary school Pajagalan 2 do not stand alone but are an accumulation of limited facilities, weak supporting policies, lack of training, and psychological challenges that have not been addressed systematically. Without a structured intervention approach from the education office and school management, learning innovation will always be symbolic, not achieving true transformation.

Teachers' Expectations for System Support and Continuous Professional Development

Despite the various obstacles, teachers showed enthusiasm and high expectations for improving their professional capacity, especially in using technology for learning. From the interviews, all teachers expressed consistent desires: they hope for regular, relevant training, ongoing guidance, and real support from schools and local governments to facilitate the digital transformation of learning. Teacher Mrs. S said, "We need training that is appropriate to the conditions in the classroom. If it's just theory or expensive technology, it's difficult for us to follow. But if there is practical training, it helps." This shows that contextual training—appropriate to school resources, teacher capacity, and learning needs—is the primary preference. This aligns with the theory of

Situated Learning [37], [38], which emphasizes that meaningful professional learning will only occur if it is based on the real context in which teachers work. Therefore, teacher training should not be top-down or generic but based on direct practice and local needs.

Some teachers also hope for the formation of a learning community between teachers that focuses on digital learning innovation. Teacher Mr. D suggested, "It would be beneficial if we could have a small group in the school that learns technology with each other. We don't have to wait for training from the office. "This idea is in line with the Professional Learning Community (PLC) concept, where teachers learn from each other, share experiences, and jointly develop solutions to learning problems. A study by [39]–[41] showed that PLCs can increase teacher innovation, collaboration, and self-confidence in dealing with technological change. Teachers also have high hopes for support from the principal and local government. All teachers stated that without policies and incentives from above, changes at the individual level would be challenging to maintain. Teacher Mrs. R said, If the school doesn't provide time and budget, it's difficult. We are also limited in terms of time and money. Teachers hope professional development programs are designed in a planned, measurable, and integrated manner with the school system. Effective professional development must be sustainable, collaborative, directly related to teaching practice, and have institutional support [42]-[44].

In addition to training, teachers also want access to appropriate technology. They suggested that schools provide laptops for teachers, strengthen internet connections, and increase visual devices such as LCDs. One teacher even said, "We want schools to be places that support future learning, not just blackboards and chalk." This expectation reflects teachers' enthusiasm for change but waiting for the space and tools that allow them to move. These findings show that teachers' expectations are not just technical requests but reflect their desire to develop, innovate, and provide the best for their students. In a region like Sumenep Regency, this expectation is a valuable social and cultural capital. If utilized seriously through inclusive policies and empowering programs, then fundamental education transformation is not impossible.

This study's results reveal several significant findings regarding teacher readiness in implementing the deep learning approach and technology-based learning innovation in elementary schools, especially in the context of non-urban areas such as elementary school Pajagalan 2, Sumenep Regency. These findings indicate that teachers' understanding of deep learning is still partial and relies solely on technical understanding, while teacher readiness in its implementation is also greatly influenced by limited infrastructure, training, and institutional support. To fully understand the impact and meaning of these findings, a deeper interpretation is needed by linking them to the theoretical framework and previous studies and reviewing the theoretical and practical contributions of this study, its limitations, and suggestions for future development.

First, regarding interpreting the results, the low level of teachers' understanding of deep learning shows that this term is still relatively foreign to many elementary education practitioners. However, globally, the deep learning approach has become an essential pillar in developing 21st-century education. In this context, deep learning refers not only to computer algorithms but also to a pedagogical approach that emphasizes students' ability to relate information deeply, think critically, solve problems, and actively construct knowledge. Teachers' limited understanding of educational technology, especially abstract or conceptual technology, is one of the main obstacles in the digital transformation process in schools [45], [46]. The findings of this study support this statement and reinforce the importance of technological literacy programs that are not only operational but also pedagogical.

Teacher readiness found in this study also shows that internal factors (such as self-efficacy, motivation, and previous experience) greatly influence teachers' courage in adopting new technology. This is in line with Self-Efficacy theory [47], [48], which states that an individual's belief in their ability to succeed in a task will determine the extent to which they will try, persist, and overcome obstacles. Teachers who feel less competent or have experienced technical failure in using technology tend to be reluctant to try again, even though they understand the importance of innovation in learning. This finding emphasizes the importance of psychological support and a conducive environment for teachers to learn through failure and make these experiences part of increasing professional capacity.

