

Enhancing Students' ICT Literacy Through a Web-Based Project Learning Model

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ABSTRACT

The integration of content components and ICT technology in education is crucial for enhancing student competencies. This study examines the effectiveness of a web-based learning model using project-based learning (PjBL) to improve ICT literacy skills. A quasi-experimental design with a non-equivalent control group was employed. The experimental group was taught using the web-based project learning model, while the control group received traditional instruction. The study involved 60 tenth-grade students from MAN 2 Kota Bengkulu, selected through cluster sampling. Data were collected using a questionnaire, with instrument validity evaluated using the Aiken index and reliability assessed through the Cronbach's alpha coefficient. Descriptive quantitative analysis was used to interpret the results. The findings indicate a significant difference in ICT literacy skills between the experimental and control groups, as evidenced by a p-value < 0.05. This suggests that the web-based project learning model effectively enhances students' ICT competencies. The results highlight the positive impact of integrating web-based project learning on student engagement and ICT skill development. This underscores the necessity of modern teaching approaches in adapting to digital learning environments. The study concludes that web-based project-based learning significantly improves ICT literacy skills. It recommends teacher training programs and curriculum development policies to enhance educators' competencies in technology-enhanced learning. Future research should explore its application across various subjects and educational levels.

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1. INTRODUCTION

Enhancing education quality in schools, particularly through the use of technology, is crucial. Technology facilitates learning and allows access to information anytime and anywhere. As we enter the era of the Fourth Industrial Revolution, schools must innovate to keep pace with the rapid technological advancements (Hermino & Arifin, 2020). In this context, teachers can leverage technological progress in education to enhance students' skills and intelligence. Integrating technology into the learning process greatly aids students in discovering new information, leading to innovations that society can embrace. These innovations aim to meet the needs of a rapidly advancing society, considering the diverse characteristics of students. To align with 21st-century skills, students need to

be active, proactive, independent learners who can collaborate effectively (Ball, Joyce & Anderson, 2016).

Based on preliminary research, including observation, several problems were revealed, namely the suboptimal integration of meaningful ICT in learning, the lack of ICT literacy in students, and the absence of a learning model that integrates ICT according to the objectives, materials, and learning styles of students. Learning models that utilize information technology are very important to encourage innovation in learning resources and media, as well as to help students overcome the challenges they face (Suyanto & Asep, 2013). Therefore, this study aims to overcome these problems by implementing a web-based learning model. This approach is supported by Afriana et al. (2016), Lutfi et al. (2018), and Kristiani et al. (2017), who stated that project-based learning integrated with Science, Technology, Engineering, and Mathematics (STEM) can improve learning outcomes.

ICT literacy is an essential skill for the 21st century that emphasizes not only the use of technology but also cognitive skills, including idea generation, categorization, drawing conclusions, decision-making, and the ability to apply those decisions in the ongoing process of accessing new information (Joyce & Emily, 2012). Therefore, it is essential to teach students 21st-century skills to help them adapt and professionally implement social values.

The significance of providing teachers with training to enhance their knowledge and competence in 21st-century skills is emphasized by Tican & Deniz (2019). Ahmad et al. (2016) emphasize that students must actively engage in applying 21st-century skills, showing initiative and the capacity to collaborate effectively. As a result, both educators and students need to be proficient in using technology during the learning process to attain technological literacy. To create effective learning, the teaching approach should be student-centred, where students are more engaged in the learning process, work together collaboratively, participate in various group activities, and benefit from additional support outside the classroom, such as increasing the use of technology for submitting assignments to teachers (Singhal, 2017).

Learning models play a crucial role in the educational process. The application of suitable learning models helps achieve learning goals while also motivating students' enthusiasm for learning. One such model is the information and communication technology-based learning model (Arsyad, 2016). As highlighted, achieving optimal learning outcomes requires careful selection of the right learning models. In contemporary education, there is a need for a practical learning approach that goes beyond traditional lectures, such as project-based learning. This model encourages students to create a project as part of their learning, which should be connected to their environment. This connection helps make learning memorable and enhances long-term retention in students' memories (Mutakinati et al., 2018; Potvin et al., 2021). Additionally, project-based learning enhances students' critical thinking and creativity, as they are tasked with developing a high-quality project in line with the teacher's guidance (Suranti et al., 2017; Syafrijal & Desyandri, 2019).

