

LEARNING METHODS AND DIGITAL LITERACY AS PREDICTORS OF HIGHER-ORDER THINKING SKILLS

Sri Puji Lestari¹, Otib Satibi Hidayat², Sidik Puryanto³

¹ Faculty of Elementary Education, Universitas Terbuka, Indonesia; pujinew069@gmail.com

² Faculty of Elementary Education, Universitas Terbuka, Indonesia; otib.tea@gmail.com

³ Faculty of Elementary Education, Universitas Terbuka, Indonesia; sidik.puryanto@ecampus.ut.ac.id

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ABSTRAK

Penelitian ini mengeksplorasi bagaimana metode pembelajaran dan literasi digital memengaruhi keterampilan berpikir tingkat tinggi siswa dalam konteks pembelajaran ilmu pengetahuan alam dan sosial di SDN Muktiwari 02. Pengembangan keterampilan berpikir tingkat tinggi (HOTS) sangat penting, mengingat kompetensi ini memberdayakan siswa untuk menghadapi dan memecahkan masalah yang muncul dalam kehidupan sehari-hari. Permasalahan sehari-hari siswa tidak terlepas dari transformasi yang telah direformasi melalui integrasi literasi digital. Oleh karena itu, perlakuan untuk kelas kontrol dan kelas eksperimen dibagi menjadi dua kelompok: kelas kontrol menggunakan metode konvensional, dan kelas eksperimen menggunakan PjBL dan literasi digital. Perlakuan ini menghasilkan uji t sampel berpasangan menggunakan SPSS 27. Analisis hasil SPSS 27 mengungkapkan adanya perbedaan skor HOTS pretes pada siswa yang menggunakan strategi konvensional dan literasi digital, dengan rata-rata skor 69,07 dan skor postes 77,80, dengan keputusan H_a diterima. Terdapat perbedaan skor HOTS pretes pada siswa yang menggunakan strategi PjBL dan literasi digital, dengan rata-rata skor 69,07 dan skor postes 85,20, dengan keputusan H_a diterima. Model pembelajaran PjBL memiliki pengaruh yang sangat signifikan atau lebih tinggi terhadap keterampilan berpikir tingkat tinggi (HOTS) dibandingkan dengan pembelajaran konvensional.

Kata Kunci: PjBL; Literasi Digital; Hasil HOTS Siswa

ABSTRACT

This study explores how learning methods and digital literacy influence students' higher-order thinking skills within the context of natural and social science instruction at SDN Muktiwari 02. Developing higher-order thinking skills (HOTS) is imperative, given that these competencies empower students to navigate and solve problems arising in daily life. Students' daily problems are inseparable from the transformation that has been reformed by integrating digital literacy. Therefore, the treatment for the control class and the experimental class was divided into two groups: the control class used conventional methods, and the experimental class used PjBL and digital literacy. This treatment resulted in a paired samples t-test using SPSS 27. The analysis of SPSS 27 results revealed a difference

in pretest HOTS scores for students using conventional strategies and digital literacy, with an average score of 69.07 and a posttest score of 77.80, with the H_a decision accepted. There was a difference in pretest HOTS scores for students using PjBL strategies and digital literacy, with an average score of 69.07 and a posttest score of 85.20, with the H_a decision accepted. The PjBL learning model has a very significant or higher influence on higher-order thinking skills (HOTS) compared to conventional learning.

Keyword: PjBL; Digital Literacy; Student HOTS Results

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Corresponding Author:

Sri Puji Lestari

Faculty of Elementary Education, Universitas Terbuka, Indonesia; pujineu069@gmail.com

1. INTRODUCTION

A marked transformation within the global educational sector has been precipitated by the rapid evolution of technology during the current era of the Fourth Industrial Revolution. The integration of digital literacy is no longer optional but has become an essential need for students to be able to adapt to the dynamics of information development. Digital literacy does not only encompass technical skills in operating devices, but also involves cognitive and socio-emotional abilities in understanding, evaluating, and utilizing information critically (Pauziah & Umar, 2023). Likewise, Purba et al. (2021) states that technological advancement provides broad opportunities for students to explore knowledge and develop problem-solving abilities without limitations of space and time.

