JUDIKDAS JURNAL ILMU PENDIDIKAN DASAR INDONESIA
DOI : https://doi.org/10.51574/judikdas.v5i1.5792
Volume 5 No. 1 (2025) pp 1-17

Elementary School Readiness for Deep Learning Implementation

Received: 01/11/2025
Accepted: 23/12/2025
Published: 31/12/2025

[1]Dessy Setyowati, [2]Elvani Hertati, [3]Yunika Afryaningsih, [4]Iir Nikmatul Fathonah
Universitas Nahdlatul Ulama Kalimantan Barat, Indonesia

[1]*dessysetyowati03@gmail.com *Corresponding author*
[2]*elvani@unukalbar.ac.id*
[3]*yunikafryaningsih@unukalbar.ac.id*
[4]*iir.nf@unukalbar.ac.id*

How to cite :
Setyowati, D., Hertati, E., Afryaningsih, Y., & Fathonah, I. N. (2025). Elementary School Readiness for Deep Learning Implementation. *Jurnal Ilmu Pendidikan Dasar Indonesia, 5*(1), 1-17. https://doi.org/10.51574/judikdas.v5i1.5792

Abstract
The implementation of deep learning in elementary schools requires school readiness across various aspects that support learning oriented toward understanding, active engagement, and problem solving. This study aimed to analyze the readiness of elementary schools to implement deep learning in Sungai Raya District, Kubu Raya Regency. The study employed a descriptive quantitative approach involving elementary school teachers as respondents. Data were collected using a closed-ended questionnaire with "Appropriate" and "Not Appropriate" response categories and were analyzed using frequencies and percentages. The results indicate that school readiness was multidimensional and uneven across the assessed aspects, with relatively stronger conditions in teachers' understanding and readiness, curriculum adaptation, active student involvement, project-based and problem-solving learning, and assessment practices. Greater limitations were identified in technological infrastructure and access, technology utilization, the availability of digital learning resources, students' digital literacy and independent digital learning, as well as perceived technical and financial conditions. These findings indicate that school readiness for implementing deep learning should not be understood simply as "ready" or "not ready," but as a multidimensional condition that requires gradual strengthening. Such strengthening includes teacher capacity development, improved infrastructure and learning resources, enhanced student digital literacy, and stronger institutional support and collaboration among schools, families, and communities.

Keywords: Deep Learning, School Readiness, Elementary School, Teacher Competence, Educational Technology

Abstrak
Implementasi pembelajaran mendalam pada sekolah dasar memerlukan kesiapan sekolah dalam berbagai aspek yang mendukung proses pembelajaran yang berorientasi pada pemahaman, keterlibatan aktif, dan pemecahan masalah. Penelitian ini bertujuan untuk menganalisis kesiapan sekolah dasar dalam mengimplementasikan pembelajaran mendalam di Kecamatan Sungai Raya, Kabupaten Kubu Raya. Penelitian ini menggunakan pendekatan deskriptif kuantitatif dengan melibatkan guru sekolah dasar sebagai responden. Data dikumpulkan menggunakan kuesioner tertutup dengan kategori jawaban "Sesuai" dan "Tidak Sesuai", kemudian dianalisis menggunakan frekuensi dan persentase. Hasil penelitian menunjukkan bahwa kesiapan sekolah bersifat multidimensional dan belum merata pada seluruh aspek, dengan kondisi yang relatif lebih kuat pada pemahaman dan kesiapan guru, adaptasi kurikulum, keterlibatan aktif siswa, pembelajaran berbasis proyek dan pemecahan masalah, serta praktik

asesmen. Sementara itu, keterbatasan lebih terlihat pada infrastruktur dan akses teknologi, pemanfaatan teknologi, ketersediaan sumber belajar digital, literasi dan kemandirian digital siswa, serta kondisi teknis dan finansial yang dipersepsikan oleh guru. Temuan ini menunjukkan bahwa kesiapan sekolah untuk mengimplementasikan pembelajaran mendalam tidak dapat dipahami hanya sebagai kondisi "siap" atau "tidak siap", tetapi sebagai kondisi multidimensional yang memerlukan penguatan secara bertahap. Penguatan tersebut mencakup peningkatan kompetensi guru, infrastruktur dan sumber belajar, literasi digital siswa, serta dukungan kelembagaan dan kolaborasi antara sekolah, keluarga, dan masyarakat.

