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Improving the Digital Literacy Skills of Junior High School Students through Blended Learning

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Abstract: This study aims to determine the effect of various blended learning models on digital literacy, namely station rotation, lab rotation, and pedati. This study is a true experimental study using a pretest-posttest control group design. The research population included all eighth grade students at SMP Negeri 2 Sengkang. The research sample was taken using random sampling, resulting in four classes, namely VIII.1 as the control class with STAD learning, and three experimental classes: VIII.2 with blended learning station rotation, VIII.3 with blended learning lab rotation, and VIII.4 with blended learning pedati. The instrument used was the students' digital literacy instrument. Data was collected through a digital literacy questionnaire that was given before and after learning. Data analysis was performed using ANCOVA with a significance level of 0.05. The results revealed that the application of blended learning with the station rotation, lab rotation, and pedati models influenced digital literacy. Based on the LSD (Least Significant Difference) follow-up test, blended learning with the lab rotation model obtained the highest average score compared to the other two models. This finding emphasizes the importance of technology integration in the learning process, especially in improving students' digital literacy.

Keywords: digital literacy, station rotation, lab rotation, pedati.

▪ INTRODUCTION

Education is the basic need of a country to develop knowledge and skills, understanding and is important to continue because it shapes the society of the future, promoting sustainable development, both in school and out-of-school settings (Su et al., 2022; Bayrak et al., 2023). Education raises the level of societal development and is the most productive long-term investment as it produces self-reliant individuals who can achieve a better standard of living (Koçak et al., 2019; Yıldırımer, 2024). One of the essential aspects of fair and quality education is to ensure that all students have the same opportunity to learn without being affected by differences in background (Osei-Tutu, 2021; Ndou, 2022). Education is essentially a process of inheriting and transferring knowledge (Adnan et al., 2016). Quality education is a key factor for the overall development of individuals, nations, and countries (Deupa, 2023) as a pedagogy that involves students learning, interacting with other students, and engaging with ideas (Barret, 2021). In education, the 21st century has emerged as a pivotal era characterized by rapid technological advances and an increasingly interconnected global landscape (Sihawong & Phusee-orn, 2024; Hurskaya et al., 2024). Changes in several aspects of life have created the need for individuals to acquire 21st-century skills (Çetingöz, 2023). Therefore, 21st-century educators are required to equip a ready generation that is ready and adaptive in responding to all demands (Jamaluddin et al., 2023; Tangpong et al., 2023). Digital literacy is one of the essential 21st-century skills (Ndibalema, 2025; Matveev, 2024; Reddy et al., 2023; Gündüzalp, 2021; Bravo et al., 2021).

However, reality shows that the lack of quality education remains a significant challenge in many developing countries (Devkota & Basyal, 2024). One indication is seen

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in several studies that reveal that digital literacy is still relatively low (Budiman & Syafroni, 2023; Candrasari et al., 2020). Referring to the digital literacy roadmap the Ministry of Communication and Informatics compiled, Indonesian society's digital competitiveness index ranking is still relatively low. 2016 the ICT Development Index ranked Indonesia 114th, then rose to 111th in 2017 out of 176 countries. Meanwhile, in the IMD Digital Competitiveness Index, Indonesia ranked 56 out of 63 countries in 2020. This data shows Indonesia is still behind other Southeast Asian countries like Singapore, Thailand, and Malaysia. In addition, the digital literacy level score in Indonesia also shows disparities between regions. The western part of Indonesia has an average score of 3.43, the central region 3.57, while the eastern region only reaches 2.44 (Kominfo, 2021). Badan Pusat Statistik (2025) reports that most students, 90.76%, use the internet as entertainment, while 67.65% use it to access social media. Sadly, only 27.53% use it for online learning activities.

The lack of internet and smartphone utilization in educational content is due to the lack of technology integration in the learning activities. Students are less motivated to use the internet as a learning tool. Based on data from the GTK Secretariat of Kemdikbud, as many as 60% of teachers still apply conventional learning methods, while only 40% have adopted ICT in teaching and learning activities (Wahyuni et al., 2023). The findings state that many educators still apply simple or traditional learning methods by relying only on available facilities. This causes the learning process to be less effective and does not provide a significant improvement in the quality of education (Gaol & Simanjuntak, 2020). In addition, schools have also not optimized the use of technology as they should. Supporting facilities for digital literacy, such as internet networks, computers, and smartphones, which are already available, have not been maximally utilized. As a result, the learning process still takes place without the support of digital media to support the learning and teaching process (Hardiany et al., 2024). The real evidence of this condition is reflected in research that has involved teachers and students. Teachers revealed that although the school has available information and communication technology, such as projectors and wireless networks, it is still not optimally utilized in learning. In addition, responses from students show that teachers rarely use information and communication technology in the learning process. This condition reinforces that the low utilization of technology in learning is one factor that hinders the improvement of students' digital literacy (Fahreza et al., 2022). Another factor contributing to low digital literacy is the desire of students to find sources of answers instantly through the internet without verifying the truth of the information, resulting in incorrect answers to assignments or exams (Dewi et al., 2024).

As a solution to prepare students with ICT skills and improve low digital literacy indicators, the education system needs to shift from traditional teaching and learning methods based on printed materials to digital formats. To support this transition, blended learning assisted by a learning management system (LMS) can be applied. Blended learning is characterized by a combination of face-to-face and online learning that integrates various materials into teaching and learning (Castro-Rodríguez et al., 2021). The facilities provided in this learning allow students not present in class to access and download learning materials because the teacher has uploaded the materials online (Mdletye & Usadolo, 2024). This situation allows students and teachers to use modern digital technology to optimize learning (Shurygin, 2024). The learning management

system is a digital medium that bridges the interaction between teachers and students outside the physical classroom, enabling learning to occur more optimally. Teachers can manage various learning activities through the LMS to achieve predetermined goals (Odekeye et al., 2023). In LMS, assignments, quizzes, and glossaries are designed for individual use, while forums, wikis, and chats function as means of group interaction (Adnan et al., 2014). The use of ICT in education has brought new convenience to the learning process (Adnan, 2015). This condition reflects the demands of the 21st century, which require graduates to master ICT skills. Therefore, learning must be updated by integrating information technology to improve students' digital literacy (Yustina et al., 2022).

