

Development of Electronic Student Worksheet Based on Problem-Based Learning for Material on Environmental Change Geoh Heritage Gumuk Pasir

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Abstract: This research aims to determine the development of PBL-based electronic LKPD on environmental change material at Gumuk Pasir Geoh Heritage and the feasibility of PBL-based electronic LKPD on class X environmental change material at Gumuk Pasir Geoh Heritage. This research is development research (R&D) using a 4D development model consisting of stages definition, design, development and deployment. This research was only carried out until the development stage. This research was validated internally by media expert lecturers and material experts and externally validated by biology teachers and class X high school students. The results of the research show that based on the assessment of media expert lecturers, a score of 82.13 was obtained in the "very good" category, material experts received a score of 67.4 in the "good" category, biology teachers obtained a score of 92.84 in the "very good" category, and the assessment of class X high school students obtained a score of 94.44. "very good" category. Based on the results of the development and feasibility that have been carried out, it can be concluded that the PBL-based electronic LKPD is suitable for use in the learning process regarding environmental change material at the Gumuk Pasir Geoh Heritage.

Keywords: Electronic worksheets; Environmental changes; Problem-based learning

Introduction

21st century skills known as the 4C include communication, collaboration, critical thinking, and creativity (Trilling & Fadel, 2009; Isnaini et al., 2023; Siregar et al., 2023; Jalinus et al., 2023). 21st-century education in its learning is not only limited to conveying information but is more focused on developing students' abilities in critical thinking, solving problems, collaborating, using information and communication technology, and relating knowledge to the context of everyday life (Framework for 21st Century Learning, 2011; Yulanda et al., 2023).

21st century learning requires students to be more active in the learning process (Dada et al., 2023). However, current learning is still teacher-centered,

causing students to become passive, lazy to learn, feel bored, and lack understanding of the learning material (Hakim & Pertiwi, 2023). Another problem is the availability of teaching materials, which are still conventional in nature, so the use of these materials is not yet effective and efficient. That is the challenge in learning biology, namely how to keep students enthusiastic about participating in learning. Therefore, there needs to be interaction between teachers and students.

It will be easier for teachers to explain the main points, and students will be able to continue by reading relevant teaching materials (Kosasih, 2021). One of the most effective, interactive, and innovative teaching materials is student worksheets (LKPD) (Hasibuan et al., 2023). Student worksheets (LKPD) are an alternative

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teaching material for teachers to help make it easier for teachers and students in the learning process so that effective interactions are formed (Marsa et al., 2016). Through LKPD, which contains a list of questions, it will direct students toward scientific reasoning and build a conceptual understanding of the material being studied (Barniol & Zavala, 2016).

Based on the results of observations carried out at one of the high schools in Bantul, it shows that the school has implemented an independent curriculum for class X students, so teaching materials are needed that are in line with curriculum demands. However, the available teaching materials are not yet able to support the learning process. Apart from that, in the 21st century, it is necessary to involve the use of technology in the process of teaching and learning activities. Therefore, there is a need for teaching materials that are in accordance with curriculum developments and the use of technology.

LKPD combines various concepts that students have learned during the learning process into their daily lives (Aslam et al., 2021). The use of teaching materials in the 21st century needs to be applied to developments in technology so that it makes it easier for anyone to access various things quickly, anytime, anywhere, using various devices connected to the internet network (Rachmadtullah et al., 2023). These devices include smartphones, personal digital assistants (PDAs), and other similar handheld devices. Along with the development of information technology, more innovative worksheets are needed (Sobri et al., 2020). The LKPD can be presented in online form or with the term electronic student worksheet (Ibnusaputra et al., 2023). An electronic worksheet is a learning tool in the form of LKPD whose design for use is assisted by the internet with a systematic arrangement in electronic format (Kholifatus et al., 2021). Electronic LKPD is facilitated with pictures, learning videos, and audio, which make electronic LKPD interesting so that learning is more interactive and students' understanding is strengthened.