Kata Kunci: Deep Learning, Kesiapan Sekolah, Sekolah Dasar, Kompetensi Guru, Teknologi Pendidikan

Introduction

The development of education in the twenty-first century requires a paradigm shift from learning approaches that primarily emphasize content mastery toward approaches that emphasize conceptual understanding, higher-order thinking skills, and students' readiness to face complex real-world problems. Various educational challenges, including low literacy and numeracy achievement, disparities in educational quality, and the need to strengthen critical and collaborative thinking skills, highlight the urgency of adopting more meaningful and sustainable learning approaches (Darling-Hammond et al., 2020; OECD, 2019). These challenges are particularly important in elementary education because learning at this level provides an important foundation for students' cognitive, social, and character development.

In line with these challenges, deep learning in a pedagogical context has become an increasingly prominent topic in educational discourse in Indonesia. Deep learning is understood as a learning process that positions students as active agents in constructing knowledge through integrated cognitive, affective, and social engagement. This approach emphasizes learning awareness, meaningful learning experiences, and positive learning environments to support deeper understanding, long-term retention, and the transfer of knowledge to new situations (Fullan & Langworthy, 2014; Hattie, 2018). In its implementation, deep learning emphasizes three core principles, namely mindful learning, meaningful learning, and joyful learning, which encourage students to engage actively and reflectively in the learning process.

Deep learning is not merely interpreted as the use of technology, but rather as a pedagogical approach that encourages students to develop a deep understanding of concepts, connect knowledge to real-life contexts, and cultivate lifelong learning dispositions (Trilling & Fadel, 2009). This orientation is closely aligned with the goals of elementary education, which emphasize not only academic achievement but also the development of character, creativity, collaboration, and learner autonomy. Therefore, implementing deep learning requires changes in how teachers design learning experiences, facilitate student engagement, and provide opportunities for students to construct and apply knowledge rather than simply receive information.

In the context of elementary education in Indonesia, deep learning is positioned as an instructional approach that can be integrated into existing curricula and is not intended to replace the curriculum itself. The approach provides opportunities for teachers to develop more contextual and student-centered learning experiences that support critical reasoning, creativity, collaboration, communication, and balanced cognitive and socio-emotional development (Suyanto et al., 2025). However, the transition toward deep

e-ISSN: 2809-4085
p-ISSN: 2809-8749

learning requires schools and teachers to adjust their instructional practices, learning resources, assessment strategies, and supporting systems. Consequently, the implementation of deep learning needs to be considered not only as a pedagogical change but also as a process that requires adequate readiness at the school level.

The success of deep learning implementation is strongly influenced by teacher readiness because teachers are responsible for translating its principles into classroom practice. In primary education, teacher readiness for project-based learning involves understanding the approach, preparing appropriate learning activities, and having sufficient confidence to facilitate student-centered learning (Cintang et al., 2017; Du & Chaaban, 2020). Effective teaching practices should also encourage students' active engagement through appropriate learning activities, teacher support, feedback, and attention to students' perspectives (McKellar et al., 2020). Without adequate pedagogical readiness and opportunities for sustained professional learning, the implementation of deep learning may remain at the conceptual level and may be difficult to translate into meaningful changes in classroom practice (Harris & Jones, 2017). Therefore, strengthening teacher capacity and providing adequate institutional support are important prerequisites for implementing deep learning consistently and meaningfully.

Recent studies in Indonesia have increasingly examined teachers' readiness to implement deep learning in elementary education. Asyari et al. (2025) found that pedagogical and technological readiness, continuous professional development, and adequate infrastructure are important conditions for supporting deep learning implementation in elementary schools. Similarly, Allolinggi et al. (2025), in a study involving 160 elementary school teachers in South Sulawesi, examined readiness through conceptual understanding, pedagogical readiness, technological readiness, professional development motivation, and perceptions of institutional support. Their findings showed that teacher readiness was uneven across these dimensions, indicating that technological proficiency alone does not necessarily reflect adequate conceptual and pedagogical readiness. Sudirman & Pandang (2025) likewise found that primary school teachers experienced challenges in operationalizing deep learning pedagogy and required sustained professional development and collaborative support during curriculum reform. These findings indicate that teacher readiness remains an important issue in the implementation of deep learning in elementary education.

In addition to teacher readiness, curriculum design and assessment systems play important roles in supporting deep learning. Flexible and contextual curricula provide opportunities for exploration, reflection, and the integration of knowledge across learning experiences (Pope & Powell, 2020). Authentic assessment practices, including project-based assessment, portfolios, and self-reflection, can provide more meaningful information about students' conceptual understanding and higher-order thinking than assessment practices that rely solely on conventional testing (Andrade & Brookhart, 2019; Brookhart, 2010). However, the consistent implementation of formative assessment remains a challenge because teachers need adequate knowledge and support to use assessment as an integral part of the learning process (Wiliam, 2017). Therefore, curriculum and assessment readiness should also be considered when examining schools' capacity to implement deep learning.