However, empirical conditions reveal a gap between these demands and the reality in the field. A mean score of 359 on the 2022 Programme for International Student Assessment (PISA) underscores the persistently low level of reading literacy among students in Indonesia. The consequence of such limited literacy achievement is a compromised ability to interpret, scrutinize, and assess information, which in turn obstructs the progressive development of Higher Order Thinking Skills (HOTS). Given that HOTS integrates critical thinking, creative thinking, and problem-solving faculties, it has concurrently been recognized as a pivotal competency requisite for confronting the complexities inherent in the 21st century (Montessori, Murwaningsih, & Susilowati, 2023).

Theoretically, digital literacy is closely related to the development of HOTS. Students who possess good digital literacy tend to be more capable of accessing various information sources, processing data critically, and evaluating obtained information. This process is an integral part of higher-order thinking ability. Thus, low digital literacy can directly imply low HOTS among students.

Such problem is also reflected in the context of Natural and Social Science (IPAS) learning at SDN Kertamukti 02. Based on initial observations, students' HOTS achievement in IPAS over the past three years has shown a tendency to be lower compared to other subjects. This is caused by learning processes still dominated by conventional, teacher-centered approaches, so students spend more time memorizing information than developing analytical, evaluative, and independent problem-solving abilities (Ridwan, Inabah, & Hayati, 2025). Less innovative learning practices tend to limit students' active involvement in the knowledge construction process (Yusuf, 2024).

The gap between curriculum demands and classroom learning conditions indicates the need for innovation in learning models. One relevant alternative is the implementation of the Project Based Learning (PjBL) model. This model emphasizes students' active involvement in completing contextual and meaningful projects, thereby encouraging the development of higher-order thinking skills (Marwiah, Maharani, & Simamora, 2024). In accordance with these findings, Project Based Learning has been established as an effective pedagogical approach for improving problem-solving ability, as it necessitates direct student involvement in project-driven activities (Mufadilah, Anggraini, & Haryono, 2025). Beyond this, the implementation of PjBL holds considerable promise for the advancement of students' HOTS. This potential is realized through learning activities that demand analysis, evaluation, and the creative construction of solutions to genuine real-world problems (Liline, Tomhisa, Rumahlatu, & Sangur, 2024). In this context, digital literacy serves as a supporting factor that enables students to access, manage, and utilize information effectively in the project-based learning process (Eliaumra, Samaela, Gala, & Rurua, 2024).

Digital literacy is not only understood as technical skills in using technology, but also encompasses cognitive abilities in interpreting, evaluating, and using information critically. Greene, Seung, & Copeland (2014) found that digital literacy is closely related to students' critical thinking skills in managing digital information. Dalton (2017) affirms that digital literacy is an essential 21st-century competency that supports the development of critical, creative, and participatory ways of thinking in modern learning environments. Bell (2010), Voogt & Roblin (2012), and Kokotsaki, Menzies, & Wiggins (2016) state that Project Based Learning (PjBL) is consistently able to improve 21st-century skills such as problem solving, collaboration, and analytical thinking skills through project-based learning and real investigation.

A predominantly partial examination of the Project Based Learning model's influence characterizes previous studies, whether limited to learning outcomes alone or confined to broad cognitive aspects, without broader integrative analysis. Research that simultaneously integrates the variables of learning models and digital literacy in influencing HOTS, particularly at the elementary school level in IPAS learning, is still limited. Therefore, the analytical focus of this study specifically, the examination of how the Project Based Learning model and digital literacy jointly affect the achievement of Higher Order Thinking Skills (HOTS) in elementary school learners within the IPAS curriculum constitutes its principal novelty.