Blended learning presents a variety of variations that can be applied in learning, such as station rotation, lab rotation, and pedati. Station rotation is a feature of blended learning that requires students to move from one station to another including online instruction, collaborative activities and stations, and teacher lead instruction (Fulbeck et al., 2020). Lab Rotation is implemented by having students move between several locations within the school environment according to a fixed schedule or teacher policy. One of the places acts as a digital-based learning laboratory, while the other classrooms are used for other learning approaches (Staker & Horn, 2012). Meanwhile, the cart type consists of four learning cycles: learning (learning the material), deepening (deepening through online discussion), applying (applying by doing online assignments), and measuring (evaluating through objective tests) (Chaeruman, 2018).

Thus, this study focuses on how the three types of blended learning affect students' digital literacy. The research hypothesis states: **H1.** Station rotation, lab rotation, and pedati type blended learning have an effect on digital literacy.

▪ METHOD

Participant

The population in this study included all students in class VIII of SMP Negeri 2 Sengkang, which amounted to 227 students. The research sample consisted of four classes, namely VIII.1, VIII.2, VIII.3, and VIII.4, with a total of 128 students; each class amounted to 32 students. Sampling in this study uses a simple random sampling technique.

Research Design and Procedures

This study used a true experimental design with a pretest-posttest control group design. Since all classes were homogeneously distributed, randomization was done by lottery method in determining the experimental and control classes. This design was chosen because it allows the measurement of changes that occur due to treatment by comparing the results of the pretest and posttest in both groups.

The research procedure consists of three stages: planning, implementation, and the end. The planning stage includes literature review, problem formulation, hypothesis, preparation of research instruments, and instrument validation. The implementation stage lasted for four meetings. The time allocation required is 5 lesson hours in 2 meetings (5 x 40 minutes), so the first meeting is 3 x 40 minutes, and the second is 2 x 40 minutes. This implementation stage includes administering an initial digital literacy questionnaire, introducing the LMS, and providing interventions where experimental class 1 is presented

with station rotation, experimental class 2 with lab rotation, experimental class 3 with pedati, and control class with stad.

The implementation of Station Rotation is carried out through stages: (1) Online Instruction, lasting for 20 minutes, students explore the material through the LMS or other online sources. In this process, students can read material or watch learning videos. (2) Collaborative activities and stations are carried out offline for 30 minutes. Students work together to complete worksheets and discuss in groups. (3) Teacher Lead Instructions are carried out offline for 10 minutes. At this stage, the teacher reinforces the material and overall learning. Learning ends with an online evaluation through multiple-choice quizzes on the LMS platform.

Implementation of Lab Rotation is carried out through stages: (1) Online Learning (learning in an online laboratory) consists of three activities, namely a) Exploration, namely students explore interactive material online through LMS, YouTube, Google Search, Wikipedia, Website, WhatsApp and various other software. b) Discussion, namely students can discuss online using the discussion forum feature in LMS. c) Assignment, namely students access and deposit their assignments online through LMS. After completing learning in the online laboratory, students rotate to the offline learning stage. (2) Offline Learning is the stage where the teacher provides material reinforcement and answers questions to clarify their understanding of the knowledge obtained from the previous online stage. The learning ends with an evaluation through multiple-choice quizzes on the LMS platform.

Pedati implementation is carried out through stages: (1) Learning, where students learn the material through activities by offline reading books and listening to teacher explanations. (2) Deepening, where students deepen their understanding of the material through online discussions on the LMS platform. (3) Applying, the stage where students apply their understanding by doing assignments offline given by the teacher. (4) Measuring, the evaluation stage, is where students take multiple choice quizzes online through the LMS to ensure their understanding of the material that has been learned.

All materials used in the experimental and control classes were the same, covering nutrition and food, organs and functions, and digestive processes. Teachers act as facilitators in blended learning by guiding students in online and offline learning, managing materials in the LMS, monitoring discussion activities, and providing feedback and evaluation. Prior to implementation, teachers have received special training. After the learning activities are completed, both groups will be given a final digital literacy questionnaire, which will be analyzed with descriptive and inferential statistical analysis.

The Station Rotation, Lab Rotation, and Pedati blended learning models were selected as interventions based on their effectiveness in combining technology and face-to-face learning. All three models provide flexibility of access to digital learning resources and allow students to rotate between different types of learning. Several studies have examined the effectiveness of these models. Ananda et al. (2024), Kömür et al. (2023), and Ifadah & Prastiwi (2022) found that Station Rotation, Lab Rotation, and Pedati have proven to address the digital divide and improve digital literacy through the use of technology.

Research Instrument

The instrument used to assess digital literacy is a non-test instrument in the form of a questionnaire. This questionnaire obtains information about students' digital literacy

before and after applying blended learning. The questionnaire refers to Hague & Payton (2010) digital literacy indicators, including Functional skills and beyond, Creativity, Collaboration, Communication, the Ability to find and select Information, Critical thinking and evaluation, Cultural and social understanding, and E-Safety. The questionnaire used by researchers was adopted from the research of Yustina et al. (2022) Musfikar et al. (2023), and Syahfira et al. (2023) and then modified and adjusted to the context of the research conducted. It consists of 24 statement items. The questionnaire is structured or closed, meaning that the answers to the statements have been provided so that respondents can choose the answers never, sometimes, often, and always by giving a checkmark according to the situation. The digital literacy instrument lattice is presented in Table 1.

Table 1. Digital literacy instrument grid

No.	Digital Literacy Indicators	Statement Grid	Number of Statements
1	Functional Skills and Beyond	Operate digital devices	3
2	Creativity	Use digital technology to process various types of documents	4
3	Collaboration	Actively participate in learning digital	3
4	Communication	Communicate effectively in the digital space	3
5	The ability to find and Select Information	Search and select digital information	3
6	Critical Thinking and Evaluation	Analyzing information in the space of digital	3
7	Cultural and Social Understanding	Understand the social and cultural digital space. aspects of	3
8	E-Safety	Ensuring personal data security in the space of digital	2

To ensure clarity and validity, the instruments were tested by two academic experts who provided feedback and input. The type of validity used is content validity (expert judgment). The results of the questionnaire validity are presented in Table 2.