Technology and infrastructure constitute another important component of the deep learning ecosystem. Digital technology can support exploration, collaboration, and knowledge construction when it is integrated with appropriate pedagogical practices and

e-ISSN: 2809-4085
p-ISSN: 2809-8749

supported by adequate teacher competence and learning resources (Timotheou et al., 2023). Nevertheless, disparities in technological access and digital competence may create differences in schools' capacity to provide meaningful learning experiences, particularly in non-urban and resource-limited contexts (UNESCO, 2023). Recent research also indicates that differences in school readiness are associated with teacher pedagogical capacity, digital literacy, instructional leadership, collaborative school culture, and digital infrastructure (Setyawati et al., 2025). These findings suggest that the implementation of deep learning requires supporting conditions that extend beyond individual teacher competence.

The broader educational ecosystem is also relevant because schools do not operate independently from families and communities. Parental involvement and community participation can provide additional support for students' learning and strengthen connections between learning activities and students' social and cultural contexts (Epstein, 2011). From this perspective, school readiness for deep learning should be understood as a multidimensional condition involving teachers, curriculum, students, learning resources, technology and infrastructure, assessment practices, and relationships with parents and the community. Examining these dimensions together is particularly important in regional contexts where schools may experience different levels of access to resources, professional support, and technological facilities.

Although recent studies have provided important insights into deep learning implementation, existing research has tended to emphasize particular dimensions of readiness, particularly teacher readiness, pedagogical competence, technological competence, or organizational support (Asyari et al., 2025; Allolinggi et al., 2025; Sudirman & Pandang, 2025; Setyawati et al., 2025). Research on teacher readiness has provided valuable evidence regarding teachers' conceptual, pedagogical, and technological capacities, while organizational studies have highlighted the importance of leadership, school culture, and infrastructure. However, a broader descriptive examination that brings together these dimensions with curriculum, student readiness, assessment, and parental and community support remains important for understanding school readiness as an interconnected condition. This is particularly relevant in regional elementary school contexts, where the availability and utilization of educational resources may vary across schools.

This study addresses this need by examining elementary school readiness for deep learning implementation through a multidimensional perspective. Rather than treating school readiness as a single condition, the study examines several interrelated aspects that were operationalized through questionnaire indicators and presented in the results according to their substantive relationships. These aspects include teacher readiness, curriculum adaptation, student readiness, technology and infrastructure, learning methods and assessment, and parental and community support. The indicators were not treated as completely separate dimensions, as some questionnaire items capture the interrelationship between teacher, student, curriculum, and broader educational ecosystem factors. The study also provides empirical evidence from elementary schools in Sungai Raya District, Kubu Raya Regency, thereby providing a regional context for understanding how schools prepare for the implementation of deep learning. This approach is expected to identify not only the strengths of school readiness but also the aspects that require further improvement before deep learning can be implemented more consistently and sustainably.

Based on these considerations, this study aims to analyze elementary school readiness for deep learning implementation in Sungai Raya District, Kubu Raya Regency. The analysis focuses on teacher readiness, curriculum, student readiness, technology and

e-ISSN: 2809-4085
p-ISSN: 2809-8749

infrastructure, learning methods and assessment, and the roles of parents and the community. The findings are expected to contribute empirical evidence regarding the multidimensional nature of school readiness and provide a contextual basis for developing strategies to strengthen the implementation of deep learning in elementary education.

Research Method

This study employed a descriptive quantitative research approach to describe the readiness of elementary schools to implement deep learning based on teachers' responses. A quantitative approach is appropriate when a study seeks to examine a phenomenon through structured numerical data, while a descriptive design is used to portray the characteristics or conditions of the phenomenon under investigation without manipulating the research setting (Creswell & Creswell, 2018). Therefore, this design was selected because the present study aimed to describe the existing conditions of school readiness for deep learning implementation based on teachers' responses to structured questionnaire items. The analysis focused on several dimensions of readiness, including curriculum adaptation, educational ecosystem, technology infrastructure, internet availability, teacher technological competence, technology integration within the curriculum, student digital literacy, barriers to technology utilization, and the effectiveness of technology in supporting deep learning.

The study was conducted in elementary schools in Sungai Raya District, Kubu Raya Regency, West Kalimantan, Indonesia. The respondents consisted of 18 elementary school teachers who participated in the questionnaire, including classroom teachers and subject teachers. The teachers were selected as respondents because of their direct involvement in planning and conducting learning activities in elementary schools, making their responses relevant for describing the conditions that support deep learning implementation. Based on the available questionnaire data, the respondents represented several elementary schools in Sungai Raya District. The questionnaire responses served as the primary data source for describing school readiness from the teachers' perspectives.