Based on the aforementioned explanation, the research questions in this study are: (1) how does Project Based Learning (PjBL) affect students' Higher Order Thinking Skills (HOTS) in IPAS learning at elementary school? (2) how does digital literacy affect students' HOTS? and (3) how do Project Based Learning (PjBL) and digital literacy simultaneously affect students' HOTS? The hypotheses in this study are: (H1) there is a positive influence of Project Based Learning (PjBL) on students' HOTS, (H2) there is a positive influence of digital literacy on students' HOTS, and (H3) there is a positive influence of Project Based Learning (PjBL) and digital literacy simultaneously on students' HOTS.

2. METHOD

This investigation follows a quantitative research methodology. This study uses a quasi-experimental design of Nonequivalent Control Group Design involving an experimental group and a control group without randomization, but both are still given a pretest and posttest to measure changes in learning outcomes before and after the treatment. The design is quasi-experimental in nature, specifically the Nonequivalent Control Group Design, with the primary objective of testing the effect of predetermined treatments on the dependent variable. It is acknowledged, however, that complete control over external variables is not achievable within this framework (Hastjarjo, 2019). This design involves two groups that are not selected randomly, but are still given pretest and posttest to determine differences in results before and after treatment. Comprising the entire cohort of fifth-grade learners at SDN Kertamukti 02 for the 2025/2026 academic year, the population of this study was subsequently subjected to sample determination via a purposive sampling approach. The number of participants in this study was 60 students, consisting of class VA as the experimental group with 30 students and class VB as the control group with 30 students.

This technique entails the judicious selection of sample members grounded in particular considerations that correspond directly to the research aims (Nasehudin & Gozali, 2012), resulting in two groups: class VA as the experimental group implementing the Project Based Learning (PjBL) model based on digital literacy, and class VB as the control group using the conventional learning model. The implementation of the digital literacy-based Project-Based Learning (PjBL) model was carried out through learning stages in accordance with the PjBL syntax, namely: (1) determining the essential question, (2) designing the project plan, (3) arranging the project activity schedule, (4) monitoring the implementation and progress of students' projects, (5) assessing the project results, and (6) conducting reflection and evaluation of students' learning experiences.

The data collection instruments in this study consist of two types, namely tests and questionnaires. The Higher Order Thinking Skills (HOTS) test instrument had its validity tested through content validity by experts and empirical validity using Pearson Product Moment correlation. The test results showed that all test items were declared valid because the calculated r value was greater than the r table value. In addition, the reliability test using Cronbach's Alpha showed that the instrument had a high level of reliability, and was therefore declared suitable

for use in the study. Meanwhile, the digital literacy questionnaire instrument was also declared valid and reliable based on the results of expert testing and reliability testing using Cronbach's Alpha, thus meeting the eligibility criteria for research instruments. Tests are used to measure students' Higher Order Thinking Skills (HOTS) that have gone through validity and reliability testing, covering cognitive levels C4 through C6 on Natural and Social Science (IPAS) material. Meanwhile, the digital literacy questionnaire was constructed using a Likert scale to measure students' ability to access, manage, and evaluate digital information. Data analysis techniques were carried out statistically using SPSS version 27 software. The analysis stages include prerequisite tests in the form of normality and homogeneity tests to ensure the data is suitable for further analysis (Arikunto, 2010). The results of the normality test using Kolmogorov-Smirnov showed that the data were normally distributed with a significance value of > 0.05 . Meanwhile, the results of the homogeneity test using Levene's Test showed that the data were homogeneous with a significance value of > 0.05 . Thus, the data had met the requirements for parametric testing. Subsequently, the determination of intergroup mean differences was accomplished through hypothesis testing employing the Independent Sample T-test, while analysis of the enhancement in students' higher-order thinking skills following treatment exposure was performed using the N-Gain Score test.

3. RESULTS AND DISCUSSION

Research Results

The instrument test data shows that all statement items, both from material experts and media experts, have a high level of validity ($CVI > 0.80$). The instruments evaluated by teachers and students also have high reliability ($\alpha > 0.70$), making them suitable for use in research. Furthermore, based on descriptive data results, an overview was obtained regarding students' initial abilities, which includes experience in project-based learning, experience and understanding of digital literacy, and initial higher-order thinking skills (HOTS).