Table 2. Validity of digital literacy questionnaire

Assessment Aspect	Assessment Score	Category
Format	5.00	Very valid
Content aspect/digital literacy	4.55	Very valid
Language	4.25	Very valid
Average	4.60	Very valid

Data Analysis

The research data were analyzed using ANCOVA (Analysis of Covariance). However, a prerequisite test was carried out first, namely the Kolmogorov-Smirnov normality test and the homogeneity test using Levene. After the prerequisite tests were met, data analysis continued testing the hypothesis using ANCOVA at the significance level 0.05. ANCOVA was used to analyze the data because it allows control over the

influence of covariate variables that may affect the dependent variables. By using ANCOVA, differences between treatment groups can be analyzed more accurately after eliminating the effects of covariate variables so that the results obtained can describe the effect of treatment more objectively. The covariate variable used in this analysis is the initial digital literacy score. This variable was chosen as a covariate because by controlling this variable, the analysis can ensure that the difference in results between groups is not caused by initial ability but by the treatment given, namely blended learning. The analysis was then continued with LSD (Least Significant Difference). LSD test was used as a post hoc test after ANCOVA to conduct pairwise comparisons between treatment groups. This method helps identify which group has a real difference in improving digital literacy.

Table 3. Research timeline

Stages	Research Flow	Implementation Time
Planning	Literature review	July-September 2024
	Problem formulation	July-September 2024
	Hypothesis	July-September 2024
	Instrument preparation	September 2024
	Instrument validation	October 2024
Implementation	Data collection	October-November 2024
Final	Data analysis	December 2024-January 2025
	Research results	January 2025-February 2025
	Conclusion	February 2025

▪ RESULT AND DISSCUSSION

Based on the experimental results and data collection, data on initial and final students' digital literacy were obtained. The next step is descriptive analysis and data analysis with prerequisite test stages in the form of a normality test and homogeneity test. Furthermore, hypothesis testing is carried out using the ANCOVA test.

Descriptive Analysis

The research data was obtained from the initial questionnaire results and the final results from the experimental and control groups. Table 4 presents a recapitulation of the results in descriptive statistics. The initial and final score ranges for each of the experimental and control groups are presented in Table 5.

Table 4. Descriptive analysis of digital literacy of each class

Variables	Class		N	Average	Standard Deviation
Digital Literacy	Station Rotation	Initial	32	52.37	9.24
	Lab Rotation		32	51.88	9.23
	Pedati		32	51.59	9.94
	STAD		32	51.72	7.21
	Station Rotation	Final	32	84.11	4.32
	Lab Rotation		32	86.81	4.18
	Pedati		32	84.50	3.76
	STAD		32	62.65	5.22

Table 5. Range of initial and final values for each class

Interval	Category	Station Rotation				Lab Rotation				Pedati				STAD			
		Initial		Final		Initial		Final		Initial		Final		Intial		Final	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
81-100	Very Strong			24	75			30	93.75			25	78.12				
61-80	Strong	7	21.88	8	25	7	21.87	2	6.25	7	21.87	7	21.88	3	9.37	18	56.25
41-60	Fair	19	59.37			18	56.25			18	56.25			26	81.25	14	43.75
21-40	Weak	6	18.75			7	21.88			7	21.88			3	9.38		
0-20	Very Weak																
Total		**32**	**100**	**32**	**100**	**32**	**100**	**32**	**100**	**32**	**100**	**32**	**100**	**32**	**100**	**32**	**100**

Notes: N= Number of students, %= percentage of digital literacy score

The analysis results show that the average digital literacy of students is in the strong and very strong categories in all three blended learning models based on the categorization interval. Meanwhile, in STAD, the average digital literacy of students is in the fair and strong categories. This shows that the experimental class obtained higher results than the control class.

Prerequisite Test

Before analyzing ANCOVA, prerequisite tests were first carried out in the form of normality and homogeneity tests. The results of the normality test Kolmogorov-Smirnov showed that the data were normally distributed because of the significance value ($p > 0.05$). The normality test is presented in Table 6 below.

Table 6. Normality test of digital literacy score

Data		Kolmogorov-Smirnov			Description
		Statistic	df	Sig.	
Experiment Class 1 (Station Rotation)	Initial	.130	32	.184	Normal
Experiment Class 2 (Lab Rotation)		.141	32	.106	Normal
Experiment Class 3 (Pedati)		.140	32	.116	Normal
Control Class (STAD)		.136	32	.136	Normal
Experiment Class 1 (Station Rotation)	Final	.134	32	.152	Normal
Experiment Class 2 (Lab Rotation)		.100	32	.200	Normal
Experiment Class 3 (Pedati)		.128	32	.200	Normal
Control Class (STAD)		.121	32	.200	Normal

Furthermore, the homogeneity test was carried out using the Levene method to ensure the equality of variance between groups. The results showed that the data met the homogeneity assumption because of the significance value ($p > 0.05$). Homogeneity test The below.is presented in Table 7.

Table 7. Homogeneity test of digital literacy score

Data	Levene's Statistics	df1	df2	Sig.	Description
Initial	1.210	3	124	.309	Homogeneous
Final	1.420	3	124	.240	Homogeneous

Hypothesis Testing

After the prerequisites are met, hypothesis testing is then carried out. This study tested the hypothesis using the ANCOVA test, as presented in Table 8 below.

Table 8. Test results ANCOVA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	18270.411	1	18270.411	1043.882	.001
Model	**12234.306**	**3**	**4078.102**	**233.003**	**.001**
Error	2152.792	123	17.502		
Total	824066.633	128			

Based on Table 5, the results of hypothesis testing using ANCOVA on the model show Sig 0.001 < 0.05, meaning H0 is rejected. Thus, there is a significant difference between the four learning models regarding digital literacy scores. If there is a difference, the analysis is continued with the LSD (Least Significant Difference) test to determine the learning model that most affects students' digital literacy. The results of further testing with the LSD test are presented in Table 9.