The development of students' collaboration skills in project work is essential for their learning progress. Similarly, their communication skills will be enhanced as they present the results of projects completed with their group members. This process will help students strengthen their 4C skills, which are vital components of 21st-century education (Bedir, 2019; Kembara et al., 2018). The primary aim of using models in education is to engage students actively in learning by having them build, use, or select models to explain, predict, and control physical phenomena (Singhal, 2017). As a result, students do not need to memorize subject content or equations; they can acquire this knowledge through the use of models.

The growth of project-based learning is reinforced by the benefits of this approach, such as enhancing students' motivation to learn, fostering their ability to undertake significant tasks, and fulfilling their need for recognition (Dewi et al., 2018; Oksa & Soenarto, 2020). Additionally, it helps improve problem-solving skills, makes students more engaged and effective in tackling complex problems, promotes teamwork, and encourages the development of communication skills (Dumitrescu et al., 2014; Marzuki & Basariah, 2017). Project-based learning offers learning experience that engages

students intensively and is designed to reflect real-world scenarios (Chounta et al., 2017; Pan et al., 2021). Previous studies have also highlighted that project-based learning stimulates student engagement in the learning process (Irman & Waskito, 2020; Laili et al., 2019) and boosts motivation, leading to improved abilities (Logan et al., 2021; Mutakinati et al., 2018).

The government has introduced various policies to enhance teachers' skills in utilizing technology for education, such as providing training on technology-assisted learning processes (e-learning). E-learning, which leverages internet technology, facilitates easier learning for both teachers and students, regardless of limitations related to time, location, or other circumstances (Darmawan, 2016; Singhal, 2017). E-learning has proven to be beneficial in encouraging students to engage more actively in their studies, even when faced with constraints of time and space (Suartama, 2020). A practical way to illustrate the role of technology in education is by utilizing a web-based learning model that is based on project-based learning.

The web learning model based on projects in education aligns with the demands of 21st-century education, which emphasizes the need for students to possess technological literacy. This model combines project-based learning with online web-based instruction (Hung, Hwang, & Huang, 2012). It represents an evolution of active, student-centered learning. The process of web-based learning supports students in utilizing technology. The advantages of ongoing web learning should be introduced early, particularly at a stage when students are capable of integrating both cognitive and psychomotor skills.

E-learning can be carried out through a range of digital devices, such as smartphones and computers (Liu & Hwang, 2010). Numerous studies have demonstrated that web-based learning models are effective for this type of research (Sudjimat, 2016). A prior study by Asri and Susilowati (2018) on the use of blogs found minimal significant improvement in students' ICT literacy skills. Building upon these earlier findings, this research seeks to overcome these limitations by focusing on evaluating the application of web learning models to improve ICT literacy skills.

This web learning model plays a role in making the teaching and learning process more enjoyable. The web learning model is in accordance with the development of the times which contains two disciplines, namely technology and engineering. The use of this model is expected to create a pleasant learning environment, a good learning process and get increased learning outcomes (Darmawan, 2014). Given the background and issues outlined above, this study aims to explore the application of a web-based learning model grounded in project-based learning to enhance ICT literacy skills. In implementing this model, teachers need to grasp the content thoroughly and be able to convey various concepts using technology. Therefore, the central question of this study is: How effective is the use of a web learning model based on project-based learning in enhancing ICT literacy skills?

2. METHOD

This research aimed to assess the impact of a web-based learning model, incorporating project-based learning, on enhancing ICT literacy skills. A quasi-experimental design with a non-equivalent control group was employed to compare ICT literacy improvements between the experimental and control groups. The web-based learning model follows a structured syntax based on the principles of project-based learning (PjBL) as outlined by Sudjimat (2016). The learning process involves several key stages, beginning with selecting applications and web platforms, then identifying relevant topics for exploration. Students are then divided into groups, where they engage in project planning by defining goals, outlining steps, and assigning individual responsibilities. Throughout the learning process, students collaborate using online platforms that facilitate teamwork and knowledge sharing. The final phase includes project presentation and evaluation, where students showcase their solutions or initiatives to the class, receive peer feedback, and participate in assessments to measure learning outcomes. The structured approach ensures that students actively engage in ICT-based learning, fostering critical thinking, collaboration, and digital literacy skills. The procedural syntax for the web-

based project learning model is presented in Table 1.

