Formation of 21st Century Skills through the Implementation of Digital-Based Project-Based Learning in Science Learning: A Qualitative Study in Class V of SDN 152981 TUKKA 1A

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Abstract

This study aims to describe the application of the digital-based Project-Based Learning (PjBL) model in IPAS learning to shape the 21st century skills of grade V students of SDN 152981 TUKKA 1A. This study used a descriptive qualitative approach with data collection techniques through participatory observation, semi-structured interviews, and documentation. The research subjects consisted of one teacher and five students who were purposively selected. The PjBL model was applied through a series of stages, starting from project planning, information exploration, group work, digital media preparation, to the presentation of the final results in the form of posters and educational videos with the theme "Water Cycle and Environmental Conservation". The results showed that the application of digital-based PjBL was able to encourage the development of critical thinking, creativity, collaboration, and communication skills in an integrated manner. Students show the ability to analyze environmental problems, work together in groups productively, express ideas creatively through digital media, and communicate confidently in oral and written presentations. The learning process becomes more contextual, interactive, and meaningful, and is in line with the principles of the Merdeka Curriculum and strengthening the Pancasila Student Profile. This study concludes that digital-based PjBL is an effective learning strategy in shaping 21st century skills at the primary school level. The findings also indicate the importance of teacher training and digital infrastructure support as supporting factors for successful implementation. This research recommends further studies with a wider scope and the development of a systematic 4C skills assessment instrument.

1. Introduction

The development of information and communication technology has brought major changes in the world of education. In the 21st century era, demands for student competence are not only limited to cognitive aspects, but also include critical thinking, creativity, communication, and collaboration (4C). Merdeka Curriculum as the latest national curriculum in Indonesia also accommodates this change by emphasizing contextual, collaborative, and character-oriented learning through the Pancasila learner profile. In this context, teachers are required to develop learning strategies that are able to integrate 21st century competencies with subject matter, one of which is through a project-based learning approach.

Project-Based Learning (PjBL) is a learning model that emphasizes the active involvement of students in the learning process through real projects that are relevant to everyday life. This model has been proven effective in building 4C skills, especially when combined with the use of digital technology. Previous studies have shown the effectiveness of project-based learning (PjBL) models in improving higher-order thinking skills. Previous research such as (Hujjatusnaini, et al., 2022) and (Mirfaka et al., 2023) showed that PjBL is able to improve higher order thinking skills through contextual learning. Subsequently, research by (Putri et al., 2025) showed that the application of PjBL integrated with digital technology can significantly improve students' creativity and collaboration in science subjects in elementary schools. In addition, (Rajagukguk, 2023) found that digital projects in learning were able to significantly improve student creativity.

Meanwhile, (Wahyuni et al., 2025) found that digital PjBL is capable of fostering students' digital literacy and scientific communication through multimedia products. On the other hand, research by (Arini et al., 2024) confirms that the Merdeka Curriculum provides ample opportunities for teachers to design contextual learning oriented towards the Pancasila Student Profile through a project-based approach. Furthermore, (Novrita et al., 2024) in their meta-analysis confirmed that PjBL has a positive impact on the creativity and learning outcomes of elementary school students. However, there are still limitations in studies that specifically explore the implementation of digital-based PjBL in IPAS learning in elementary schools, particularly in developing 21st-century skills in an integrated manner. Therefore, this study aims to address this gap by providing an empirical overview of the implementation of digital project-based learning that supports the achievement of the Merdeka Curriculum and the strengthening of 4C skills (critical thinking, creativity, communication, and collaboration).

The justification for publishing this article lies in its urgency in responding to the challenges of 21st century education and the demands of implementing the Merdeka Curriculum. This research provides an empirical picture of digital project-based learning practices carried out in grade V elementary schools, which are still minimally used as objects of study. In addition, by utilizing qualitative data from observations, interviews, and documentation, this research provides in-depth insights into the learning process, social interactions, and student work in the IPAS project themed "Water Cycle and Environmental Preservation".

Based on the background and literature review that has been stated, this research hypothesis states that the application of the digital-based PjBL model can shape students' 21st century skills in IPAS learning. This study aims to describe in depth the process and results of the implementation of the model in the context of real learning in grade V of SDN 152981 TUKKA 1A. The main focus is directed at the development of the four 4C skills through the implementation of digital projects, with the hope of enriching learning strategies that support the continuous strengthening of the Pancasila learner profile.