Data were collected using a structured closed-ended questionnaire. The questionnaire was developed based on indicators adapted from Suyanto's book and consisted of statements related to the conditions supporting deep learning implementation in elementary schools. Before the questionnaire was administered, each statement was reviewed to ensure its relevance and alignment with the intended indicator. The instrument did not undergo a formal expert validation procedure or pilot testing. Instead, the statements were reviewed based on their correspondence with the indicators adapted from the reference source. The use of a structured questionnaire enabled the researchers to obtain standardized responses across participants and to quantify the distribution of responses for each identified indicator. Respondents were asked to select one of two response categories, namely "Sesuai" and "Tidak Sesuai," according to the conditions in their respective schools. The questionnaire covered several aspects of readiness, including the adaptation of deep learning within the curriculum, the educational ecosystem, technology infrastructure, internet availability, teachers' technological competence, technology integration within the curriculum, students' digital literacy, barriers to technology utilization, and the effectiveness of technology in supporting deep learning. The structured format was intended to ensure that the same indicators were assessed across respondents, allowing the responses to be summarized and compared descriptively.

The collected questionnaire data were analyzed using descriptive statistical analysis in the form of frequencies and percentages. Descriptive statistics are used to organize and summarize observed data so that patterns within a dataset can be presented systematically (Field, 2018). The percentage of responses for each questionnaire item was calculated by dividing the frequency of respondents selecting a particular response by the number of valid responses for the corresponding item and multiplying the result by 100%. The formula used was where P represents the percentage, f represents the frequency of a particular response, and N represents the total number of valid responses for the respective indicator. The results were then organized according to the dimensions of school readiness examined in the questionnaire. The number of valid responses varied across questionnaire sections: Tables 1 and 2 were based on 18 valid responses, whereas Tables 3–7 were based on 14 valid responses. Four respondents did not provide responses to the technology-related items; therefore, the percentages for Tables 3–7 were calculated based on the 14 valid responses available for those sections. The results were interpreted by examining the proportion of "Sesuai" and "Tidak Sesuai" responses to identify dimensions that demonstrated relatively stronger readiness and dimensions that still required improvement.

Results

The questionnaire results provide an overview of elementary school readiness for deep learning implementation based on teachers' responses. The findings indicate that readiness was relatively favorable in curriculum adaptation and several aspects of the educational ecosystem, while greater limitations were identified in technological infrastructure, internet availability, student digital literacy, and technology-related barriers. The findings are presented according to the dimensions measured through the questionnaire.

Adaptation of Deep Learning Within the Curriculum

The results indicate that the adaptation of deep learning within the curriculum was generally favorable. Teachers reported strong understanding of the concept, curriculum flexibility, participation in professional development, and alignment between the existing curriculum and deep learning principles. The availability of teaching materials was comparatively less favorable than the other indicators.

Table 1 Adaptation of Deep Learning Within the Curriculum (N=18)

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
1	Understanding of the concept of deep learning	18	100.00	0	0.00
2	Teacher willingness to implement deep learning in teaching	16	88.89	2	11.11
3	Teacher participation in training and professional development related to deep learning	17	94.44	1	5.56
4	Curriculum alignment with deep learning principles	17	94.44	1	5.56
5	Availability of teaching materials supporting deep learning	14	77.78	4	22.22
6	Curriculum flexibility in providing space for student exploration	18	100.00	0	0.00
7	Student independence in exploring learning materials	16	88.89	2	11.11

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p-ISSN: 2809-8749

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
8	Students' critical and analytical thinking ability	16	88.89	2	11.11
9	Student interest in problem-solving and exploratory learning	16	88.89	2	11.11

Educational Ecosystem

The educational ecosystem generally demonstrated supportive conditions for deep learning. The strongest conditions were related to active student involvement, assessment practices, parental involvement, learning spaces, and real-world problem-solving. However, limitations were found in learning-resource facilities and school-industry collaboration. Technology-supported research and data analysis also showed comparatively varied conditions. School-industry collaboration showed a relatively weak condition, with 8 respondents (44.44%) indicating that the condition was appropriate and 10 respondents (55.56%) indicating otherwise.