One of the biology learning materials is environmental change material. Environmental change material was given to class X students. Based on the Independent Curriculum stated in Minister of Education and Culture Regulation Number 008/H/KR/2022, it is stated that the characteristics of biological material need to be linked to students' lives so that it is easy to understand and achieve learning. Students are expected to have the ability to be responsive to global issues and play an active role in problem solving.

Based on the results of observations made at one of the high schools in Bantul, it is known that there is a Gumuk Pasir Geoheritage area that needs to be protected and preserved, located on Parangtritis Beach,

Bantul, which has become one of the icons of Yogyakarta. There are environmental problems related to exploitation. This is because there are activities such as tourism, illegal sand mining, animal husbandry, and shrimp cultivation that can threaten sustainability in the surrounding environment. What is becoming more of a highlight is that there are shrimp farming and livestock farming activities in the area that dispose of fecal waste from cultivation and livestock, which causes unpleasant odors in the surrounding environment, so that if left unchecked, it will pollute the surrounding community. This real problem can be raised in biology learning so that it can increase students' attention to the material being studied. Efforts to utilize the environment in learning are made by making it a learning resource (Irwandi & Fajeriadi, 2019). The environment is a learning resource that has a lot of influence on the learning process. Utilizing the environment as a learning resource will be able to help and provide concrete learning opportunities or learning opportunities with direct and real experience (Ikhsan et al., 2017). Introduction to students' environmental potential is able to develop students' adaptive thinking patterns and behavior (Nugroho, 2018).

In connection with these problems, teachers must have the right strategy in the learning process. The way to do this is by implementing creative, innovative, and fun learning models so that students are more enthusiastic and motivated (Tafonao & Loi, 2022). The use of electronic LKPD requires collaboration with the learning model. One learning model that can be used is the problem-based learning (PBL) model, which aims to direct teaching materials to support the learning process that involves students both in groups and individually. PBL is a learning model with a student-centered approach to authentic problems. PBL is a learning model in which students use real problems as a learning framework to develop critical thinking abilities, problem-solving skills, and a deep understanding of the subject matter (Astuti, 2021).

The PBL model is focused on the problems presented by teachers, and students solve these problems with all their knowledge and skills from various sources that can be obtained. PBL learning is learning that begins with exposure to problems in the real world, which encourages students to solve these problems by connecting the knowledge they have with applications in everyday life (Tivani & Paidi, 2016).

The objectives of this research are: 1) the development of PBL-based electronic LKPD on environmental change material; and 2) the feasibility test of electronic LKPD based on PBL on class X environmental change material.

Method

This research is R&D development research to produce new products. The teaching material developed is a PBL-based electronic worksheet on environmental changes in sand dune geoheritage. The development model used in developing this electronic LKPD is the 4D development model (Thiagarajan et al., 1974). This 4D development model has four stages, namely definition, design, development, and deployment. However, this research is limited to the development stage. The 4D development model can be seen in Figure 1.



Figure 1. 4D model

There are two types of data produced in this research, namely quantitative and qualitative data. Quantitative data was obtained from questionnaire scores, while qualitative data was obtained through interviews. The first stage is the define stage, which is carried out at this stage and includes initial analysis, student analysis, task analysis, concept analysis, and analysis of learning objectives used in the electronic LKPD. In the second stage, namely the design stage, test preparation, media selection, format selection, and preparation of the initial framework for this electronic LKPD are carried out. The media used in this research and development uses Google Sites, which can be accessed using Android and iOS. The third stage is the development stage; this stage is the validation stage. Internal validation is carried out by expert judgment, namely material expert validators and learning media expert validators. At the external validation stage, the electronic LKPD was assessed by high school biology teachers and 30 class X high school students, whose assessments were in the form of responses to the PBL-based electronic LKPD as users. Quantitative data was obtained from assessment questionnaire scores provided by material experts, learning media experts, biology teachers, and student responses.

A product feasibility analysis is carried out to determine product suitability. The data obtained is in the form of assessment scores obtained from experts, biology teachers, and student responses. The data was then analyzed quantitatively using Formula 1.

$$M = \frac{\sum fx}{N} \tag{1}$$

Information:

- M : Average per aspect
- $\sum fx$: Total score per aspect
- N : Number of components

After obtaining the average score per aspect, the average score is converted to a value of 100 using the following formula:

$$\text{Score} = \frac{\text{Total score obtained}}{\text{Maximum total score}} \times 100 \tag{2}$$

The scores obtained are interpreted using a scoring system and categorized in Table 1.

