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Effectiveness of Electronic LKPD for PBL-Based Practical Work to Improve Critical Thinking Skills

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Abstract: Critical thinking skills are one of the skills that students must have in studying Biology. Students must adapt to technological developments. The development of critical thinking skills in lessons related to practical activities can be done by using teaching materials. The purpose of this study was to determine the effectiveness of using PBL-based Electronic LKPD for practical work to improve critical thinking skills of grade X SMA students on bacteria material. This type of research is R&D research and development. The development model used refers to Thiagarajan (Define, Design, Develop, and Dessiminate) and this study discusses the Dessiminate stages. The sample in this study was class X using only 2 experimental classes without a control class. The data collection technique usedpretest and posttest in the form of essay questions. The results of the study show that the use of PBL-based electronic LKPD for practical work is more effective in improving thinking skills.critical learners.

Keywords: Critical Thinking; Electronics; PBL; Practicum

Introduction

The 2013 curriculum requires the implementation of scientific-based and student-centered learning. Students are expected to play an active role during learning and follow technological developments. As is known, technological developments are currently increasingly rapid and have an impact on the world of education, including biology learning. Biology is one of the sciences that can be a provisionfor humans to face technological advances(Puspitasari, 2018). Biology is one of the disciplines that originates from nature, in which there are many facts and phenomena that exist in nature, therefore humans are required to be able to understand various conditions around them, including living things and their environment (Wulandari et al, 2021). Biology contains life sciences with various studies on life, living organisms, structure and function, growth, evolution, distribution, and taxonomy which are still difficult to understand.

Therefore, some students consider biology to be a material that seems difficult, boring, and requires a lot of memorization (Jayawardana et al., 2021). The difficulty of students in learning biology is caused by its living nature so that critical thinking skills are needed. Walker argues that critical thinking is an intellectual process that begins with conceptualizing, applying, analyzing, synthesizing, and evaluating various information as a basis for taking actionm(Sugiharti & Gayatri, 2021).

Biology is a compulsory subject to study at all levels of education and the knowledge produced can be applied to life (Judge & Windayana, 2016). In studying biology, it's not just about memorizing, but you have to be able to understand each material.(Fitri et al., 2021). In addition, biology learning must be able to improve and balance hard skills and soft skills (Sari, 2019). Lufri et al (2020) also argue that biology is a science that requires understanding, application, analysis, synthesis, and evaluation and in studying it must use the questions what, why and how. In this way, students will be able to master the concept as well as understand the concepts in the subject of biology.According to the Ministry of National Education (2007), the first point of the objective of biology learning is that students are expected to have the ability to understand concepts, explain the

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relationship between concepts, and apply concepts in daily activities to understand the material being studied in order to solve problems given in the learning process.

Critical thinking in biology learning can be achieved through an interesting and meaningful learning process (Mahayukti et al., 2017). Critical thinking skills must be possessed so that students have other abilities such as problem solving skills, communication skills, and mathematical representation skills (Lestari & Surya, 2017). Critical thinking skills determine the success of student learning which is linked to practical activities to make it easier for students to understand the material so that it can be linked to everyday life (Afrilianto, 2012). Wahyuni (2015) also stated that critical thinking is a form of thinking that attempts to understand problems in depth, has an open mind towards other people's decisions and opinions, correctly evaluates the information received before making a decision and is able to connect cause and effect in finding solutions to problems faced both in learning process activities and in everyday life.

Other research shows that improving students' critical thinking skills can be achieved by using learning media (Kurniawan et al., 2018).Learning media is a tool for transferring learning materials (Nurhidayat & Saptono, 2021).The learning media used today must be integrated with models and technology, such as electronic LKPD or Electronic LKPD. Electronic LKPD contains student worksheets that are packaged electronically (Adawiyah et al., 2021). If usually LKPD is in hard copy form, then Electronic LKPD is arranged in such a way using a soft copy application so that it is easier to share with students (Wijayanti et al., 2021). Electronic LKPD can be combined with various media such as video, audio, animation, images, and others as a product. The developed Electronic LKPD can be accessed anytime and anywhere by using the electronic devices they have. The development of learning media must be based on the circumstances and needs of students and adjusted to the competencies contained in the curriculum.

Based on the results of the needs analysis carried outYusnita & Astriani, (2022)with grade X biology teachers at SMAN 4, SMAN 9, and SMAN 19 Palembang, the curriculum currently used is the 2013 curriculum. In addition, the learning model used by teachers is PBL and Discovery Learning. The learning model used is only limited to administrative supplements, not applied, especially when studying after Covid-19 and rarely doing practical work, students are only given LKPD containing questions. Teachers have not been able to apply the learning model and teachers also said that the method used is not effective because it causes many students to get bored quickly, which has an impact on student grades which are often below the Minimum Completion Criteria (known with KKM). During biology learning, especially bacteria material, it was also found from the results of the needs analysis questionnaire that teachers had never developed their own student worksheets and had not tried to combine learning using electronic devices, let alone doing practical activities.