Table 9. LSD test results

Model	Mean Difference	Sig.	Testing	Description
Station Rotation and Lab Rotation	2.780*	.009	Sig. < 0.05	Different
Station Rotation and Pedati	-0.515	.624	Sig. > 0.05	Not Different
Lab Rotation and Pedati	2.265*	.032	Sig. < 0.05	Different
Station Rotation and STAD	21.351*	.001	Sig. < 0.05	Different
Lab Rotation and STAD	24.131*	.001	Sig. < 0.05	Different
Pedati and STAD	21.866*	.001	Sig. < 0.05	Different

The pedati and station rotation blended learning have similar effects on digital literacy. This is due to the comparable frequency of digital technology use, where students access the internet in almost the same duration and rotation pattern. In terms of activities in station rotation, students learn online in two stages, namely online instruction and evaluation. Similarly, in the pedati type, online learning takes place in two stages: in-depth and evaluation.

Table 10. Digital literacy indicator score for each grade

Initial								
Indicator	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Station Rotation	63.02	45.31	55.99	52.08	63.28	53.13	38.02	54.69
	Strong	Fair	Fair	Fair	Strong	Fair	Weak	Fair
Lab Rotation	64.58	44.34	56.77	56.25	57.03	54.17	38.02	43.75
	Strong	Fair	Fair	Fair	Fair	Fair	Weak	Fair
Pedati	63.02	44.14	57.55	57.55	59.11	48.44	38.54	50.39
	Strong	Fair	Fair	Fair	Fair	Fair	Weak	Fair
Final								
Indicator	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Station Rotation	96.09	56.25	90.63	94.53	94.53	94.53	59.11	100
	Very strong	Fair	Very strong	Very strong	Very strong	Very strong	Fair	Very strong
	95.05	59.38	95.88	93.75	95.31	95.05	72.66	100

Lab Rotation	Very strong	Fair	Very strong	Very strong	Very strong	Very strong	Strong	Very strong
	95.57	53.52	95.05	91.41	94.01	95.05	66.93	100
Pedati	Very strong	Fair	Very strong	Very strong	Very strong	Very strong	Strong	Very strong

Based on Table 10, each model affects the improvement of digital literacy indicators. Station rotation is more effective in functional skills and communication because the approach allows students to practice more directly and interact in structured learning. Meanwhile, the model Lab Rotation excels in creativity, collaboration, the ability to find and select information, and cultural and social understanding due to its exploratory approach that allows students to be more innovative in utilizing technology, interacting in digital learning, and the opportunity to hone their information literacy skills. Critical thinking and evaluation show equal effectiveness in the Lab Rotation and Pedati models as they encourage a discussion-based approach, an analytical that helps students be more critical of digital information. Regarding e-safety, all models show results similar to digital safety awareness, which is consistently embedded in each learning approach.

Then, to determine which model is better at improving digital literacy, the values in the estimated marginal means presented in Table 11 can be used. For more details, Figure 1 presents a visualization of the average digital literacy score between groups.

Table 11. Corrected average value

Type	Mean
Blended Learning Lab Rotation Type	86.81[a]
Blended Learning Pedati Type	84.54[b]
Blended Learning Station Rotation Type	84.03[b]
Student Teams Achievement Division (STAD)	62.68[c]

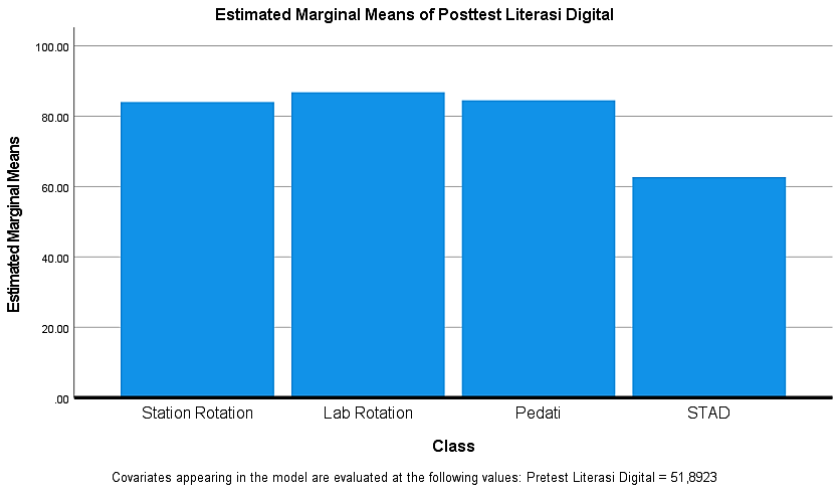

Figure 1. Digital literacy score

The lab rotation has the most optimal effect on digital literacy compared to other models. Type This model has unique characteristics because most students spend their time in the technology area and engage in online activities (Mirkodirova & Usmonova,

2024). In this study, the application of blended learning lab rotation has a high frequency of technology use because this model is more dominant in online learning activities such as exploration, discussion, assignment, and evaluation. On the other hand, offline learning is only during the teacher's reinforcement of the material. This is the main influential factor, so the lab rotation type increases digital literacy more than other types. This finding is supported by previous research, which states that students with higher levels of digital literacy show more involvement in learning through digital technology (Bergdahl et al., 2020), meaning that the higher the level of digital literacy, the higher their internet usage behavior (Prihatini & Muhid, 2021).

Discussion

Behaviorism theory explains the effectiveness of blended learning in improving digital literacy through stimulus and response. In blended learning, various web-based learning resources stimulate students to access and understand materials, triggering behavioral changes (Jalinus et al., 2020). Repeated information delivery in a digital environment strengthens students understanding and response to the material (Trisnawati, 2019). Based on constructivism theory, blended learning supports digital learning with various teaching materials and learning resources. This allows students to build independent knowledge, develop metacognition, and connect it with prior knowledge. This process involves meaning construction through active interaction, such as discussion, chat, and guidance from the teacher as a facilitator. Whereas in cognitivism theory, which focuses on information processing in learning, through blended learning that provides extensive teaching materials, students can process these materials to expand their knowledge, from receiving information to processing it to storing it in memory (Jalinus et al., 2020).