Table 1. Interpretation of Values and Categories (Riduwan, 2013)

Value	Category
81 - 100	Very good
61 - 80	Good
41 - 60	Enough
21 - 40	Less
≤ 20	Not good

Results and Discussion

PBL-based electronic LKPD material on Gumuk Pasir geoheritage environmental changes, which can be accessed by class X students, is a product produced in this research and development. This electronic LKPD can be accessed by students via a smartphone or personal computer connected to the internet network. Smartphones are used as tools, methods, and mechanisms in education to disseminate information quickly and easily (Lestari et al., 2023). This integration of electronic LKPD plays a role in saving space, time, and costs (Ozila & Zen, 2023).

The 4D development model is used in research on how to develop electronic LKPD, which consists of the Define, Design, Develop, and Disseminate stages. The development stages have been carried out sequentially in order to obtain a good product. This research has only reached the development stage.

Define

The definition stage was carried out to determine the needs of one of the high school schools in Bantul. Researchers collect information that occurs in the field and problems regarding biology teaching materials in the learning process. It is known that the teaching materials used are still printed books and PowerPoint. Furthermore, 100% of students already have Android or iOS-based smartphones, but their use is still limited to communication tools, namely accessing entertainment, using social media, using games, and accessing news. The teaching process requires the use of tools and techniques for successful implementation. Implementing the learning process with technology helps increase the effectiveness of learning and makes it easier to adapt to the learning theme (Murati & Ceka, 2017).

Another finding resulting from observations is that biology teachers have not used local potential as a learning resource and teachers only use the school environment and use reference books or printed books which are still focused on the K13 curriculum. The basic things that serve as guidelines can be used to facilitate the learning process. Learning that uses a contextual approach emphasizes the use of existing concepts and skills to analyze problems in the real world that are relevant to the intellectual, physical, and social conditions of students (Hastuti & Alanis, 2022). Therefore, it can be used as a source of information for developing electronic LKPD based on PBL material on environmental changes in the Gumuk Pasir geoheritage, which can be accessed by students with their electronic devices.

Design

The design stage is the stage in designing and drafting learning tools or the initial design of electronic LKPD products based on PBL. The define stage, which was carried out previously, is used as a reference in the design of learning media. The first is the preparation of research instruments. The assessment tools designed include expert lecturer validation sheets (material experts and media experts), practicality test questionnaire sheets by biology teachers, and student response questionnaires to the developed PBL-based electronic LKPD. Second, the choice of medium is adjusted to the material used. The media used is PBL-based electronic LKPD using Google Sites; this is based on advanced technological developments, so the website mode can be accessed by Android or iOS. Third format selection. Fourth, the initial design for making an electronic LKPD is carried out. The initial design results are in the form of a draft LKPD containing the title, learning objectives to be achieved, environmental change learning materials that are in accordance with PBL, assignments, and supporting information.

The design is carried out systematically in preparing the electronic LKPD in accordance with the draft, which aims to ensure that the sequence of material presented is clear and structured so that students can easily use and study the PBL-based electronic LKPD. One of the optimal uses of learning media is to make its appearance as attractive as possible without reducing the value of the material presented (Rosyiddin et al., 2023). The electronic LKPD consists of three learning activities. Learning activity 1 contains material related to analyzing the causes and impacts of environmental change. Learning activity 2 contains material related to the analysis of environmental pollution cases. Learning activity 3 contains material related to environmental change efforts and solutions. This PBL-based electronic LKPD is equipped with learning videos and news links

that are directly connected to Google, and there are practice questions on each material topic to help students understand the material on changes in the Gumuk Pasir geoheritage environment. The following is a student worksheet design, which can be seen in Figure 2.