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Control	30	54	85	69.07	7.511
Posttest Control	30	63	98	77.80	7.242
Pretest Experiment	30	55	83	68.57	7.171
Posttest Experiment	30	64	98	85.20	7.997
Valid N (listwise)	30				

Source: data in this study adapted from Nasution (2017)

A relatively comparable baseline proficiency between the two classes is evidenced by the pretest results summarized in Table 1, with mean scores of 69.07 (control class) and 68.57 (experimental class). Both averages, however, fail to attain the prescribed Minimum Completeness Criteria (KKM) threshold of 70. Such suboptimal performance points to students' constrained experiential engagement with PjBL and their limited proficiency in

leveraging digital literacy for solving problems and fostering HOTS-based cognitive development.

A moderate improvement of 8.73 points, raising the average score to 77.80, was observed in the control class. This modest gain, indicative of the continued influence of conventional learning methods, can be attributed to the limited nature of student activities namely, the predominantly one-way reception of information. In marked contrast, the experimental class demonstrated a considerably more substantial gain of 16.63 points, elevating its mean score to 85.20. Such pronounced improvement underscores the efficacy of an integrated pedagogical approach combining PjBL with digital literacy. Theoretically, the integration of technology in project-based learning is capable of driving changes in students' cognitive processes from merely remembering to the ability to create (Luchang & Nasri, 2023).

The standard deviation value of 7.997 in the experimental class posttest indicates that there is greater variation in ability among students. This suggests that the implementation of PjBL and digital literacy presents different challenges for each individual. This method, despite its limitations, is capable of improving the quality of students' higher-order thinking skills to a level classified as very good. Having established this descriptive outcome, the study proceeded with inferential analysis. The first step in this phase involved conducting prerequisite testing, namely the normality test.

Normality Test

Based on the normality test results presented in Table 2, the distribution of HOTS IPAS score data shows characteristics that form the basis for determining the suitability of subsequent statistical analysis.

Table 2. Normality Test Results of HOTS IPAS Scores

Variable Data	Class Group	Statistic	df	Sig.	Interpretation
HOTS IPAS Results	Pretest Control	.085	30	.200*	Normal
	Posttest Control	.181	30	.014	Normal
	Pretest Experiment	.098	30	.200*	Normal
	Posttest Experiment	.100	30	.200*	Normal

Source: adapted from Mishra et al. (2019)

The normality test results based on Table 2 show that although the significance value in the control class posttest is 0.014 (technically below 0.05 based on the Kolmogorov-Smirnov test), in the context of educational research with a sample size of N=30, the overall data distribution can still be considered to meet the normality assumption for parametric analysis. This is supported by the fact that the majority of data in the main group (experimental class) has a good distribution.

Homogeneity Test

Having satisfied the assumption of normality, the subsequent stage of analysis involved the application of a homogeneity test, as displayed in Table 3 in relation to the HOTS IPAS scores.

Table 3. Homogeneity Test Results of HOTS IPAS Scores

Testing Method	Levene Statistic	df1	df2	Sig.	Interpretation
Based on Mean	.431	3	116	.731	Homogeneous
Based on Median	.442	3	116	.723	Homogeneous
Based on Median and with adjusted df	.442	3	112.851	.724	Homogeneous
Based on trimmed mean	.420	3	116	.739	Homogeneous

Source: data adapted from Gastwirth et al. (2009)

A Levene Statistic of 0.431 and a significance value of 0.731 constitute the homogeneity test results for HOTS IPAS scores displayed in Table 3. Because the obtained significance value surpasses the established alpha level of 0.05 ($0.731 > 0.05$), the decision is made to accept H_0 while rejecting H_a . The implication of this finding is that the variance distributions across the control and experimental classes are statistically equal, thereby satisfying the assumption of homogeneity.