2. Method

This part should contain sufficient detail that would enable all procedures to be repeated. It can be divided into subsections if several methods are described. Authors should be as concise as possible in experimental descriptions. The experimental section must contain all of the information necessary to guarantee reproducibility. Previously published methods should be indicated by a reference and only relevant modifications should be described. For statistical analysis, please state the appropriate test(s) in addition to a hypothesized p-value or significant level (for example 0.05).

This research uses a descriptive qualitative approach that aims to deeply understand how the application of the digital-based Project-Based Learning (PjBL) model can shape 21st century skills in IPAS learning. This approach was chosen because the researcher wanted to explore the processes, experiences, and perceptions of subjects naturally without quantitative intervention. The main focus of the research is on the development of 4C skills consisting of critical thinking, communication, collaboration, and creativity. Therefore, this research is not oriented towards statistical measurement, but rather on exploring the meaning, context, and dynamics of learning activities that take place in class V of SDN 152981 TUKKA 1A. The stages of this research can be illustrated in the following flowchart:

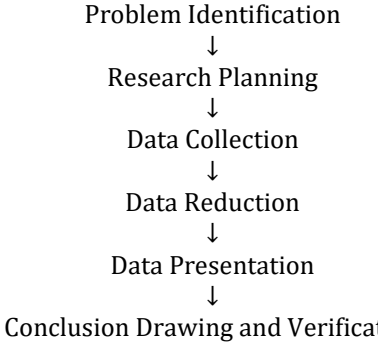

Figure 1. Research Flow

The subjects in this study were one grade V teacher and five students who were purposively selected based on their active involvement in the implementation of the digital project. Data collection techniques were conducted through observation, interview, and documentation. Observation was conducted in a participatory manner during the IPAS learning process, especially when students worked on digital-based projects. Semi-structured interviews were conducted with teachers and students to explore teachers' perceptions of planning, implementation, and challenges in using the PjBL model, as well as to find out students' experiences during the project. Interview questions focused on aspects of student engagement, group cooperation, use of digital media, and development of thinking and communication skills. Documentation was done by collecting digital project results such as posters, videos, presentations, as well as reflective notes of students and teachers during the project implementation.

According to Miles and Huberman in (Sugiyono, 2017) the data collected was analyzed using an interactive analysis model consisting of three main stages, namely: data reduction, data presentation, and conclusion drawing/verification. Data reduction is done by compiling and simplifying relevant information according to the research focus. Data presentation was carried out in the form of descriptive

narratives and thematic matrices that made it easier for researchers to identify patterns of findings. Conclusions were drawn continuously throughout the research process until valid findings were obtained. To improve data validity, researchers used triangulation techniques and source triangulation by comparing data from observations, interviews, and documentation from various sources (teachers and students).

3. Results and Discussion

3.1. Results

This study aims to describe and analyze the application of digital-based Project-Based Learning (PjBL) model in IPAS learning to shape students' 21st century skills, especially in the aspects of creativity, critical thinking, collaboration, and communication (4C). The research was conducted qualitatively descriptively in class V of SDN 152981 TUKKA 1A, with data collection techniques through participatory observation, semi-structured interviews, and documentation of students' digital products. Data analysis used the Miles & Huberman interactive approach, including data reduction, data presentation, and conclusion drawing, as well as triangulation of techniques and sources to maintain the validity of the findings.

The results showed that the application of the digital-based PjBL model significantly contributed to the development of students' 21st century skills. The project implemented in small groups focused on the theme of "Water Cycle and Environmental Preservation", with outputs in the form of digital posters and educational videos. Through this process, students showed active involvement in every stage of learning, from project planning, information exploration, teamwork, digital media development, to the presentation of the final results. These activities encourage students to think critically in solving environmental problems, communicate effectively with peers, collaborate in task sharing, and develop creativity in designing attractive and informative digital products.

Observations noted that students showed high enthusiasm when designing visual designs, selecting educational content, and integrating creative elements into the media they created. Their creativity was reflected in their ability to combine personal ideas with functional digital design elements. In addition, critical thinking skills are evident in the way students identify real problems in the school environment and design applicable solutions, such as creating biopore holes, mini waterways, or digital campaigns on waste management. This whole process not only improves the conceptual understanding of the IPAS concept, but also strengthens the integration between knowledge, skills and attitudes.

