



ANALYSIS THE IMPLEMENTATION OF PROJECT-BASED LEARNING (PJBL) BASED ON DIGITAL APPLICATIONS IN BIOLOGY GRADE 10 VIRUS LEARNING AT SMAN 1 KLAPANUNGGAL

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Article Info

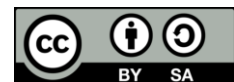
Keywords:

Biology virus material,
 Digital applications,
 Project-based learning,
 Senior high school

ABSTRACT

Education in the 21st century requires the implementation of student-centered learning models that are capable of developing 4Cs (Critical thinking, Creativity, Collaboration, and Communication). One learning model that is relevant to these demands is Project-Based Learning (PjBL) especially when integrated with the use of digital applications. This study aims to analyze: (1) the effectiveness of implementing PjBL based on digital applications, and (2) the challenges of PjBL learning based on digital applications. This study uses a qualitative approach with a triangulation method. The research sample was 70 students enrolled in class X of SMAN 1 Klapanunggal. Data were analyzed using the interactive model of Miles and Huberman with four stages. The research findings show that: (1) the implementation of PjBL based on digital applications in learning class X Biology virus material at SMAN 1 Klapanunggal shows a good level of effectiveness, marked by increased student activity, increased understanding of the concept of virus material, development of collaboration and communication skills, and good student responses to learning, and (2) there are various challenges that arise, including differences in students' digital literacy abilities, limited learning time, technical constraints and infrastructure, and group work management.

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1. INTRODUCTION

Education in the 21st century requires significant transformations in the learning process, shifting from teacher-centered instruction to student-centered learning. Learning is no longer solely oriented toward the acquisition of cognitive knowledge but also emphasizes the development of students' attitudes and psychomotor skills. This paradigm shift aims to equip students with 21st century skills, including critical thinking, creativity, collaboration, and communication, known as the 4Cs (Griffin et al., 2012).

Biology learning as part of Natural Sciences, plays a crucial role in fostering scientific thinking skills and enhancing students' awareness of environmental issues. Biology which studies living organisms and their interactions with the environment, requires not only conceptual understanding but also students' ability to conduct investigations and solve real-world problems (Rose et al., 2024). However, in practice, Biology instruction in schools remains predominantly teacher-centered and focused mainly on cognitive aspects. This condition tends to result in passive learning, limited student engagement, and difficulties in connecting biological concepts with their applications in everyday life.

A decline in students' learning motivation is particularly evident in virus-related topics, which are characterized by abstract, microscopic, and complex concepts. Viruses are microscopic biological entities found in various environments, with sizes ranging from approximately 20 to 300 nanometers. Concepts related to viral structure, replication, and roles in life are difficult to understand deeply without the support of contextual and visual learning strategies. As stated by (Taylor, 2014), it is impossible to define viruses based on their form or physical characteristics until they can be directly observed.

One learning model considered capable of addressing these challenges is Project-Based Learning (PjBL). PjBL is a student-centered learning model that promotes active student engagement through project activities (Mulyadi, 2015), supports deeper and more meaningful conceptual understanding (Nayono & Nuryadin, 2013), and enhances 21st-century skills. In the context of Indonesian education, project-based learning aimed at developing the Pancasila Student Profile can be effectively supported through the integration of digital applications.

Along with the rapid development of information and communication technology, the integration of digital applications into learning activities has become increasingly relevant. The use of digital tools such as collaboration platforms (Google Classroom, Padlet), design and presentation applications (Canva), learning management systems (Edmodo), assessment applications (Quizizz), Augmented Reality (AR) technology, video conferencing, and virtual whiteboards can create more engaging and interactive learning experiences. These applications support students throughout the project process, including planning, data collection, collaboration, and presentation of results. Consequently, the integration of digital applications into PjBL has the potential to enhance student engagement, creativity, and digital literacy (Miagusttin et al., 2024). Moreover, digital-based PjBL provides interactive, flexible, and meaningful learning experiences for students as digital natives.

Nevertheless, the implementation of digital application-based PjBL still faces various challenges, including teacher readiness, availability of supporting facilities and infrastructure, and effective management of learning time (Wati & Kuswanto, 2025). Therefore, research on the analysis of the implementation of digital application-based PjBL in Biology learning for class X with virus material is important and relevant to be studied in depth. The detailed research is to analyze the effectiveness of the implementation and identify challenges that may arise in Project Based Learning (PjBL) based on digital applications in Biology learning for class X at SMAN 1 Klapanunggal

2. RESEARCH METHODS

This study employed a qualitative research approach using a triangulation method. The qualitative approach was selected to gain an in-depth, holistic, and contextual understanding of how digital applications function and facilitate students' collaboration and communication during the implementation of Project-Based Learning (PjBL) (Creswell, 2012). Meanwhile, the triangulation method was applied to enhance the credibility and validity of the data. The research participants consisted of 70 Grade X students at SMAN 1 Klapanunggal. Data were collected through observations, interviews, and document analysis (Miles & Huberman, 1994). Primary data sources included interview results from Biology teachers and Grade X students, while secondary data sources comprised teaching modules, instructional materials, and students' project outputs in the form of digital posters. Data analysis was conducted using the interactive data analysis model proposed by Miles and Huberman, which involves four stages: (1) data collection, (2) data reduction, (3) data display, and (4) conclusion drawing and verification (Miles et al., 2014). These stages were carried out cyclically and iteratively, with each stage interconnected throughout the research process.