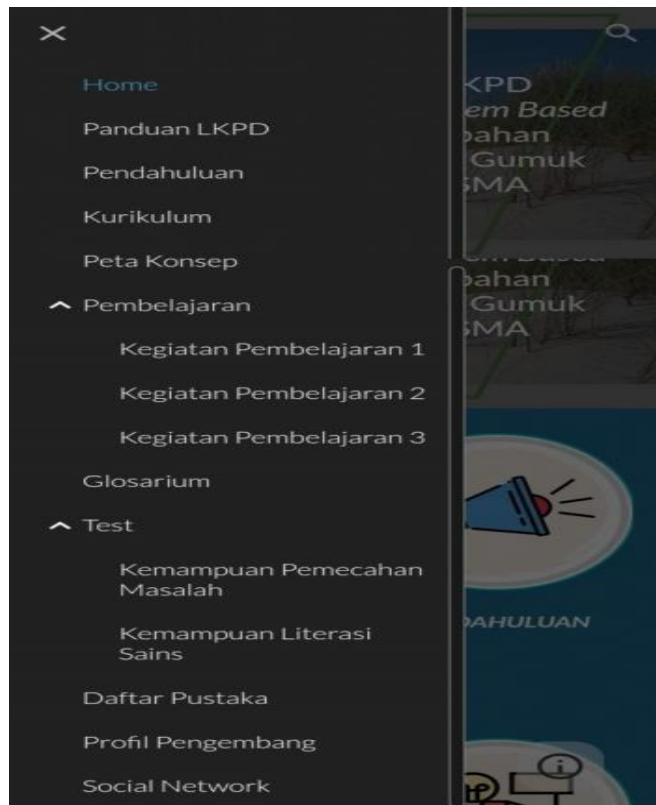


Figure 2. Electronic LKPD design

Development

The development stage is the validation stage. The validation stage is used to determine the feasibility of PBL-based electronic LKPD products. Validation was carried out by validators, including learning media expert lecturers and material expert lecturers, as well as biology teachers and class X high school students.

Media assessment consists of two aspects, namely software and visual communication. Results can be seen in Table 2.

Table 2. Media Expert Validation Results on Electronic Student Worksheet Products

Assessment aspects	Score	Criteria
Software	86	Very good
Visual Communication	78.25	Good
Average	82.13	Very good

Assessing the feasibility of PBL-based electronic LKPD products by media experts, the software aspect obtained a score of 86 with very feasible criteria, and the visual communication aspect obtained a score of 78.25

with a feasible category. Looking at the overall assessment of the suitability of PBL-based electronic LKPD in terms of media, it is in the very suitable category for use in biology learning, material on environmental change in the Gumuk Pasir geoheritage, with an average score of 82.13. Media validators provide input to review the learning images and videos presented so that they are in line with the context and learning activities. Overall, it can be concluded that this electronic LKPD teaching material is suitable for learning in terms of media. Developing good student worksheets will help students be active and creative in finding the right answers (Fajriah & Suryaningsih, 2020).

Meanwhile, there are five aspects to assess the material: suitability, accuracy, didactics, construction, and technical. The research results can be seen in Table 3.

Table 3. Results of Material Expert Validation of Electronic Student Worksheet Products

Assessment Aspects	Score	Criteria
Assessment Aspects	50	Enough
Material Feasibility	56.25	Enough
Accuracy of Material	70.75	Good
Didactic	85	Very Good
Construction	75	Good
Technical	67.4	Good

Assessment of the feasibility of PBL-based electronic LKPD products by material experts obtained results in the feasibility aspect of the material obtaining a score of 50 in the sufficient category, the accuracy aspect of the material obtaining a score of 56.25 in the sufficient category, the didactic aspect obtaining a score of 70.75 in the feasible category, the construction aspect obtaining a score of 85 in the very feasible category, and the technical aspect obtaining a score of 75 in the feasible category. The material validator provides input to review the preparation of learning activities using the PBL model so that it can be used in accordance with PBL syntax. Apart from that, the validator also provides input to review the selected discourse or news so that it is appropriate to the context used. This aspect is very important in improving the quality of teaching materials because it has a direct impact on the quality of learning.