Table 2 Educational Ecosystem (N = 18)

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
1	Availability of technology supporting learning	12	66.67	6	33.33
2	Technology utilization for deeper learning exploration	14	77.78	4	22.22
3	Ability of students and teachers to use technology for research and data analysis	11	61.11	7	38.89
4	Learning spaces supporting discussion, collaboration, and exploration	17	94.44	1	5.56
5	Laboratory, digital library, and other learning resources	7	38.89	11	61.11
6	Access to learning environments supporting experimentation and innovation	14	77.78	4	22.22
7	Implementation of project-based learning and inquiry strategies	16	88.89	2	11.11
8	Learning methods encouraging real-world problem solving	17	94.44	1	5.56
9	Active student involvement in constructing knowledge	18	100.00	0	0.00
10	Project-, portfolio-, and self-reflection-based assessment	18	100.00	0	0.00
11	Flexibility in the assessment system	17	94.44	1	5.56
12	Formative assessment for monitoring critical thinking	17	94.44	1	5.56
13	Parental involvement in supporting exploration and independent learning	18	100.00	0	0.00
14	Collaboration between schools and industry	8	44.44	10	55.56
15	Community support for a conducive learning environment	15	83.33	3	16.67

Technology Infrastructure and Internet Availability

The results for technology infrastructure reveal substantial differences among the indicators. Projectors or smart boards were the most commonly available technological facilities, while computer laboratory facilities showed the lowest level of conformity. The number of technological devices was also insufficient according to more than half of the valid responses. Internet availability showed relatively better conditions in terms of general stability, but Wi-Fi coverage, uninterrupted access to digital learning materials, and internet speed remained limited.

Table 3 Technology Infrastructure and Internet Availability (N = 14)

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
Technology Infrastructure					
1	Adequate computer laboratory facilities	1	7.14	13	92.86
2	Availability of tablets or laptops	8	57.14	6	42.86
3	Availability and use of projectors or smart boards	11	78.57	3	21.43
4	Clear policy for routine technology maintenance	9	64.29	5	35.71
5	Sufficient number of technological devices	6	42.86	8	57.14
Internet Availability					
6	Stable and reliable internet access	9	64.29	5	35.71
7	Internet rarely experiences disruption during learning	9	64.29	5	35.71
8	Adequate Wi-Fi coverage throughout the school	4	28.57	10	71.43
9	Uninterrupted access to digital learning materials	5	35.71	9	64.29
10	Sufficient internet speed for online learning	4	28.57	10	71.43

Teacher Technological Competence and Technology Integration

Teacher technological competence showed relatively favorable results. Most valid respondents reported receiving technology-related training and feeling confident in using technology for teaching. However, the use of digital learning platforms and student interaction through digital media was less consistently reported. Technology integration within the curriculum showed a similar pattern, although the use of technology through simulations and interactive media was reported more favorably.

Table 4 Teacher Technological Competence and Technology Integration (N = 14)

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
Teacher Technological Competence					
1	Teachers frequently use technological devices in learning	10	71.43	4	28.57
2	Teachers receive training related to technology use in learning	11	78.57	3	21.43
3	Teachers feel confident using technology for teaching	11	78.57	3	21.43
4	Teachers utilize digital learning platforms	9	64.29	5	35.71
5	Teachers engage students through digital media	9	64.29	5	35.71

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p-ISSN: 2809-8749

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
Technology Integration					
6	Learning materials integrate digital technology	9	64.29	5	35.71
7	School policies support digital technology-based learning	9	64.29	5	35.71
8	Teachers encourage students to use digital learning resources	9	64.29	5	35.71
9	Technology enriches learning through simulations or interactive media	11	78.57	3	21.43

Student Digital Literacy

The results indicate that students' basic digital literacy was relatively favorable, particularly in understanding the use of technological devices for learning and receiving guidance on safe and responsible technology use. However, independent use of digital learning applications showed an even distribution between the two response categories. The use of technology for collaboration was also not yet consistently reported.

Table 5 Student Digital Literacy (N = 14)

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
1	Students understand how to use technological devices for learning	11	78.57	3	21.43
2	Students can independently use digital learning applications	7	50.00	7	50.00
3	Students use technology for collaboration in tasks or projects	8	57.14	6	42.86
4	Students receive guidance on safe and responsible technology use	10	71.43	4	28.57

Technology-Related Barriers

The results demonstrate the presence of several technology-related barriers. Technical problems, limited access to technological devices, difficulties in technology integration, perceived financial obstacles, and technical barriers affecting technology-based learning were reported by the respondents. For indicators 2–5, a higher proportion of "Sesuai" responses indicates a greater presence of the respective barrier. Indicator 1 was worded differently, as it described the absence of frequent technical problems. Therefore, its "Sesuai" response indicates a favorable condition, whereas a higher "Tidak Sesuai" response indicates that technical problems were experienced more frequently than suggested by the statement. In this indicator, 3 respondents (21.43%) selected "Sesuai," while 11 respondents (78.57%) selected "Tidak Sesuai," indicating that technical problems remained a notable issue.