Other analysis results also stated that students often have difficulty working on questions given by teachers because the teacher's explanation is not supported by practical activities that cause many students to get scores below the KKM set by the school, which is 70. Therefore, teachers need the application of interesting learning media that are linked to practical activities so that they have the potential to improve critical thinking skills. Electronic LKPD is one of the media used because it has been proven to improve students' critical thinking skills (Ariyansah et al., 2021; Novriani et al., 2021). This study aims to determine the effectiveness of using PBL-based electronic LKPD for practical work to improve students' critical thinking skills on bacteria material.

Method

To facilitate the conduct of research studies, a research flow is needed which functions as a reference regarding the steps taken in finding the thing being studied, starting from the observation and needs analysis stages to drawing conclusions which can be seen in Figure 1.

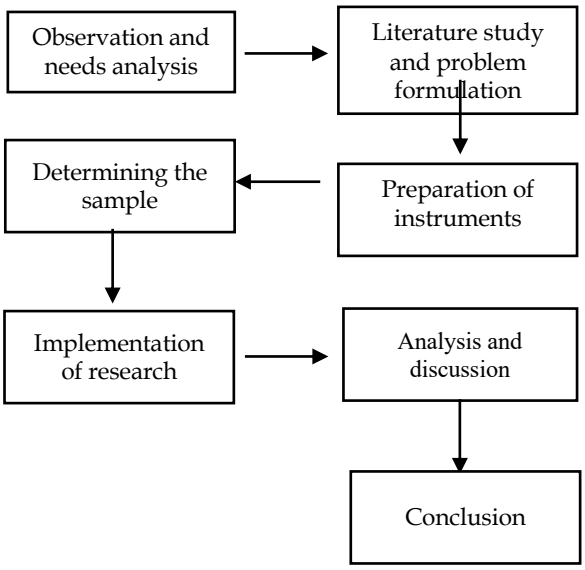

Figure 1. Research Flow

This type of research is research and development (R&D), using the 4D model through 4 stages, namely Define, Design, Develop, and Dessiminate. The stage in this study is the Dessiminate stage. The subjects in the electronic LKPD development research were class X students of SMAN 4 Palembang. Data collection was based on the sub-district area representing the Ulu part

of Palembang City. The effectiveness test used pretest and posttest tests in the form of essay questions using 2 experimental classes without a control class. The reason for not using a control class is because the results of the experimental class can already represent the learning outcomes of students to be measured. This is reinforced by the opinion(Thiagarajan, 1974), although using an experimental class is permitted, it is better to still use a control class so that there is a comparison to show some improvements.

Analysis of the Effectiveness of Electronic LKPD for PBL-Based Practical Work

The effectiveness of the implementation of PBL-based electronic LKPD for practical work was carried out using the N-gain test obtained from the Pretest and Posttest score values with the experimental class assisted by SPSS according to(Hake, 1998)as follows (Formula 1).

$$N - Gain = \frac{S\ post - S\ pre}{\text{S maks} - \text{S pre}} \quad (1)$$

Information:
S post = Posttest score; S max = Ideal maximum score; S pre = Pretest score

The N-gain test was conducted to obtain facts about how much learning outcomes had improved.(Majdi, 2018). The high and low N-gain are then calculated and the results obtained are grouped based on the criteria for obtaining the N-gain score (Table 1)

Table 1. N-Gain Value Criteria

N-gain value	Criteria
N-gain≥ 0.7	Tall
0.3 ≤ N-gain ≤0.7	Currently
N-gain ≤0.3	Low

The effectiveness of the Electronic LKPD for psychomotor skills is calculated using the formula and scoring criteria which can be seen in Table 2.

$$\text{Capaian optimum} = \frac{\text{Total skor perolehan}}{\text{Skor } maksimum} x\ 100 \quad (2)$$

Table 2. Scoring Criteria for Learning Outcomes in the Critical Thinking Skills Domain

Score	Information
4	Very good
3	Good
2	Enough
1	Not enough

Assessment of learning outcomes by educators based onMinister of Education and Culture Regulation, (2013)In primary and secondary education, the conversion of scores and predicates for learning outcomes in the skills domain can be seen inTable 3.