A material will be considered good quality if it meets certain standards, such as being relevant, comprehensive, well structured according to learning objectives, having clear explanations, and being supported by visual elements such as pictures or videos. The contextualization of learning materials needs to be structured so that it is more meaningful for students' lives. This can be done by sorting textual material into material that can be linked to real things (Parhan, 2018). Looking at the overall assessment of the feasibility of

PBL-based electronic LKPD in terms of material, it is in the category suitable for use in biology learning, environmental change material, with an average score of 67.4.

The assessment of PBL-based electronic LKPD by biology teachers can be seen in Table 4.

Table 4. Biology Teacher Validation Results on Electronic Student Worksheet Products

Assessment Aspects	Average value	Criteria
Software engineering	91.62	Very good
Visual Communication	91.62	Very good
Material Feasibility	100	Very good
Material accuracy	87.5	Very good
Didactic	91.62	Very good
Construction	92.5	Very good
Technical	95	Very good
Average	92.84	Very good

Assessment of the feasibility of PBL-based electronic LKPD products by 2 biology teachers showed that the overall average result of PBL-based electronic LKPD was in the very suitable category for use in biology learning on environmental change material with an average score of 92.84. Validators do not provide specific input or suggestions.

Before being used, the PBL-based electronic LKPD on environmental change material on Geoheritage Gumuk Pasir was tested on a limited basis with class X students who were not subjects in the control class and experimental class. Limited trials were carried out to obtain responses or assessments from biology teachers and students. The trial was carried out with the aim of obtaining data and information regarding the practicality of PBL-based electronic LKPD products.

The results of student responses can be seen in Table 5.

Table 5. Results of Student Responses

Assessment Aspects	Score	Criteria
Assessment Aspects	95.25	Very good
Presentation	94.50	Very good
Language	95	Very good
Language	93	Very good
Average	94.44	Very good

Based on Table 5, the results of limited trials by students show that the electronic LKPD product developed received a very feasible category in these four aspects, and an average score of 94.44 was obtained in the very feasible category. According to Suryaningsih et al. (2021), electronic LKPD has the advantages of being practical, easy to use, and having features that make it more attractive.

This electronic LKPD has gone through a validation process by material experts and learning media experts,

as well as by biology teachers. After that, the LKPD was revised based on input from experts and biology teachers before being tested on class X high school students. The revised electronic LKPD was given to students as trial participants. The students' response to the electronic LKPD was very positive, indicating that the electronic LKPD could be developed for other materials. This is in line with research by Adesti et al. (2020), which states that practical media is media that can be used in the school environment and outside the school. This electronic LKPD can be accessed anywhere at any time with a network without any time limits, so it can be used practically. This is in line with research that reveals that the use of e-learning can support the implementation of learning using the PBL model because it can improve students' learning abilities (Verstegen et al., 2016).

The use of worksheets is effective in improving students' higher-order thinking skills at various grade levels, subjects, and learning models (Anjani et al., 2023; Fadhila, 2022; Tamam et al., 2023). PBL-based electronic LKPD uses real problems that exist in the surrounding environment, namely the problems that exist in Gumuk Pasir, by linking them to environmental change material so as to direct students to improve their learning outcomes. This is in line with research by Saputra (2020) that is, one of the characteristics of PBL is using everyday problems which will have direct benefits when solving problems that occur in society. Based on these learning activities, students already have problem-solving skills to deal with environmental problems in their surrounding environment. The syntax for PBL-based LKPD is a learning model that uses real world problems as a learning context for students to learn how to think and skills in solving problems and gaining knowledge and concepts from learning material (Yunitasari & Pratama, 2024).

Conclusion

Based on the assessment of material experts, media experts, biology teachers, and students, it can be concluded that the PBL-based electronic LKPD on the material on environmental changes in the Gumuk Pasir geoheritage meets the criteria for being suitable for use in the learning process. The results of research and assessments from material experts obtained a score of 67.4 in the "good" category, media experts obtained a score of 82.13 in the "very good" category, biology teachers obtained a score of 92.84 in the "very good" category, and students' assessment as a trial obtained a score of 94.44 in the "very good."

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Author Contributions

N.D.H. contributed to designing the research, conducting the research, and writing the research article. D. plays a role in guiding the implementation of research and writing articles.

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Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this paper.

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