Table 1. Syntax learning activities for web-based project learning model

Learning steps	Activity		Explanation
	Teacher	Students	
Asking questions about physics in everyday life	Apperception by providing questions that have been studied previously.	Provide answers to teacher questions	Face to face
	Delivering themes and learning objectives	Listen and pay attention	Face to face
	Providing instructions on how to use e-learning	Use and manage e-learning	Face to face Online
Developing project planning	Provide teaching materials	Access and download teaching materials that the teacher has given you.	Online
	Provide assignments and instructions for group discussion activities.	Access and download assignments with activity instructions	Online
Conduct independent learning	Provides the opportunity to seek information in terms of deepening the material on e-learning.	Access, manage and communicate information obtained from e-learning (internet)	Online
Designing collaboratively	Providing opportunities to do activities	Using engineering design Solving problems Analyzing ideas	Face to face Face to face
	Provide opportunities to carry out activities	Designing products	Face to face
	Control the course of activities		
Testing the results	Listening to and assessing the presentation of group activity results	Testing and improving the results of activities that have been carried out	Face to face
	Reflecting on the presentation results from students	Communicating results	Face to face
	Giving students the opportunity to ask questions	Students actively ask questions about concepts that are not yet understood	Face to face
Conducting an assessment	Guide students to conclude the learning that has been done	Summarize the material	Face to face
	provide post-tests	Do the post test	Online
	provide post-test results via e-learning	Access and download the poster results	Online

The study sample comprised 60 tenth-grade students from a Madrasah Aliyah Negeri (MAN) in Bengkulu City, with 30 students assigned to the experimental group and 30 to the control group.

Cluster sampling was employed as the sampling method, where groups of students were selected rather than individuals to represent the broader population, following predefined criteria (Sugiyono, 2015). This school was chosen due to its well-equipped facilities, including Wi-Fi access and smartphone availability, which facilitated the seamless implementation of the project-based learning model in a web-based environment.

Data collection was conducted using a questionnaire instrument designed to assess students' ICT literacy skills. The questionnaire aimed to measure students' knowledge and proficiency in using information and communication technology (ICT) within the learning process. It was administered to students in both the experimental and control groups to evaluate the impact of the web-based learning model. The instrument used to assess ICT literacy abilities is outlined in Table 2, following the framework established by Asri & Susilowati (2018).

Table 2. Grid of ICT literacy capability instruments

Aspects	Indicator
Access	Knowing how to use, search for, and obtain information and retrieve that information.
Manage	Establishing a system within an organization to manage and design new, incomplete information for reclassification.
Integrate	Analyze, condense, contract data, and distinguish existing information with the help of computer devices.
Evaluate	Evaluate the quality, relevance, suitability, sufficiency of information needs, and effectiveness of incoming information from reliable sources.
Create	Acquiring precise information by adapting, applying, designing, and generating content in the digital space.
Communicate	Providing pertinent information and sharing valuable content with the community through efficient digital tools.

Three education experts have validated this research instrument, confirming its validity. Validity analysis is conducted to assess whether the instrument items are valid. The validation process involves measuring the expert agreement index using the Aiken index (V). The results indicate that the ICT literacy instrument questionnaire has an Aiken index of 0.86, demonstrating its validity. The instrument's reliability is assessed using the Cronbach's alpha coefficient, with a reliability value of 0.93 for the ICT literacy questionnaire, placing it in the high reliability category (Taber, 2018).

The data from this study were analyzed using a quantitative descriptive approach with the Statistical Package for Social Sciences (SPSS). The normality of the data was assessed using the One-Sample Kolmogorov-Smirnov Test, and homogeneity was tested using the Levene test. Additionally, an independent sample t-test was performed to identify significant differences between the average scores of the experimental and control groups.