Figure 1. Miles and Huberman Data Analysis Model

Data Collection

Data were collected through observations of Project-Based Learning (PjBL) activities on virus-related topics, interviews with Biology teachers and Grade X students, and documentation of project outputs in the form of digital posters created using Canva. The learning process focused on the development of educational posters about virus-related diseases, in which students worked collaboratively in groups and utilized various digital

applications, including Canva, Google Docs, Google Drive, and WhatsApp, to support project planning, content development, collaboration, and communication.

Data Reduction

The data reduction stage involved selecting, focusing, and simplifying raw data obtained from interviews and observations. The analysis indicated that Canva was the dominant digital application used in project development, while Google Docs and WhatsApp were utilized to support student collaboration and communication. Additionally, Google Drive was employed by the teacher as a platform for collecting and managing students' project submissions.

Data Display

The data were presented in the form of descriptive narratives and diagrams illustrating the relationships among learning components. Observational findings indicated that student collaboration increased as learners were able to work collaboratively in online environments using Canva and Google Docs. Effective communication between students and teachers was facilitated through WhatsApp Groups and Google Classroom (Thomas, 2000).

Conclusion Drawing

Conclusion drawing was conducted by interpreting the research findings. It can be concluded that the implementation of digital application-based Project-Based Learning (PjBL) contributed to the enhancement of students' collaboration, communication, and creativity skills. Nevertheless, several challenges were identified, including limited internet connectivity, variations in students' digital competencies, and constraints related to the availability of learning devices (Vygotsky, 1978)

3. RESULT AND ANALYSIS

Based on the research that has been conducted, the research findings are analyzed and presented in accordance with the research objectives, namely analyzing the effectiveness of implementation and identifying challenges that may arise in Project Based Learning (PjBL) based on digital applications in Biology learning for class X at SMAN 1 Klapanunggal.

Effectiveness of Digital Based Project Based Learning in Biology Learning on Virus Topics

The findings of the study indicate that the implementation of digital application-based Project Based Learning in Biology learning on virus related topics demonstrated a high level of effectiveness. This effectiveness was reflected in several key aspects, including increased student engagement, improved conceptual understanding, enhanced collaboration skills, and the development of students' digital literacy.

a. Increased Student Engagement

Students were not merely positioned as passive recipients of information but were actively involved in the planning, implementation, and completion of project tasks. Learning activities such as group discussions, information searching from digital sources, project product development, and the presentation of project outcomes encouraged active participation among nearly all students. Canva as the primary application, enabled students to express creativity in designing digital posters, while Google Docs and WhatsApp facilitated effective group coordination and communication. This learning model supports the development of 21st-century skills, including collaboration, communication, creativity, and digital literacy (Trilling & Fadel, 2009).

b. Improvement in Conceptual Understanding of Virus Topics

Students demonstrated that the implementation of digital-based PjBL facilitated a deeper understanding of viruses. Students were able to create solutions to problems concerning the diversity of living things and their roles, viruses and their role, the application of biotechnology, ecosystem components and their interactions, and environmental change. This was evident in the resulting project products, such as digital posters, demonstrating students' ability to organize information logically and scientifically.

c. Development of Collaboration and Communication Skills

Digital-based PjBL learning encourages students to work collaboratively in groups (Bender, 2012). Research results show that students learn to divide roles, discuss, and solve problems together. This collaborative process trains communication skills, responsibility, and cooperation among group members.

d. Students Responses to The Learning Process

Students responded positively to the implementation of digital-based PjBL, stating that learning became more engaging, less monotonous, and helped them understand the virus material more easily. Digital-based projects also increased learning motivation by providing space for creativity and expression. The results of this study also reinforce (Vygotsky, 1978) social constructivism theory, which emphasizes that effective learning occurs through social interaction and the use of cultural tools, including digital technology.

Thus, the implementation of digital application-based PjBL at SMAN 1 Klapanunggal contributed to the development of students' competencies in understanding biological concepts related to virus topics, as well as enhancing their collaborative skills and digital communication abilities.