The effectiveness of blended learning has been studied in various previous studies. Ananda et al. (2024) found that a blended learning model with a station rotation approach effectively empowers digital literacy. This is due to using online platforms and digital devices as learning spaces, thus helping students become more digitally literate. Another study by Kömür et al. (2023) also showed that Station rotation and Lab rotation models effectively develop students digital skills. By combining face-to-face and online teaching, this model allows students to work with technology and digital tools in a structured way. Furthermore, research by Ifadah & Prastiwi (2022) stated that the application of the pedati model in learning increases digital literacy. This success is influenced by the systematic structure, where each stage refers to the elements of the digital literacy framework. In addition, online learning that utilizes the internet and software further increases the intensity of technology use, thus strengthening students digital literacy. learningThe various research findings above are consistent with the results of this study. This consistency shows that using technology in learning through blended learning of types of station rotation, lab rotation, and pedati significantly improves digital literacy.

Each blended learning model has its advantages and disadvantages. The station rotation model encourages students to search for various information and prepares students for the digital era (Basuki & Arianto, 2023), provides wider access to digital media with the internet, and encourages collaboration (Akinoso et al., 2020). However, this model also has the disadvantage of requiring good time management so that the transition between stations can occur smoothly (Fulbeck et al., 2020). The lab rotation

model has excellent flexibility, allows students to access materials widely (Almarzuqi et al., 2024; Adiwisastra et al., 2020), can maximize the digital experience (Yulfiperius et al., 2022), and helps focus on learning students because a teacher is monitoring each activity (Ambarli et al., 2020). However, most online sessions dominate most learning, so teachers and students need stable internet access and adequate quotas to support smooth learning. The Pedati model has advantages in optimizing the use of technology packaged in various digital platforms (Utama, 2022), is flexible, not limited by time and space (Rahayuningsih et al., 2024), and its working procedures are systematic and logical (Chaeruman, 2018). However, this model cannot run optimally without digital materials. Therefore, teacher readiness in preparing digital materials is an important factor for learning to be carried out well (Jultri, 2020). In specific learning contexts, the Lab Rotation model is more suitable for learning that requires intensive access to digital devices because it allows students to utilize technology more deeply. Therefore, selecting a blended learning model should consider several factors, such as infrastructure availability, support from the school, and teachers' ability.

The provision of technological infrastructure is important to ensure that every school has access to technological devices and a stable internet connection to support blended learning (Rindawan et al., 2024). A good internet connection allows seamless access to digital educational resources such as platforms-learning, digital databases, and interactive educational applications. Easy and fast access allows students and teachers to use various online learning resources, making learning more effective and efficient (Ramadhan, 2024). Therefore, school support is important in ensuring the availability of devices, content management, system maintenance, and internet networks adequate for all students (Puspitarini, 2021). Schools and governments can work together to provide the necessary technology resources and provide ongoing training and support for teachers in using technology and implementing blended learning methodologies (Salim, 2023). Adequate training and technical support for teachers is essential to maintain the successful implementation of this method. Teachers need to know about strong technology and skills in integrating it into learning (Astriani & Anbiya, 2024). Teachers not only need to master the technical skills of using technology but must also be able to design and manage learning effectively through face-to-face and online communication. In addition, teachers also need to develop pedagogical skills that include adapting teaching materials into digital formats, managing online interactions with students, and facilitating collaboration and discussion in virtual learning spaces. Therefore, teachers need continuous training to improve their ability to use technology productively (Mangidi, 2024). The three factors above are equally important as they support the success of blended learning implementation. The learning process will not run optimally without adequate infrastructure, school support, and teacher readiness.

The limitation of this study lies in the training of students in using the LMS, which still needs to be improved. Ideally, students need to be familiarized with the LMS before the intervention to understand how to use it optimally and get used to the tools used. However, in this study, adaptation, and introduction to the LMS were carried out in a few meetings before the intervention was given, so there is still a need for improvement in the habituation of using the LMS.

The practical implication of this finding shows that blended learning in learning can improve digital literacy if given the proper application and optimally facilitated. Teachers

can implement this model by providing interactive digital teaching materials, utilizing LMS as a learning platform, facilitating active interaction through online and face-to-face discussions, and designing learning activities encouraging students to search, evaluate, and use information digitally. These findings can be the basis for developing educational policies related to digital literacy and blended learning. The government and educational institutions can support technology integration in learning by providing adequate technology infrastructure, strengthening teacher training, and creating policies that support using LMS as a learning tool. These policies should also ensure equitable access for all students to support inclusive and sustainable digital learning.

▪ CONCLUSION

Based on the research, blended learning of station rotation, lab rotation, and pedati type affects students' digital literacy. The ANCOVA analysis results show a significance value of 0.001 ($p < 0.05$), indicating a difference in digital literacy scores between the various models. LSD test results show that the blended learning lab rotation type has the most effective effect on improving digital literacy, with an average of corrected 86.81, followed by the pedati type at 84.54, then the station rotation type at 84.03. This finding confirms the importance of utilizing technology in learning, which can help students access, evaluate, and use information more effectively. Therefore, the results of this study provide an important contribution to the field of education, especially in the development of technology-based learning models that support improving students digital literacy.

The implications of this study emphasize that blended learning in learning can improve digital literacy if given the proper application and facilitated optimally. Integrating technology in learning requires adequate training for teachers and students and continuous policy support to ensure the effective use of digital tools. However, this study has limitations, especially in terms of the duration of students adaptation to the LMS, which is still limited. Therefore, future research needs to explore more effective strategies for improving students LMS readiness so that technology-based learning can run more optimally.