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p-ISSN: 2809-8749

Table 6 Technology-Related Barriers (N = 14)

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
1	Technology use rarely experiences technical problems	3	21.43	11	78.57
2	Students experience difficulties accessing technological devices because of limited facilities	10	71.43	4	28.57
3	Teachers experience difficulties integrating technology into learning	9	64.29	5	35.71
4	Cost is a major obstacle to technology use in schools	11	78.57	3	21.43
5	Technical barriers affect the effectiveness of technology-based learning	13	92.86	1	7.14

Perceived Effectiveness of Technology in Deep Learning

Despite the limitations identified in infrastructure and technology utilization, teachers generally perceived digital technology as beneficial for supporting deep learning. The strongest responses were related to technology helping students understand complex concepts and making learning more engaging. Technology was also perceived as supporting critical and analytical thinking, student engagement, and learning outcomes.

Table 7 Perceived Effectiveness of Technology in Deep Learning (N = 14)

No.	Indicator	Sesuai (n)	Sesuai (%)	Tidak Sesuai (n)	Tidak Sesuai (%)
1	Digital technology helps students understand complex concepts	13	92.86	1	7.14
2	Technology makes learning more engaging for students	13	92.86	1	7.14
3	Technology helps students think more critically and analytically	12	85.71	2	14.29
4	Technology contributes to increased student engagement	12	85.71	2	14.29
5	Technology-based learning improves learning outcomes compared with conventional methods	12	85.71	2	14.29

Discussion

Curriculum and Pedagogical Readiness for Deep Learning

The findings demonstrate that the participating elementary schools have a relatively strong pedagogical foundation for implementing deep learning. Teachers generally demonstrated an understanding of the concept, willingness to implement the approach, participation in professional development, and perceptions of curriculum flexibility. These conditions are important because deep learning emphasizes learning processes that move beyond content transmission toward meaningful understanding, active engagement, reflection, and the development of higher-order competencies (Fullan & Langworthy, 2014; Trilling & Fadel, 2009; Hattie, 2018). Recent studies in Indonesian elementary education similarly emphasize that deep learning is associated with meaningful, mindful, and joyful learning experiences that encourage active student engagement and deeper conceptual understanding (Andayanie et al., 2025; Nafi'ah & Faruq, 2025).

e-ISSN: 2809-4085
p-ISSN: 2809-8749

The relatively strong curriculum-related readiness found in this study is also consistent with recent empirical research examining elementary teachers' readiness for deep learning. Allolinggi et al. (2025), for example, examined elementary teachers' readiness across conceptual understanding, pedagogical readiness, technological readiness, professional development, and institutional support. Similarly, Sudirman et al. (2025) emphasize teacher readiness as an important condition for implementing a curriculum based on deep learning principles. These studies support the present finding that teachers' conceptual understanding and willingness to implement deep learning constitute an important starting point for implementation.

However, the present findings also reveal that conceptual and pedagogical readiness does not automatically guarantee the availability of practical resources. The relatively lower condition of teaching materials supporting deep learning indicates a potential gap between understanding the approach and operationalizing it in classroom practice. This finding is consistent with recent literature identifying limited teacher training, inadequate learning facilities, and difficulties translating deep learning principles into classroom practices as continuing implementation challenges (Feri, 2025; Nafi'ah & Faruq, 2025). Therefore, professional development should not stop at conceptual socialization but should also support teachers in designing learning experiences, materials, assessments, and classroom activities that embody meaningful, mindful, and joyful learning.

Educational Ecosystem and Uneven Institutional Readiness

The educational ecosystem findings show that several practices associated with deep learning are already present in the participating schools. Active student involvement, project-based and inquiry-oriented learning, real-world problem solving, reflective assessment, and parental involvement were reported relatively positively. These practices are consistent with the broader conceptualization of deep learning as an approach that encourages students to connect learning with real-life experiences, actively construct knowledge, collaborate, and reflect on their learning (Fullan & Langworthy, 2014; Trilling & Fadel, 2009). Recent research on deep learning in primary education similarly identifies meaningful experiences, student engagement, and contextual learning as important components of deep learning implementation (Andayanie et al., 2025; Nafi'ah & Faruq, 2025).

Nevertheless, the findings show that the educational ecosystem is not equally supportive across all components. The limited availability of laboratories, digital libraries, other learning resources, and external collaboration indicates that pedagogical readiness exists alongside institutional limitations. The relatively low response for school-industry collaboration in the present study should be interpreted cautiously in the context of elementary education. Rather than implying that elementary schools require vocational-style industry partnerships, this indicator can be understood as representing opportunities for schools to connect learning with external resources and real-world contexts. For elementary education, such external collaboration may be more appropriately developed through partnerships with community organizations, local institutions, and other stakeholders relevant to children's learning environments. This finding therefore suggests that strengthening the broader educational ecosystem requires not only adequate learning resources but also forms of external collaboration that are appropriate to the developmental characteristics and educational needs of elementary school students.