Challenges of Digital-Based Project-Based Learning in Biology Learning on Virus Topics

The research results show that the implementation of digital application-based PjBL in Biology learning on viruses demonstrates a high level of effectiveness. However, in reality, PjBL implementation still presents several challenges. These challenges relate to pedagogical aspects, technical aspects, and student characteristics.

a. Differences in Students' Digital Literacy Skills

Digital-based learning revealed variations in students' digital literacy skills. While most students were generally able to operate digital applications independently and creatively, some experienced difficulties in using applications such as Canva and Google Docs. Digital-based learning requires students not only to use technology but also to critically understand, evaluate, and manage digital information (Gilster, 1997). These differences led to unequal contributions within group work and, in some cases, hindered the smooth completion of project tasks.

b. Limited Instructional Time

Digital-based PjBL requires a relatively longer time allocation, encompassing project planning, information gathering, product development, presentation, and reflection. Limited instructional time in the classroom became one of the main challenges, particularly when virus-related content needed to be completed in accordance with predetermined curriculum targets.

c. Technical Constraints and Infrastructure Limitations

The implementation of digital-based PjBL is highly dependent on the availability of digital devices and stable internet access. Limited access to personal digital devices and unstable internet connectivity affected students' ability to search for information, collaborate online, and submit digital assignments. Some students were required to share devices, which reduced the effectiveness of project completion. However, both teachers and students attempted to address these challenges through flexible role distribution, shared use of devices, and intensive communication via digital platforms (Thomas, 2000; Trilling & Fadel, 2009).

d. Group Work Management

Group work is a key element in PjBL, requiring students to be actively involved and work effectively. However, this study found that not all students are able to work effectively. Some students tend to be passive and dependent on other group members. Differences in the level of responsibility and commitment among group members pose a challenge in maintaining effective collaboration and equal role distribution during the PjBL learning process.

4. CONCLUSION

Based on the research findings described above, it can be concluded that: (1) the implementation of digital application-based Project-Based Learning (PjBL) in Grade X Biology learning on virus-related topics at SMAN 1 Klapanunggal demonstrated a good level of effectiveness, as evidenced by increased student engagement, improved conceptual understanding of virus content, the development of collaboration and communication skills, and positive student responses to the learning process; and (2) several challenges were identified, including differences in students' digital literacy levels, limited instructional time, technical and infrastructural constraints, and issues related to group work management.

5. REFERENCES

- [1] Bender, W. N. (2012). *Project-Based Learning: Differentiating Instruction for The 21st Century*. Corwin Press.
- [2] Creswell, J. W. (2012). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* 4th Edition. Pearson.
- [3] Gilster, P. (1997). *Digital Literacy*. Wiley.
- [4] Griffin, P., McGaw, B., & Care, E. (2012). *Assessment and Teaching of 21st Century Skills*. Springer.
- [5] Miagusttin, A. P., Syakori, K. R., Nurhangesti, M., Septiani, R., Alifiya, S. N., & Ningrum, T. S. (2024). Penerapan Teknologi dalam Pembelajaran: Menghadapi Era Digital di Abad Ke-21. *Universitas Indraprasta PGRI*, 1-15.
- [6] Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook** (2nd ed.). Sage Publications.
- [7] Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook** (3rd ed.). Sage Publications.
- [8] Mulyadi, E. (2015). Penerapan Model Project Based Learning untuk Meningkatkan Kinerja Siswa SMK. *Jurnal Pendidikan Teknologi Dan Kejuruan*, 22(4), 387-396.
- [9] Nayono, S. E., & Nuryadin, E. R. (2013). Pengembangan Model Pembelajaran Project Based Learning pada Mata Kuliah Computer Aided Design. *Jurnal Pendidikan Teknologi Dan Kejuruan*, 21(4), 340-347.
- [10] Rose, A. E., Nancy, A., Sudira, E., Haria, Y., & Suryanda, A. (2024). Strategi Inovatif Pembelajaran Eksplorasi Strategi Inovatif Pembelajaran Biologi di Abad 21: Strategi Inovatif Pembelajaran Biologi di Abad 21. *DIAJAR: Jurnal Pendidikan Dan Pembelajaran*, 3(1), 102-107.
- [11] Taylor, M. W. (2014). What is a Virus?. In *Viruses and Man: a History of Interactions*. Cham: Springer International Publishing., 23-40.
- [12] Thomas, J. W. (2000). *A Review of Research on Project-Based Learning*. Autodesk Foundation.
- [13] Trilling, B., & Fadel, C. (2009). *21st Century Skills: Learning for Life in our Times*. Jossey-Bass.
- [14] Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.
- [15] Wati, P. K., & Kuswanto, A. (2025). Implementasi Model Pembelajaran Berbasis Proyek (PJBL) dalam Meningkatkan Keterampilan Praktik Administrasi Perkantoran Siswa: Tinjauan Pustaka untuk Guru SMK. *Bookchapter Administrasi Perkantoran*, 1, 305-326.