▪ REFERENCES

Adiwisastra, M. F., Mulyani, Y. S., Alawiyah, T., Wibisono, T., Iskandar, I. D., & Purnia, D. S. (2020). Implementation of the lab rotation model in blended learning based on student perspectives. Journal of Physics: Conference Series, 1641(1). https://doi.org/10.1088/1742-6596/1641/1/012038

Adnan, A., Saenab, S., & Saleh, A. R. (2016). Unleash students' motivation with blended knowledge transfer instructional model. In ICMSTEA 2016: International Conference on Mathematics, Science, Technology, Education, and their Applications (pp. 240-243). https://ojs.unm.ac.id/icmstea/article/view/2659/1397

Adnan. (2015). *Model pembelajaran biologi konstruktivistik berbasis TIK (MPBK Berbasis TIK) untuk Siswa SMP*. Journal of EST, 1(1). 1-11. https://ojs.unm.ac.id/JEST/article/view/1132

Adnan., Abimanyu, S., Patta, R., & Arsyad, N. (2014). The improving of junior high school student in learning motivation through implementation constructivistic biology learning model based on information and communication technology.

Journal of Education and Practice, 5(2), 63-71. https://www.iiste.org/Journals/index.php/JEP/article/view/10639/10866

Akinoso, S. O., Agoro, A.A., & Alabi, O.M. (2020). Effect of station rotation mode of instructional delivery for mathematics in the era of advancing technology. Journal of the International Society for Teacher Education, 24(2), 60-72. https://files.eric.ed.gov/fulltext/EJ1304479.pdf

Almarzuqi, A.A., Sulaiman, T. Bin, & Mustakim, S.S. (2024). Effects of blended learning through lab-rotation (bllr) model on motivating high school students to learn chemistry subject. International Journal of Academic Research in Business & Social, 14(6), 434-444. https://doi.org/10.6007/ijarbss/v14-i6/21682

Ambarli, S., Syahrial, Z., & Sukardjo, M. (2020). *Pengaruh model blended learning rotasi dan kecerdasan intrapersonal terhadap hasil belajar Ipa Di SMP*. Jurnal Visipena. 11(1). 16-32. https://doi.org/10.46244/visipena.v11i1.1089

Ananda, O.T., Mahana, S., Susanto, H., Zubaidah, S., & Setiawan, D. (2024). The Effectiveness of the padlet-assisted ricosre-station rotation in promoting students' digital literacy. In International Conference on Current Issues in Education (ICCIE 2023) (pp. 221-231). Atlantis Press. https://doi.org/10.2991/978-2-38476-245-3_24

Astriani, N., & Anbiya, B.F. (2024). *Blended learning: konsep. Manfaat, dan tantangannya, serta implikasinya dalam pembelajaran PAI.* Jurnal Harmoni Nusa Bangsa, 2(1), 25-32. http://dx.doi.org/10.47256/jhnb.v2i1.492

Badan Pusat Statistik. 2025. *Lebih dari 60% anak sekolah akses internet untuk media sosial* (https://data.goodstats.id/statistic/lebih-dari-60-anak-sekolah-akses-internet-untuk-media-sosial-58t9C), diakses 1 februari 2025.

Barrett, S.E. (2021). Maintaining equitable and inclusive classroom communities online during the COVID-19 Pandemic. Journal of Teaching and Learning, 15(2), 102–116. https://doi.org/10.22329/jtl.v15i2.6683

Basuki, M., & Arianto, F. (2023). The effect of the station rotation model on the collaborative skills of eighth-grade junior high school students. International Journal of Science Academic Research, 4(7), 5932-5934. https://www.scienceijsar.com/sites/default/files/article-pdf/IJSAR-1676.pdf

Bayrak, Ö., Sandıkçı, F., & Şahin, T.G. (2023). Turkish teachers' experiences on the distance education process and technological education tools. Malaysian Online Journal of Educational Technology, 11(4), 226–237. https://doi.org/10.52380/mojet.2023.11.4.534

Bergdahl, N., Nouri, J., & Fors, U. (2020). Disengagement, engagement and digital skills in technology-enhanced learning. Education and Information Technologies, 25(2), 957–983. https://doi.org/10.1007/s10639-019-09998-w

Bravo, M.C.M., Chalezquer, C.S., & Serrano-Puche, J. (2021). Meta-framework of digital literacy: Comparative analysis of 21st century skills frameworks. Revista Latina de Comunicacion Social, 79, 76–110. https://doi.org/10.4185/RLCS-2021-1508

Budiman, R., & Syafrony, A.I. (2023). The digital literacy of first-year students and its function in an online method of delivery. Asian Association of Open Universities Journal, 18(2), 176–186. https://doi.org/10.1108/AAOUJ-01-2023-0017

Candrasari, C., Claretta, D., & Sumardjiajti. (2020). *Pengembangan dan pendampingan literasi digital untuk peningkatan kualitas remaja dalam menggunakan internet.*

Dinamisia : Jurnal Pengabdian Kepada Masyarakat, 4(4), 611–618. https://doi.org/10.31849/dinamisia.v4i4.4003

Castro-Rodríguez, M.M., Marín-Suelves, D., López-Gómez, S., & Rodríguez-Rodríguez, J. (2021). Mapping of scientific production on blended learning in higher education. In Education Sciences (Vol. 11, Issue 9). MDPI. https://doi.org/10.3390/educsci11090494

Çetingöz, D. (2023). Development of 21st century skills during preschool period: a phenomenological Study in Türkiye. International Journal of Educational Administration and Policy Studies, 15(1), 46-63. https://doi.org/10.5897/ijeaps2023.0755

Chaeruman. (2018). *PEDATI: Model desain sistem pembelajaran blended.* Jakarta: Jakarta State University. https://doi.org/10.13140/RG.2.2.15595.90408

Deupa, M.S. (2023). Teaching profession in nepal: attitude and job satisfaction of the school teachers. Far Western Review, 1(2), 29-45. https://doi.org/10.3126/fwr.v1i2.62109

Devkota, J., & Basyal, D.K. (2024). Intervention strategies in nepal's school-level education programs for the country's socioeconomic transformation. International Education Studies, 17(5), 45-58. https://doi.org/10.5539/ies.v17n5p45

Dewi, L.E., Syofyan, R., & Putra, D.G. (2024). *Pengaruh literasi digital dan motivasi belajar terhadap hasil belajar siswa.* Jurnal Ecogen. 7(2). 288-298. https://doi.org/10.24036/jmpe.v7i2.16028