An important implication of this finding is that schools should not necessarily be

e-ISSN: 2809-4085
p-ISSN: 2809-8749

classified simply as "ready" or "not ready." A school may demonstrate strong pedagogical practices while still lacking adequate supporting resources. This interpretation is supported by recent studies showing variation in teacher readiness and implementation experiences across different elementary-school contexts. For example, Paidi et al. (2025) found that elementary teachers in Serang Regency demonstrated a moderate level of readiness for implementing deep learning, illustrating that readiness can vary according to context. The present study extends this perspective by examining readiness across several interconnected dimensions rather than treating teacher readiness as a single condition.

Technology Readiness: Infrastructure, Teacher Competence, and Student Digital Literacy

The technology-related findings reveal a more uneven pattern of readiness. Basic facilities such as projectors or smart boards were more commonly available, whereas computer laboratories, sufficient numbers of technological devices, comprehensive Wi-Fi coverage, uninterrupted access to digital learning materials, and internet speed remained more limited. This finding is consistent with recent literature identifying infrastructure and technology limitations as continuing challenges in implementing deep learning in primary education (Nafi'ah & Faruq, 2025). The finding also supports the broader argument that digital transformation in education depends not only on teachers' willingness to use technology but also on the availability and reliability of the technological environment.

At the same time, the present study shows that technological infrastructure and teacher competence do not necessarily develop at the same level. Teachers generally reported receiving technology-related training and feeling confident in using technology, although the integration of digital platforms and student engagement through digital media was less consistent. This pattern is consistent with research on technology integration among elementary teachers showing that teachers may use technological tools primarily for instructional presentation while still requiring support to integrate technology more deeply into pedagogy (Nurwahidah et al., 2023). The implication is that technological competence should not be interpreted solely as the ability to operate devices; it should include the ability to select and integrate technology according to pedagogical objectives.

The findings concerning student digital literacy reinforce this distinction. Students were generally reported to understand the basic use of technological devices, but their independent use of digital learning applications and technology for collaboration was less consistent. This suggests that basic digital skills are not sufficient for deep learning. Students need to develop the ability to use digital resources independently, collaboratively, critically, and responsibly. This argument is compatible with the broader emphasis on 21st-century learning competencies, in which technology functions not merely as a medium for receiving information but as a means of communication, collaboration, creativity, and knowledge construction (Trilling & Fadel, 2009). Recent discussions of deep learning similarly emphasize active engagement and contextual use of technology rather than technology use for its own sake (Prasetiya et al., 2025).

Technology Barriers Despite Positive Perceptions

One of the most important findings is the coexistence of substantial technology-related barriers and positive teacher perceptions of technology. Respondents reported limitations in device access, difficulties integrating technology, perceived financial obstacles, and technical problems affecting technology-based learning. At the same time, teachers generally perceived technology as useful for helping students understand complex

e-ISSN: 2809-4085
p-ISSN: 2809-8749

concepts, increasing engagement, and supporting critical and analytical thinking. This contrast demonstrates that teachers may recognize the pedagogical value of technology even when the conditions for its optimal implementation are not yet available.

This finding is consistent with studies emphasizing that technology can contribute to deeper and more meaningful learning when it is integrated with appropriate pedagogical strategies (Timotheou et al., 2023). Recent research on digital deep learning also emphasizes that technology should function as part of a meaningful learning design rather than simply being added to conventional instruction (Prasetiya et al., 2025). Thus, the positive perceptions found in the present study may reflect teachers' recognition of technology's potential to enrich learning even when technological access remains uneven.

However, positive perceptions alone are insufficient to ensure sustainable technology integration. The findings indicate that teachers perceive financial and technical factors as continuing barriers to implementation. This finding is consistent with recent research identifying infrastructure limitations, teacher readiness, and institutional support as interconnected challenges in implementing deep learning in elementary education (Allolinggi et al., 2025; Nafi'ah & Faruq, 2025). Consequently, interventions should combine teacher professional development with improvements in infrastructure, technical support, and access to learning resources.

The Uneven Readiness of Elementary Schools for Deep Learning

Taken together, the findings indicate that readiness for deep learning in the participating elementary schools is uneven across dimensions. Curriculum and pedagogical readiness appear relatively stronger, as reflected in teachers' understanding of deep learning, curriculum flexibility, active learning practices, assessment, and willingness to implement the approach. In contrast, technological readiness is less consistent, particularly in infrastructure, internet access, student digital independence, and technology-related barriers.