3. FINDINGS AND DISCUSSION

The effectiveness of the web learning model is assessed based on its impact on ICT literacy skills. The model is considered effective if it leads to an improvement in these skills. The results of the initial test include normality and homogeneity tests. The normality test significance values are determined using the Kolmogorov-Smirnov method. For the experimental class, the normality test result is 0.151, and for the control class, it is 0.122. Since both significance values are greater than 0.05, it can be concluded that the data from the questionnaires are normally distributed. In the homogeneity test for ICT literacy skills data, the significance value is 0.389. Since this value is greater than 0.05, it indicates that the data comes from a population with homogeneous variance. Additionally, the effectiveness of the model is determined by the results of the independent sample t-test.

Next, perform a hypothesis test using an independent sample t-test. With a 95% confidence level, if the p-value is less than 0.05, it indicates a significant difference in the average ICT literacy scores between the two learning models. The results demonstrate that the ICT literacy competency is higher with the web-based learning model compared to the traditional method. The web learning model obtained an average pre-test score of 11.84 and a post-test of 80.23, while the conventional strategy obtained a score of 9.54 for the pre-test and 54.76 for the post-test. (Table 3) and figure 1.

Table 3. Description of ICT literacy

Variable	Stat.	Web-Based Project Learning				Conventional Teaching			
		n	Pre-test	Post-test	N<G>	n	Pre-test	Post-test	N<G>
ICT literacy	\bar{x}	30	11.84	80.23	.80	30	9.54	54.76	.25
	%		25	100			25	75	
	s		1.46	1.97			1.45	1.82	

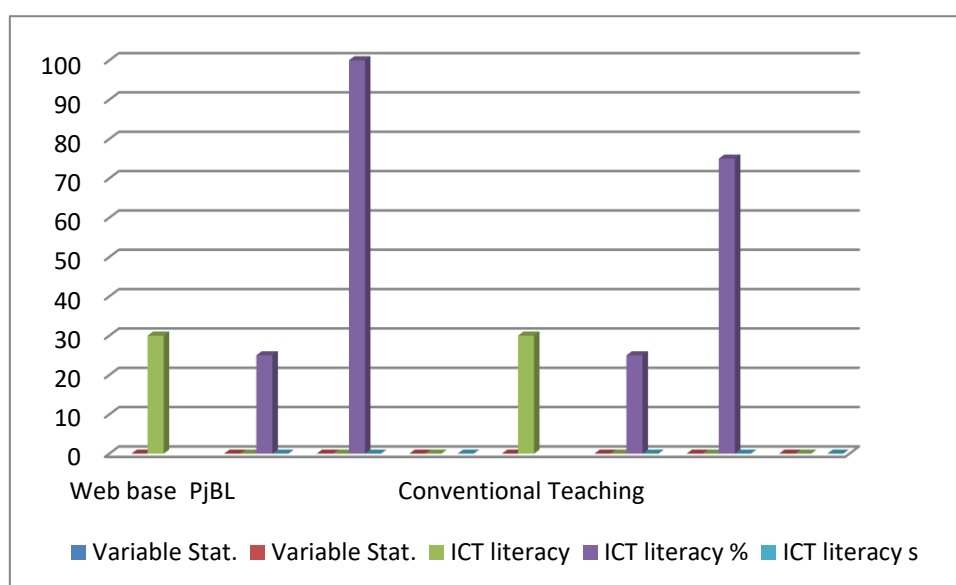


Figure 1. Comparison of PjBL results and conventional models

Table 4. The result of the independent sample t- test

Group	t	Asymp. Sig. (2-Tailed)
Pretest Experiment Control	.832	.011
Posttest Experiment Control	17.653	.000

The table above indicates that the p-value is less than 0.05, leading to the rejection of H_0 . Therefore, it can be concluded that there is a significant difference in ICT literacy skills between the experimental and control classes. This shows a notable difference in the average ICT literacy scores based on the two different learning models. From the explanation above, it is evident that the web-based learning model using project-based learning in the experimental class is more effective in enhancing ICT literacy compared to the traditional model in the control class.

Discussion

According to the findings of this study, the use of technology within the project-based web learning model proves to be an effective and efficient approach for learning, leading to a significant difference in the average ICT literacy scores between the two learning models. The study's results highlight the success of the project-based web learning model in enhancing ICT literacy skills. Web-based PjBL learning has advantages including the formation of collaborative teams and the existence of links so that students can access information from various sources, both inside and outside the learning environment. It can encourage students to be more active and independent in learning. This is due to the fact that the learning model incorporates the principle of e-learning, aligning with Hung's (2012) view that e-learning utilizes computer and internet technologies to provide various solutions for enhancing learning and performance. Darmawan (2014) also defines e-learning as an internet-based platform that connects educators and students in an online learning environment. E-learning was developed to address the challenges of time, location, conditions, and circumstances that can limit the interaction between educators and students.