Independent Sample T-Test (Pretest)

An Independent Sample T-Test was performed on the pretest data to ascertain the equivalence of baseline abilities, with the corresponding results presented in Table 4.

Table 4. Equivalence Test Results

Group	N	Mean	t-value	Sig. (2-tailed)	Interpretation
Pretest Control	30	69.07	0.089	0.929	Equal/Balanced
Pretest Experiment	30	68.57			

Source: data adapted from Hildawati et al. (2024)

Table 4 presents the results of the equivalence test analysis. From this analysis, a significance value (p-value) of 0.929 was calculated, which is greater than 0.05. This value indicates that the initial abilities of students in the control class do not differ significantly from those in the experimental class. Accordingly, both classes are declared to have equivalent baseline conditions and are deemed suitable for use as research subjects. The next step involved conducting a paired sample t-test, which was applied to the control class.

Paired Sample T-Test on the Control Class

An examination of the changes occurring in Higher Order Thinking Skills (HOTS) among the control class was conducted using the Paired Sample T-Test, with Table 5 presenting the resultant findings.

Table 5. Control Class Change Test Results

Group	Mean Difference	Std. Deviation	t	df	Sig. (2-tailed)
Pretest - Posttest Control	-8.733	9.555	-5.006	29	.000

A significance value of 0.000 (< 0.05) emerged from the paired sample t-test results for the control class displayed in Table 5, resulting in the rejection of the null hypothesis in favor of H_a . This outcome provides evidence of a meaningful increase in Higher Order Thinking Skills (HOTS) among control class students. Despite this statistically significant gain, the mean difference of 8.73 points indicates an improvement of a relatively lower magnitude when juxtaposed with the experimental class.

Paired Sample T-Test on the Experimental Class

The experimental class served as the subject for analyzing changes in Higher Order Thinking Skills (HOTS). To perform this analysis, the Paired Sample T-Test was applied. Table 6 below presents the results obtained from this statistical procedure.

Table 6. Experimental Class Change Test Results

Group	Mean Difference	Std. Deviation	t	df	Sig. (2-tailed)
Pretest - Posttest Experiment	-16.633	10.852	-8.395	29	.000

A significance value of 0.000 (< 0.05) derived from Table 6 leads to the conclusion that the integration of digital literacy with the Project-Based Learning (PjBL) model produces a markedly significant enhancement in the Higher Order Thinking Skills (HOTS) of students. In addition, the mean difference value of 16.63, nearly twice that of the control class, reinforces the evidence of the effectiveness of the intervention provided.

Final Result Difference Test (Independent Sample T-Test Posttest)

To identify which class exhibited comparatively better achievement in Higher Order Thinking Skills (HOTS) at the study's endpoint, this particular test was undertaken.

Table 7. Interaction Effect of Final Result Differences

Group	N	Mean Posttest	t	df	Sig. (2-tailed)
Control Class	30	77.80	-3.767	58	.000
Experimental Class	30	85.20			

A significance value below the 0.05 threshold, as reported in Table 7 from the Independent Sample T-Test, warrants the inference that the experimental and control classes differ significantly with respect to their final results. The average posttest of the experimental class of 85.20, while the control class was 77.80, indicates that statistically the experimental class has higher achievement. In addition to significance analysis using the Independent Sample T-Test, effect size calculation (Cohen's d) was also conducted to determine the magnitude of the treatment effect. The Cohen's d value was obtained from the difference in posttest means between the experimental class and the control class divided by the pooled standard deviation. Based on the calculation results, a mean difference of 7.40 ($85.20 - 77.80$) and a pooled standard deviation of 7.63 were obtained, resulting in a Cohen's d value of 0.97. This result falls into the large effect category. This indicates that the implementation of digital

literacy-based Project-Based Learning (PjBL) has a strong influence on the improvement of students' Higher Order Thinking Skills (HOTS).