3.2. Discussion

The findings of this study indicate that the digital-based PjBL model is an effective and relevant learning strategy in shaping 21st century skills at the primary school level, and is in line with the spirit of the Merdeka Curriculum which encourages contextual, collaborative, and oriented learning to strengthen the Pancasila learner profile.

Students' critical thinking skills are evident when they make direct observations of school environmental conditions, such as areas prone to inundation and the presence of plastic waste. Based on interviews, students said that they identified problems, analyzed causes, and discussed possible solutions collaboratively in groups. This activity shows that students not only understand the water cycle theory conceptually, but are also able to relate it to the real conditions around them and apply simple data-based problem solving. Some groups, for example, proposed making biopore holes, mini waterways, and poster and digital video campaigns on the importance of keeping the environment clean.

This inquiry process encourages students to observe, record, analyze and evaluate information systematically. In group discussions, they ask reflective questions, explain cause-and-effect relationships, and develop logical problem-solving strategies. Observations noted active interaction and independent processing of ideas, which showed that students were able to build arguments and be accountable for their choices. This is in line with the learning objectives of IPAS which emphasizes a problem-based scientific approach and fact-based decision-making.

Furthermore, this critical thinking ability strengthens the relevance of the inquiry-based PjBL model as asserted by (Supriatna et al., 2020), which states that active engagement in real projects increases students' analytical capacity. This finding is also in line with Bloom's Taxonomy theory, especially in the realm of evaluation and synthesis, where students are required to assess situations, integrate information, and develop applicable solutions. Thus, the learning process not only equips

students with knowledge, but also fosters critical thinking skills that are essential in facing the challenges of the 21st century.

Through direct observation in class, it was seen that students showed high enthusiasm in designing visual designs, selecting educational content, and combining them into a final product in the form of digital posters and videos themed “Water Cycle and Environmental Preservation”. Their creativity is reflected in their ability to combine personal ideas with functional digital design elements. This project provided a space for students to express ideas freely and interestingly. In particular, the products showed originality and flexibility in message delivery. Students combined text, images, and colors harmoniously, reflecting an understanding of the IPAS material as well as aesthetic ability. Creativity is also evident in their courage to explore various graphic design applications.

In this process, they do not rely solely on instructions, but make design decisions independently and reflectively. The interview results support this finding. Some students stated that they felt more free and challenged to think “outside the box”. One student said, “I like being able to choose my own pictures and colors that fit the water recycling message.” This shows that the project-based approach encourages a sense of ownership of the work and freedom of digital expression.

The documentation of students' digital products demonstrates their ability to creatively convey scientific and moral messages. This supports the findings of (Oktavianto, 2017), who stated that digital media in project-based learning encourages students' courage to experiment and think innovatively. In the context of IPAS, creativity includes not only visual aspects, but also the integration of scientific knowledge and environmental values. In line with the theory (Ardianti, 2022), creativity in education emerges when students are given the freedom to design solutions, rather than simply following instructions. The digital-based PjBL approach provides such freedom and is proven to be able to develop students' creative potential in the context of meaningful learning.

Collaboration was a key element that developed significantly during the implementation of the digital-based PjBL project. Based on classroom observations and teacher notes, students were able to fairly and structurally divide roles within the team, such as being a researcher, script writer, poster illustrator, video narrator, and content editor. Each member has specific responsibilities that complement each other, creating effective and meaningful cooperation.

Interactions during group discussions show that students learn to listen, give input, and resolve conflicts in a deliberative manner. In interviews, students admitted that working in groups was not always easy, but they felt challenged to resolve differences of opinion in a mature manner. In fact, some students who are usually passive in conventional learning, began to show active participation when given roles in real projects.

Observations also noted that group work took place in a cooperative rather than competitive atmosphere. Students gave each other feedback and built a spirit of mutual support to achieve shared results. Teachers noted an increased sense of social responsibility and emotional involvement in the teamwork process. This finding is in line with the results of research (Mariana, 2020) which concluded that group work in the PjBL model can increase empathy and solidarity between team members. This reinforces Vygotsky's view in (Khoiruzzadi, 2021) in social cognitive theory, that the development of cognition occurs through meaningful social interactions.