This finding is particularly relevant when compared with recent studies of deep learning readiness. Existing studies have examined teacher understanding, pedagogical readiness, technological readiness, and institutional support, but many have focused primarily on teachers' readiness or on the conceptual implementation of mindful, meaningful, and joyful learning (Allolinggi et al., 2025; Paidi et al., 2025; Andayanie et al., 2025). The present study contributes a different emphasis by showing how different dimensions of readiness can develop unevenly within the same school context.

The central contribution of this study therefore lies not in claiming that the participating schools are simply "ready" or "unready," but in identifying a disparity between pedagogical readiness and technological readiness. Teachers appear to have a relatively favorable foundation for implementing deep learning, while the technological ecosystem does not yet provide equally strong support. This finding extends recent discussions of deep learning implementation by demonstrating that readiness should be interpreted as a multidimensional condition rather than a single aggregate characteristic. The finding is particularly relevant for regional elementary schools, where teachers may adapt creatively to resource limitations while still requiring systemic support to expand and sustain technology-supported deep learning.

Implications for Deep Learning Implementation

The findings have several implications for strengthening deep learning implementation in elementary schools. First, professional development should move beyond introducing the concept of deep learning toward practical development of learning materials, meaningful technology integration, student-centered learning strategies, and reflective assessment. This recommendation is consistent with recent studies emphasizing the importance of teacher readiness and practical implementation support in deep learning (Allolinggi et al., 2025; Sudirman et al., 2025).

Second, technological development needs to address infrastructure and pedagogical integration simultaneously. Improving internet connectivity, device availability, and technical support is necessary, but these investments need to be accompanied by professional learning that helps teachers use technology for exploration, collaboration, problem solving, and reflection. Recent research on digital learning similarly emphasizes that technology becomes more meaningful when it is integrated into appropriate pedagogical strategies rather than treated as an independent component of instruction (Nurwahidah et al., 2023; Prasetiya et al., 2025).

Third, student digital literacy needs to be developed as part of deep learning rather than as a separate technological objective. Students should progressively be supported in using digital resources independently, collaboratively, critically, and responsibly. This direction is consistent with the broader emphasis on 21st-century competencies and the recent conceptualization of deep learning as an approach that integrates cognitive, affective, and metacognitive development (Trilling & Fadel, 2009; Kurnianingsih et al., 2026).

Overall, the findings demonstrate that elementary school readiness for deep learning is a multidimensional and uneven process. The participating schools possess a relatively strong pedagogical foundation, but technological and institutional conditions remain less consistent. This study therefore contributes empirical evidence that the implementation of deep learning in regional elementary schools requires a differentiated strategy: strengthening existing pedagogical capacity while simultaneously addressing technological infrastructure, digital literacy, learning resources, and institutional support. Such an approach is more responsive to the actual conditions of schools than treating deep learning implementation as a uniform transition that requires the same intervention across all dimensions.

Conclusion

This study aimed to analyze the readiness of elementary schools to implement deep learning in Sungai Raya District, Kubu Raya Regency, based on teachers' responses to a structured questionnaire. The findings indicate that school readiness is multidimensional and uneven across the aspects examined. Relatively stronger conditions were found in curriculum adaptation, teachers' understanding and willingness to implement deep learning, active student involvement, problem-solving learning, and assessment practices. In contrast, technological infrastructure, internet availability, student independence in using digital learning applications, learning resources, and technology-related conditions showed greater limitations.

The findings demonstrate that pedagogical readiness can be relatively stronger than technological readiness within the same elementary-school context. Teachers generally showed a favorable level of technological competence and perceived digital technology as beneficial for supporting students' understanding, engagement, and critical and analytical thinking. However, limitations in technological access, technology integration, technical conditions, and perceived financial constraints may hinder the optimal implementation of

e-ISSN: 2809-4085
p-ISSN: 2809-8749

technology-supported deep learning. These findings suggest that school readiness should not be understood simply as "ready" or "not ready," but as a multidimensional condition in which different aspects may develop at different levels.

This study is limited by its reliance on structured questionnaire data and the relatively small number of valid responses for the technology-related indicators, which were based on 14 respondents compared with 18 respondents in other sections. In addition, the findings reflect teachers' perceptions of school conditions and do not provide objective measurements of school budgets, technological infrastructure, or actual classroom implementation. Future research should involve a larger and more diverse sample and may complement questionnaire data with interviews, classroom observations, and other forms of empirical evidence to provide a deeper understanding of how school readiness affects the actual implementation and sustainability of deep learning in elementary education.

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