Fahreza, F., Thaariq, S.M.H., & Amiyati. (2022). *Analisis pemanfaatan tik (teknologi informasi dan komunikasi) di sd negeri 1 jeuram kabupaten nagan raya.* Genta Mulia:Jurnal Ilmiah Pendidikan, 13(2), 374-380. https://doi.org/10.61290/gm.v13i2.145

Fulbeck, E., Atchison, D., Giffin, J., Seidel, D., & Eccleston, M. 2020. Personalizing student learning with station rotation. american institutes: overdick family foundation. https://www.air.org/sites/default/files/Station-Rotation-Research-Brief-Final-July-2020.pdf

Gaol, C.A.L., & Simanjuntak, S. (2023). *Analisis kesulitan guru menerapkan teknologi dalam proses pembelajaran di sd negeri 08 bilah hilir labuhan batu ta 2022/2023.* Journal on Education, 6(1), 2441-2448. https://doi.org/10.31004/joe.v6i1.3267

Gündüzalp, S. (2021). 21 st Century skills for sustainable education: prediction level of teachers' information literacy skills on their digital literacy skills . Discourse and Communication for Sustainable Education, 12(1), 85–101. https://doi.org/10.2478/dcse-2021-0007

Hague, C., & Payton, S. (2010). Digital literacy across the curriculum. Bristol: Futurelab.https://www.nfer.ac.uk/media/jnhety2n/digital_literacy_across_the_curriculum.pdf

Hardiany, D.R., Susilowati, E., & Siswati, A. (2024). *Pkm implementasi digital literacy dalam pembelajaran bahasa inggris pada siswa SMK Di Kabupaten Semarang.* Jurnal Bakti Humaniora. 4(1). 7-12. https://doi.org/10.35473/jbh.v4i1.3151

Hurskaya, V., Mykhaylenko, S., Kartashova, Z., Kushevska, N., & Zaverukha, Y. (2024). Assessment and evaluation methods for 21st century education: measuring what matters. Futurity Education, 4(4). 4-17. https://doi.org/10.57125/FED.2024.12.25.01

Ifadah, E., & Prastiwi, M.S. (2022). *Keefektifan pembelajaran daring pada materi biologi dalam meningkatkan literasi digital siswa.* Berkala Ilmiah Pendidikan Biologi (BioEdu), 11(1), 228-239. https://doi.org/10.26740/bioedu.v11n1.p228-239

Jalinus, N., Verawardina, U., & Krismadinata. 2020. Model flipped blended learning. Jawa Tengah: CV. Sarnu Untung. https://books.google.com/books/about/BUKU_MODEL_FLIPPED_BLENDED_LEARNING.html?id=6BcREAAAQBAJ

Jamaluddin, A.B., Palennari, M., Fatmawati, A., & Rosba, E. (2023). SIRI learning model in empowering biology students' critical thinking. Jurnal Penelitian Pendidikan IPA, 9 (SpecialIssue), 22-29. https://doi.org/10.29303/jppipa.v9iSpecialIssue.5511

Jultri, S. (2021). *Desain pembelajaran pedati sebagai alternatif pengembangan metode asinkron.* In Prosiding Seminar Nasional Pembelajaran Bahasa dan Sastra Indonesia (SemNas PBSI)-3 (pp. 61-66). FBS Unimed Press. https://digilib.unimed.ac.id/id/eprint/41222

Kementerian Informasi dan Komunikasi RI. (2021). Road Map Literasi Digital 2021-2024. Jakarta: Siber Kreasi Deloitte. https://perpustakaan.sman7bpp.sch.id/wp-content/uploads/2023/03/Roadmap-Literasi-Digital-2021.pdf

Koçak, D., Türe, H., & Atan, M. (2019). Efficiency measurement with network DEA: an application to sustainable development goals 4. International Journal of Assessment Tools in Education, 6(3), 415-435. https://doi.org/10.21449/ijate.539487

Kömür, İ.A., Kilinç, H., & Okur, M.R. (2023). The rotation model in blended learning. Asian Journal of Distance Education, 18(2), 63-74. https://doi.org/10.5281/zenodo.8197798

Mangidi, R.A. (2024). *Pendekatan blended learning sebagai strategi pembelajaran masa depan.* Jurnal Sultra Elementary School, 5(2), 189-208. https://doi.org/10.54297/jses.v5i2.138

Matveev, M. (2025). Digital neuropedagogy: harnessing cognitive science and technology for educational efficiency. Journal of Teaching English for Specific and Academic Purposes, 12(3), 693–712. https://doi.org/10.22190/JTESAP240922052M

Mdletye, Z., & Usadolo, S.E. (2024). Using a blended learning approach to encourage course interaction in a first-year business communication module. Research in Social Sciences and Technology, 9(1), 185-212. https://doi.org/10.46303/ressat.2024.11

Mirkodirova, Z., & Usmonova, S, (2024). Blended learning and its potential benefits. Foreign Linguistic and Linguodidactics, 2(2), 38-44. https://doi.org/10.47689/2181-3701-vol2-iss2-pp38-44

Musfikar, R., Al-Thariq, A., & Ridwan, R. (2023). *Kompetensi literasi digital di kalangan anak muda.* Jurnal Infomedia: Teknik Informatika, Multimedia, dan Jaringan, 8(2), 88-93. http://dx.doi.org/10.30811/jim.v8i2.4496

Ndibalema, P. (2025). Digital literacy gaps in promoting 21st century skills among students in higher education institutions in Sub-Saharan Africa: a systematic review. In Cogent Education 12(1). 1-15. https://doi.org/10.1080/2331186X.2025.2452085

Ndou, N. (2022). Circuit managers' views on quality education at selected public schools in the Limpopo Province, South Africa. South African Journal of Education, 42(2), 1-9. https://doi.org/10.15700/saje.v42n2a1947