The research findings suggest that the implementation of a project-based learning web model can enhance students' ICT literacy. This is because students are already highly familiar with using smartphones, sending text messages, and browsing the internet, which significantly aids their participation in e-learning methods. This is further supported by the research of Eliana et al. (2016), which highlights that e-learning improves learning efficiency, effectiveness, and accountability.

E-learning makes it easier for teachers to assess and evaluate the effectiveness of learning, allowing for better control over student activities. Social media and other online communication platforms enable students to stay connected and engage in discussions related to the course, fostering a sense of community. In the rapidly evolving world of e-learning, the technology used to create engaging courses is constantly advancing, and course content must be regularly updated to offer students the most current information. Kahn and Khader (2014) suggest that e-learning is not only transforming how educators deliver instruction to students but also reshaping the educational paradigm, altering how students interact with learning materials and access up-to-date information.

The research findings indicate that the web learning model, which is based on project-based learning in the experimental class, is more effective in enhancing ICT literacy compared to the conventional model used in the control class. This is due to the advantages of the web learning model, which is grounded in constructivism theory. This approach allows students to develop a deeper understanding of the material by actively engaging in problem-solving and applying their ideas (Krajcik & Blumenfeld, 2006).

Robinson's (2013) study concluded that project-based learning, as an innovative teaching method, is effective in engaging students in real-world tasks, thereby enhancing their knowledge and skills. Without innovation in teaching, students are unlikely to fully absorb or engage with the material

presented by the teacher. Therefore, it is essential for teachers to develop new learning innovations (Lapitan et al., 2021; Sudaryono et al., 2020). Education must foster the development of critical thinking, communication, collaboration, and creativity skills—essential competencies for success in 21st-century learning (Luciana, 2020). These skills are particularly important in the context of the advanced 4.0 industrial era, which demands technological proficiency and the ability to critically evaluate information. The development of 4C skills is crucial for creating high-quality human resources (Bedir, 2019; Kembara et al., 2018).

Project-based learning is an approach that uses projects as a medium to facilitate the learning process and help students achieve competencies in attitudes, knowledge, and skills (Chounta et al., 2017; Dumitrescu et al., 2014; Marzuki & Basariah, 2017). The focus of this learning method is on student activities aimed at producing products by applying research, analysis, creativity, and presentation skills based on real-world experiences (Irman & Waskito, 2020; Pan et al., 2021). These products can include tangible items or services such as designs, diagrams, written works, artwork, or technological and craft creations. By engaging in Project-Based Learning, students have the opportunity to practice planning, carrying out activities according to the plan, and showcasing or reporting their results (Logan et al., 2021; Mutakinati et al., 2018). Project-based learning allows students to actively engage in their learning, enabling them to deepen their understanding through direct involvement (Potvin et al., 2021; Suranti et al., 2017). Previous studies have shown that this approach enhances the learning environment in the classroom (Nurtanto et al., 2019). Other research suggests that project-based learning facilitates easier learning for students, leading to improved academic performance (Ratnawati et al., 2020). In conclusion, incorporating the Project-Based Learning model, aligned with 21st-century education, can enhance students' learning outcomes, knowledge, and attitudes.

4. CONCLUSION

The study's findings suggest that the project-based web learning model is both effective and efficient. There is a notable difference in the average ICT literacy scores between the two learning models. The project-based web learning model, applied in the experimental group, proves to be more effective in enhancing ICT literacy compared to the conventional model used in the control group. This model fosters critical thinking, creativity, and better understanding. Based on these results, it is recommended that teachers who have been trained in project-based web learning use this approach in their teaching. Recommendations based on the results of this study provide empirical information for teachers to make it easier to deliver lessons to their students to prepare various means in implementing the web-based learning model moreover the importance of the role of education stakeholders to create relevant policies to integrate STEAM training into teacher development programs. Future research directions include the need to apply longitudinal model research with larger samples, in addition to developing other innovative models involving artificial intelligence.

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