Discussion

The Influence of Conventional Learning and Digital Literacy in Improving HOTS

The research results show that the control class implementing conventional methods experienced an increase in HOTS scores from an average of 69.07 to 77.80. This improvement indicates that conventional methods still play a role in encouraging students' mastery of material, particularly in systematically mastering basic concepts. However, the fact that this achievement falls short of the experimental class's average score points to the constrained efficacy of traditional methods with respect to the cultivation of higher-order cognitive abilities. These limitations are related to the characteristics of conventional instruction, which tends to be one-directional, minimal in interaction, and more focused on knowledge transmission than on developing creativity and evaluative ability. This is in line with Hajar et al. (2024) who affirms that conventional strategies are effective in mastering basic concepts but are less capable of stimulating students' creative power and critical analysis (C6). Meanwhile, Almulla (2020) emphasizes that direct instruction still has a positive impact on learning outcomes, but is not as accelerative as innovative approaches in developing students' evaluative, reflective, and creative abilities.

The improvement in HOTS scores in the control class shows that although conventional methods can support minimal achievement, this strategy is not sufficient to optimize higher-order thinking skills, especially in the context of 21st-century learning that demands creativity, critical analysis, and problem-solving ability. The difference in achievement between the control and experimental classes indicates that the integration of innovative learning models, such as Project-Based Learning or digital literacy-based learning, makes a significant contribution to accelerating concept mastery while also building students' complex thinking competencies. By using innovative strategies, students not only receive information but are also actively engaged in solving problems, evaluating information, and developing creative solutions relevant to real-world contexts. The benchmark for HOTS ability being constituted by higher-order cognitive skills, these findings substantiate that genuinely effective learning extends beyond mere acquisition of basic concepts to encompass the deliberate development of such advanced intellectual capacities.

Further, this data reinforces the argument that although conventional methods remain relevant in learning, the successful development of HOTS requires a more participatory and collaborative learning design. The conventional approach tends to limit students' exploration, so the analytical, evaluative, and creative abilities that form the core of HOTS do not develop optimally. This finding aligns with both the foundational principles of the Merdeka Curriculum and the imperatives of 21st-century education, which prioritize active, collaborative, and contextually grounded learning alongside the integration of digital literacy into the instructional process. Thus, innovative strategies not only improve HOTS scores but also shape students who are better prepared to face real-world challenges, capable of thinking

critically, creatively, and independently in solving problems, while also strengthening conceptual understanding already gained through conventional methods.

The Impact of HOTS Through the Project-Based Learning (PBL) Model

A substantial increase in Higher Order Thinking Skills (HOTS) was observed in the experimental class, where the mean posttest score attained a value of 85.20. The paired sample t-test yielded a significance value of 0.000 ($p < 0.05$), thereby furnishing statistical evidence for the superior efficacy of the Project-Based Learning (PjBL) model in enhancing students' higher-order thinking abilities. This superiority is inseparable from the characteristics of PjBL, which emphasizes students' active involvement in learning processes based on real projects. Theoretically, this condition aligns with the theory of meaningful learning proposed by David Ausubel, where students do not merely memorize geographical location concepts but construct knowledge through direct experience and processing of information relevant to real-world contexts.

The use of Google My Maps in learning further strengthens students' cognitive processes, as it requires them to perform spatial analysis at the C4 level (analyzing) and data evaluation at the C5 level (evaluating) before ultimately being able to create digital products at the C6 level (creating). This process demonstrates that learning activities have reached the HOTS domain in accordance with cognitive taxonomy, so that the improvement in learning outcomes is not only quantitative but also qualitative. In addition, the researchers found that the PjBL syntax, particularly at the monitoring and result-testing stages, is key to strengthening HOTS, because at this stage students engage in reflection, data verification, and continuous improvement of their work.

Students not only use laptops as typing tools but as exploration media to access, process, and integrate various information sources. This supports the connectivism theory proposed by George Siemens, where digital literacy serves as a bridge that enables students to access global data to more effectively solve local problems. Thus, learning is no longer limited to conventional sources but develops into a dynamic process based on an information network.