On the other hand, the results of this study also show that external support, such as infrastructure, training, and institutional policies, greatly determines teacher readiness. This strengthens the findings of [49], [50], which state that the availability of resources and structural support from the organization greatly influences technology integration in education. The absence of ongoing training, minimal supporting devices, and weak school leadership in encouraging technology adoption cause teachers to rely on personal initiative. This is a significant challenge, especially in areas like Sumenep Regency, where there is limited access to technology-based professional development. The theoretical contribution of this study lies in broadening the understanding of teacher readiness in local and non-urban contexts. While most previous studies have focused on urban environments or high-resource schools, this study enriches the literature by presenting perspectives from elementary schools facing structural constraints. In doing so, it highlights the importance of considering local contexts in designing education policy interventions. The practical contribution is also evident: the findings provide a basis for education departments and schools to formulate needs-based and practice-based training

policies. For example, training that combines pedagogical theory and technical skills with live simulations in teachers' classrooms will be more effective than one-way, ceremonial training.

However, every study has limitations, and acknowledging these limitations is essential to provide methodological transparency and open up space for further research. This study used a descriptive qualitative approach with a limited number of respondents, namely six teachers from one school. This means that the study's results cannot be generalized to the entire teacher population in Indonesia or even to all teachers in Sumenep Regency. In addition, the limitations of narrative data make this study unable to provide a quantitative statistical picture of the level of teacher readiness more broadly. However, a qualitative approach allows for an in-depth exploration of the perceptions, experiences, and contexts that shape teacher readiness, which are often missed in quantitative surveys.

Based on the results and limitations, further research is highly recommended to address existing weaknesses and expand the scope of findings. Comparative studies between regions—for example, urban and rural areas—will provide a complete understanding of the gap in teacher readiness to adopt technology. In addition, a mixed methods approach that combines in-depth interviews and quantitative surveys can also provide a comprehensive picture of the dominant factors that influence readiness. Longitudinal research is also worth considering to monitor teacher readiness changes, especially after training interventions or new education policies. Equally important is the discussion of the social and ethical implications of the results of this study. Inequality in teacher readiness reflects broader inequalities in access to and quality education. If technology integration only occurs in schools with more resources, then educational transformation will widen the gap between regions and between students. Therefore, this study serves as a reminder that the digital transformation of education must be carried out inclusively, with special attention to technologically disadvantaged areas. Another ethical issue that needs to be considered is how technology is used in teaching and learning. Although technology opens up many opportunities, careless use can ignore the humanistic aspects of education. Teachers must remain at the center of the learning process, and technology must be a complement, not a substitute. In addition, data security and student privacy must also be a primary concern in any development of technology-based systems. In this context, teachers must be positioned as policy implementers and key actors in the transformation process. The findings of this study indicate that teachers have high expectations for training support, collaboration, and facilities—which indicates that they are ready to change as long as they are given the space and tools to do so. Therefore, the moral and strategic responsibility lies with local governments, education policymakers, and training institutions to create a learning ecosystem that empowers teachers, is fair to all schools, and is adaptive to the times.

4. CONCLUSION

This study shows that teacher readiness in implementing deep learning approaches and learning innovations in elementary schools, especially at elementary school Pajagalan 2, Sumenep Regency, is still at various levels and tends to be low. This readiness is greatly influenced by internal factors (teacher knowledge, skills, and self-efficacy) and external factors (technology infrastructure, professional training, and institutional policies). Teachers are generally enthusiastic and motivated to adopt technology in the learning process, but limited facilities, lack of contextual training, and the absence of systematic policy support are the main obstacles in practice in the field. Teachers' understanding of deep learning is still superficial and generally only interpreted as using technology, not as a pedagogical approach emphasizing deep, reflective, and integrated learning. In addition, although some teachers have used digital media in learning, its use is still limited to presentation functions and has not reached the transformational level referred to in the SAMR model. These findings strengthen previous theories such as self-efficacy (Bandura), the technology acceptance model (TAM), and the importance of professional learning communities (PLC) in strengthening teacher readiness. This study also highlights the importance of contextual understanding of teacher readiness, as geographic, social, and institutional factors influence how technology can be effectively integrated into primary education. It is recommended that local governments, through education offices, design policies to strengthen teacher capacity based on local needs. Training should be technical, pedagogical, and designed in a sustainable, contextual, and oriented towards real practice in the classroom. In addition, there needs to be affirmative intervention in the form of budget allocation for procuring technological devices in primary schools that do not yet have adequate access, especially in rural areas such as Sumenep.

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