Communication skills developed significantly during the implementation of the project. Students showed an increased ability to convey ideas, both verbally and through digital media. The presentation of the project results was done openly in front of the class using Google Slides, as well as in the form of a video displayed through a projector. This activity provides space for students to practice public speaking skills and convey ideas with confidence. The video documentation shows that students are able to explain the contents of the project in their own language, although it is still simple. Some students have even started using scientific terms related to the topic of IPAS, such as “water cycle,” “evaporation,” and “infiltration.” The teacher noted that before the project started, many students were still shy about public speaking. However, after a series of recording exercises, scripting, and presentation simulations, they appeared more expressive and communicative.

Interviews with students revealed that the digital rehearsal process helped them improve their articulation, intonation, and clarity of message. One student said: “I was nervous at first, but after trying the recording several times, I became smoother when presenting.” This improvement includes both verbal and nonverbal aspects, such as the use of intonation, eye contact, and the selection of visual

illustrations that support the message. In addition, the ability to compose narrative text for videos is also an indicator of the development of digital literacy and written communication. This finding is consistent with research (Alvonco, 2015) which emphasizes that technology-based projects can improve students' oral and written communication skills. This theoretical support is also reinforced by (Martina, 2019), (Darmuki, 2022), and (Fajarwati, 2017), which emphasize the importance of PjBL in shaping higher order thinking skills and authentic communication in 21st century learning.

Overall, the results showed that the application of the digital-based Project-Based Learning (PjBL) model in IPAS learning not only improved cognitive understanding of concepts, but also encouraged the development of integrated 21st century skills, namely creativity, critical thinking, communication, and collaboration (4C). The four aspects do not develop separately, but are intertwined in the process of planning, implementing, and reflecting on the project. This finding is in line with the spirit of Merdeka Curriculum in shaping a creative, critical, communicative, and independent Pancasila Learner Profile, and confirms the views of (Fitri, 2018) and (Nawawi, 2017) that project-based learning, especially those supported by technology, can facilitate authentic contextual and communicative learning experiences.

In addition, this finding is also reinforced by research (Rochmad, 2018), which highlights the role of digital projects in enhancing learners' creativity, as well as by (Aktafianto, 2023) and (Christian, 2021), which show the effectiveness of PjBL in encouraging higher-order thinking skills and cooperation at the elementary school level. Thus, digital project-based learning not only shapes conceptual understanding in IPAS, but also equips students with broader and sustainable skills, including digital literacy as an important provision in the era of technological transformation.

Practically, this finding shows the relevance of the PjBL model to the implementation of Merdeka Curriculum, which emphasizes contextual learning and strengthening student character. However, this study has several limitations, including the limited number of subjects (five students and one teacher), the short duration of implementation (one learning theme), and the challenges of uneven access and technological literacy. These limitations limit the generalizability of the results, so further studies are needed with a wider range of participants and a longitudinal approach to observe long-term impacts.

Furthermore, the development of a systematic 4C skills assessment instrument is important so that assessment can be carried out objectively and continuously. This research opens up opportunities for further exploration, such as through large-scale classroom action research or mixed methods approaches to obtain a more comprehensive picture of the effectiveness of PjBL in IPAS learning. The practical implication is the importance of teacher training in designing meaningful digital projects as well as adequate technological infrastructure support in the elementary school environment.

3.3. Conclusion

The main conclusion of this research confirms that the application of digital-based Project Based Learning (PjBL) model in IPAS learning is proven to be effective in shaping elementary school students' 21st century skills, particularly creativity, critical thinking, collaboration, and communication (4C). This research is important because it shows that contextual learning based on digital projects is able to integrate conceptual understanding with practical skills that are relevant in the era of digital transformation. The active involvement of students in all stages of the project has facilitated the growth of ownership, reflective participation, and real data-based problem solving skills. However, this study recognizes the limitations in the number of participants, implementation time, and technological challenges. Therefore, it is recommended that further research be carried out with a wider scope and longer duration, as well as the development of systematic 4C assessment instruments and teacher training in designing meaningful digital projects to support the optimal effectiveness of the Merdeka Curriculum implementation.

Author Contributions

Aisyah Khairina: Conceptualization, Methodology, Data Curation, Writing - Original Draft, Review & Editing.

All authors have read and approved the final manuscript.

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The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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