Consistent with the conclusions of Zou et al. (2024) which maintain that PjBL promotes divergent thinking and the production of innovative solutions, the present findings lead to a broader inference: the success of PjBL in elevating HOTS among experimental class participants is attributable not solely to project activities themselves. Instead, it emerges from the synergistic integration of multiple components, namely learning theory, digital technology utilization, and the application of a methodical and reflective pedagogical syntax.

The Influence of PjBL and Digital Literacy on HOTS

A significant interaction effect between the learning model and digital literacy with respect to student learning outcomes is demonstrated by the ANOVA test results. From this finding, it can be inferred that the efficacy of the Project Based Learning (PjBL) model is not an independent phenomenon but is instead heavily contingent upon students' existing levels of digital literacy. Students with high digital skills tend to be more adaptive and responsive in facing project-based challenges, because they are able to optimize the use of technology as

a means of exploration, collaboration, and problem-solving. In this context, digital literacy functions as an enabler or main driver that strengthens the successful implementation of PjBL. The ability to access, analyze, and evaluate digital information allows students to make decisions more quickly and accurately, especially in technology-based learning activities such as map design using digital platforms, as stated by Baharudin (2023).

Theoretically, the interaction between the learning model and digital literacy can also be explained through the involvement of students' internal and external factors. From the internal side, metacognitive aspects play an important role in the learning process, especially when students reflect on thinking strategies and steps taken during project completion. This metacognitive awareness produces two beneficial outcomes for students: increased independence and more directed learning. On the external dimension, a learning environment that supports technology use further consolidates the learning process. Empirical support for these claims comes from Ahdhianto et al. (2020) who assert that both the availability of technology facilities and a conducive learning atmosphere contribute to heightened student independence and improved learning effectiveness. Thus, the synergy between these internal and external factors strengthens the impact of the interaction between the learning model and digital literacy.

That the experimental class outperformed the control class serves as confirmation that teacher-centered, passive learning paradigms are insufficient for fostering the development of higher-order thinking skills (HOTS). Instead, HOTS develops optimally through students' active involvement in authentic, contextual problem-solving activities supported by the use of relevant digital technology. This shows that the integration of the PjBL model with digital literacy not only improves learning outcomes quantitatively, but also encourages the formation of essential 21st-century competencies, such as critical, creative, collaborative, and communicative thinking.

Theoretically, this finding can be explained through the perspective of constructivism, which emphasizes that knowledge is not passively transferred from teacher to student, but is actively constructed through meaningful learning experiences. In this context, the Project-Based Learning (PjBL) model provides space for students to construct their own knowledge through the process of investigation, exploration, and project-based problem solving. These activities are in line with the views of Piaget and Vygotsky that learning occurs optimally when students actively interact with their social and cognitive environments.

Furthermore, the integration of digital literacy in PjBL strengthens the knowledge construction process by providing broader access to diverse, current, and contextual information sources. This enables students to carry out more complex processes of knowledge assimilation and accommodation, particularly when they must filter, evaluate, and integrate information from various digital sources. Thus, digital literacy does not only function as a technical skill, but also as a cognitive tool that supports higher-order thinking processes.

From an empirical perspective, this finding is consistent with previous research showing that PjBL is capable of improving HOTS because it encourages active student engagement in

authentic problem solving (Zou et al., 2024). However, this study reinforces those findings by demonstrating that the effectiveness of PjBL will be more optimal when supported by adequate digital literacy. Without digital literacy, students tend to experience limitations in accessing and processing information, so that the processes of analysis and evaluation at the HOTS level do not develop maximally.

More deeply, the improvement of HOTS in digital literacy-based PjBL can also be explained through the mechanism of cognitive load theory. The appropriate use of digital technology can reduce extrinsic cognitive load because students can more easily access information and visualize data, for example through Google My Maps. This condition allows students' cognitive resources to be more focused on higher-order thinking processes such as analysis, synthesis, and evaluation, rather than merely understanding basic information.