Odekeye, O.T., Fakokunde, J.B., Metu, D.V., & Adewusi, M.A. (2023). Perception of learning management system (lms) on the academic performance of undergraduate students during the COVID-19 Pandemic. International Journal of Education and Development using Information and Communication Technology, 19(1), 7-19. https://files.eric.ed.gov/fulltext/EJ1391613.pdf

Osei-Tutu, E.M. (2021). Improving equity in tertiary education in Ghana. Journal of Interdisciplinary Studies in Education, 10, 21-38. https://ojed.org/jise/article/view/2888

Prihatini, M., & Muhid, A. (2021). *Literasi digital terhadap perilaku penggunaan internet berkonten islam di kalangan remaja muslim kota.* Journal An-Nafs: Kajian Penelitian Psikologi, 6(1), 23-40. https://doi.org/10.33367/psi.v6i1.1307

Puspitarini, D. (2022). Blended learning sebagai model pembelajaran abad 21. Ideguru: Jurnal Karya Ilmiah Guru, 7(1), 1-6. https://doi.org/10.51169/ideguru.v7i1.307

Rahayuningsih, S., Widayanti, F.D., & Kristiawan, I. (2024). *Desain pembelajaran pedati pada model blended learning.* Paedagoria: Jurnal Kajian, Penelitian dan Pengembangan Kependidikan, 15(2), 116-125. https://doi.org/10.31764/paedagoria.v15i2.19197

Ramadhan, G.J.M. (2024). *Optimalisasi jaringan dan infrastruktur ti untuk mendukung proses belajar mengajar di sekolah.* Journal of Knowledge and Collaboration, 1(1), 1-6. https://doi.org/10.59613/vpc49n04

Reddy, P., Chaudhary, K., & Hussein, S. (2023). A digital literacy model to narrow the digital literacy skills gap. Heliyon, 9(4). 1-16. https://doi.org/10.1016/j.heliyon.2023.e14878

Rindawan, R., Irmansyah, J., Kurniawan, E., Yusuf, R., & Suriatno, A. . (2024). *Penguatan kapasitas guru dalam pembelajaran berbasis teknologi di sekolah dasar se-kecamatan praya barat daya.* Sasambo: Jurnal Abdimas (Journal of Community Service), 6(3), 468–484. https://doi.org/10.36312/sasambo.v6i3.2043

Salim, N.A. (2023). *Blended learning: peluang dan tantangan pelaksanaannya pada sekolah dasar*. Academy of Education Journal, 14(2), 1581-1591. https://doi.org/10.47200/aoej.v14i2.2230

Shurygin, V., Abdullayev, I., Hajiyev, H., Yakutina, M., Kozachek, A., & Zakieva, R. (2024). Blended learning: the effect on students' self-regulation and academic achievements. Novitas-ROYAL, 18(1), 137–154. https://doi.org/10.5281/zenodo.11057892

Sihawong, U., & Phusee-orn, S. (2023). Developing a model to enhance junior high school teacher 21st century learning management competencies. Journal of Education and Learning, 13(1), 101-110. https://doi.org/10.5539/jel.v13n1p101

Staker, H., & Horn, M.B. 2012. Classifiying K-12 blended learning. afrika selatan: innosight institute. https://www.christenseninstitute.org/wp-content/uploads/2013/04/Classifying-K-12-blended-learning.pdf

Su, C.S., Seckel, M.J., & Vásquez, C. 2022. What learning opportunities does the chilean primary education curriculum offer to train in sustainability?. Mathematics Teaching Research Journal. 14(3). 108-132. https://files.eric.ed.gov/fulltext/EJ1361577.pdf

Syahfira, I., Siregar, Y. D., & Purwaningtyas, F. (2023). *Hubungan antara literasi digital dengan penggunaan media sosial mahasiswa program studi pendidikan agama*

islam sekolah tinggi agama islam "uisu" pematang siantar. Shaut Al-Maktabah: Jurnal Perpustakaan, Arsip dan Dokumentasi, 15(1), 92-102. https://doi.org/10.37108/shaut.v15i1.802

Tangpong, C., Sirisuthi, C., & Agsonsua, P. (2023). Development of the educational management model to enhance educational quality towards excellence of the secondary educational service area office Thailand. International Education Studies, 16(2), 26-34. http://dx.doi.org/10.5539/ies.v16n2p26

Trisnawati, A. 2019. *Aplikasi dan metode blended learning.* Madiun: UNIPMA Press. http://eprint.unipma.ac.id/98/1/37.%20aplikasi%20dan%20metode%20blended%20learning.pdf

Utama, A.H. (2022). *Desain pembelajaran pedati untuk mengembangkan metode pembelajaran daring asinkron selama masa pandemi Covid-19.* J-INSTECH, 3(1), 26-35. https://doi.org/10.20527/j-instech.v3i1.7920

Wahyuni, E.E., Sudarti, S., Wuryaningrum, R., & Wicaksono, I. (2023). *Implementasi aplikasi asisten belajar (si bela) untuk meningkatkan kemampuan literasi digital peserta didik.* JRPD (Jurnal Riset Pendidikan Dasar), 7(1), 21-35. https://journal.unismuh.ac.id/index.php/jrpd/article/view/13474/7052

Yıldırımer, K.S. (2024). Roadmap for equality in education: problems, solutions and implementation strategies. Dinamika Ilmu, 24(1), 11-28. https://doi.org/10.21093/di.v24i1.7515

Yulfiperius., Edwar., Pujiastutie, E.T., Darmawi, E., Belladona, M., Juwanto., Utami, R.T., Kurniah, R., Akhir, A.F.P., & Syahruddin. 2022. *Pedoman pembelajaran blended learning. Bengkulu: lembaga penjaminan mutu universitas prof. Dr. Hazairin, sh.* https://lpm.unihaz.ac.id/wp-content/uploads/2023/06/Pedoman-Blended-Learning.pdf

Yustina, Mahadi, I., Daryanes, F., Alimin, E., & Nengsih, B. (2022). The effect of problem-based learning through blended learning on digital literacy of eleventh-grade students on excretory system material. Jurnal Pendidikan IPA Indonesia, 11(4), 567–577. https://doi.org/10.15294/jpii.v11i4.38082