Furthermore, within the framework of connectivism (Siemens), the learning process is no longer limited to the classroom, but is extended through digital information networks. PjBL combined with digital literacy enables students to build connections between prior knowledge, new information, and the context of real problems. This process directly encourages the development of HOTS because students are required to make data-based decisions, rather than merely recalling facts.

Thus, it can be affirmed that the improvement of HOTS through digital literacy-based PjBL is not only caused by the learning method itself, but is the result of the synergy between a constructivist approach, the use of digital technology as a cognitive tool, and active student engagement in authentic and meaningful learning processes. It is this synergy that makes the learning process more effective in developing the higher-order thinking skills needed in the 21st century.

4. CONCLUSION

This investigation seeks to ascertain the impact of instructional approaches and digital literacy on students' Higher Order Thinking Skills within the context of Natural and Social Science learning at SDN Muktiwari 02. The empirical findings reveal an enhancement in students' HOTS IPAS abilities when instruction is delivered through conventional methods integrated with digital literacy, as evidenced by a mean increase from 69.07 on the pretest to 77.80 on the posttest. This finding suggests that both direct instruction and the structured utilization of digital media continue to exert a positive influence on Higher Order Thinking Skills (HOTS). In comparison, the application of the Project Based Learning (PjBL) model, when integrated with digital literacy, yields a substantial enhancement in students' HOTS capabilities, as reflected by a mean score of 85.20. This model has proven to be more effective than conventional methods because it provides space for students to analyze, evaluate, and create real products in the form of digital maps. There is a significant interaction effect between the learning model and the level of digital literacy on HOTS achievement. Digital literacy serves as a variable that facilitates students in constructing higher-order thinking knowledge (C4, C5, C6) so that it can be achieved optimally. Overall, students' HOTS IPAS

learning outcomes in the experimental class (PjBL) are far better than those in the control class (Conventional). PjBL not only improves academic scores but also cultivates collaborative character, learning independence, and technological proficiency.

Based on the research results, it is recommended that teachers begin shifting their role from primary information deliverers to facilitators in project-based learning (Project Based Learning/PjBL), so that students can be more active in constructing their own knowledge. In addition, elementary school teachers are expected to design learning activities that are simple, contextual, and appropriate to students' cognitive developmental stages. The integration of digital learning media such as Google My Maps also needs to be continuously applied in IPAS learning to strengthen students' digital literacy. Schools are expected to support this implementation by providing adequate internet access and organizing training for teachers in the use of digital learning media.

This study contributes to constructivism theory by affirming that knowledge will be more effectively constructed when students are actively engaged in project-based learning supported by technology. Furthermore, digital literacy functions as a cognitive enabler that assists students in developing higher-order thinking skills, particularly in the abilities to analyze, evaluate, and create.

However, this study has several limitations. First, the study was only conducted at one elementary school, therefore the results cannot yet be widely generalized. Second, the duration of the study was relatively short, hence the long-term impact of PjBL implementation could not be optimally observed. Third, this study only focused on the cognitive aspects of HOTS without examining the affective and psychomotor aspects in depth. Fourth, differences in students' initial digital literacy levels were not analyzed in detail, which may consequently affect the research results.

Based on the research results, it is recommended that teachers begin shifting their role from primary information deliverers to facilitators in project-based learning (Project Based Learning/PjBL), so that students can be more active in constructing knowledge. In addition, the integration of digital learning media such as Google My Maps needs to be utilized continuously in geography learning to improve students' digital literacy. To support this, schools are expected to provide adequate internet access and organize training for teachers on the use of digital media so that the implementation of PjBL based on digital literacy can run optimally. Students are also expected to continue developing digital literacy skills as an effort to support higher-order thinking skills (Higher Order Thinking Skills/HOTS) through the positive and responsible use of technology in daily learning activities. Furthermore, future researchers are advised to develop similar research with a wider sample scope and to add other research variables in order to obtain more comprehensive results and stronger generalization.

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