Table 3. Conversion of Scores and Predictions for Learning Outcomes in the Skills Domain

Optimum Achievement	Letter	Category
86-100	A	Very good
81-85	A-	
76-80	B+	Good
71-75	B	
66-70	B-	
61-65	C+	Enough
56-60	C	
51-55	C-	
46-50	D+	Not enough
0-45	D	

Results and Discussion

The field implementation test of the use of Electronic LKPD for PBL-based Practical Work was conducted in class X MIPA B and X MIPA C as experimental classes. To determine the effectiveness of the use of LKPD on critical thinking skills, it was seen by analyzing the pretest and posttest questions that covered critical thinking indicators andanalyzed using the N-gain formula (Hake, 1998). The results of the analysis can be seen in Table 4.

Table 4. Experimental Class N-Gain Analysis Results

Class	Pretest	Posttest	N-Gain Value	Criteria
X MIPA B	35.2	82.5	0.72	Tall
X MIPA C	31.3	83.6	0.75	Tall

The results of the analysis that have been carried out on the experimental class X MIPA B obtained an N-Gain of 0.72 with high criteria and class X MIPA C obtained an N-Gain of 0.75 with high criteria. This shows that the Electronic LKPD for Practical Work based on PBL is effective in improving critical thinking outcomes in students. Effectiveness of useThe effectiveness of electronic LKPD for PBL-based practical work on bacteria material is seen based on the improvement of critical thinking and psychomotor learning outcomes. Effectiveness can also be seen from the difference in data on the improvement of student learning outcomes given in the learning process. The pretest and posttest questions used to see the improvement of students' critical thinking outcomes use essay tests that have been adjusted to critical thinking indicators.

The results of the N-Gain value show that there is a difference in the pretest and posttest values of the total number of students with a total of 21 students, namely 31% getting a value of 0.3.≤N-Gain≤0.7 with a moderate category and 47 students, namely 69%, received an N-Gain score≥0.7 with a high category means that the students experienced an increase in learning with a high category with an average N-Gain acquisition of class X MIPA B of 0.72 and X MIPA C of 0.75, the increase in critical thinking results in general is in the high category.

This proves that with the increase in critical thinking results, it can be said thatThe implementation of electronic LKPD for PBL-based practical work can improve students' critical thinking skills on bacteria material and is effective in improving learning outcomes. According to research conducted by(Astuti et al., 2018)concluded that the use of PBL-based LKPD can effectively improve critical thinking skills in students.

Essay questions used in the pretest and posttest are also more effective in seeing the improvement of critical thinking results that will be measured because the use of essay questions encourages students to answer questions broadly based on their opinions that they have compiled rather than multiple choice questions that students only choose without any reason why they choose the question. This is also in line with the opinionZubaidah et al., (2018)Essay tests are more often chosen because essay tests encourage students to show responses or answers rather than just choosing answers. Essay tests also have more potential to improve students' skills in expressing reasons, compiling, analyzing, synthesizing, and evaluating.

In addition, to determine the students' thinking skills, observations were also made on their psychomotor domain. The students' psychomotor learning outcomes were observed using observation sheets assessed by researchers at the 1st and 2nd meetings measured in the third and fourth PBL syntax, namely when collecting data through practical activities in the Electronic Practical Worksheet. The results of the observations can be seen in Table 5.

Table 5. Student Learning Outcomes in the Psychomotor Domain

Meeting	Psychomotor Values	Achievement (%)	Category
(Practical)	Preparing practical tools and materials	94	Very good
Normal Flora	Using practical tools	79	Good
Fingers)	Mastering practical work steps	81	Very good
	Group Cooperation	88	Very good
	Incubating the results of the practicum	100	Very good
	Average meeting 1	88	Very good
(Observing Normal	Conduct observations of the results of the practicum	94	Very good
Finger Flora Practical)	Making an interim report of the experimental results	93	Very good
	Drawing conclusions	87	Very good
	Average meeting 2	91	Very good
(Creating Learning	Substance	96	Very good
Media)	Language	92	Very good
	Aesthetics	80	Good
	Completeness of practical results	78	Good
	Average results of the practicum	86	Very good

The learning outcomes of students in the psychomotor domain show that in all meetings there are different criteria and there is an increase in each meeting. The psychomotor domain value is measured using an observation sheet and then analyzed with the optimum achievement test which can be seen on Table 5. Psychomotor assessment needs to be done because it is to find out the psychomotor skills of students during the learning process and will greatly support the sustainability of the practicum that will be carried out because students will be assessed directly. The psychomotor results of students who learn using Electronic LKPD PBL-based Practical Worksheets for 2 meetings can be seen inTable 5with a very good category. The psychomotor results of students at each meeting reached a range of 73-100% for each indicator. So it can be said that the use of Electronic LKPD Practicum based on PBL can also improve the psychomotor domain of students, where students are required to be active and agile during learning activities. This is in accordance with research conducted by Imron & Saroi, (2020) that learning using the PBL model can improve psychomotor abilities in students.

At every meetingIn the Electronic Practical Worksheet, there are steps in conducting practical work as a means of taking students' psychomotor scores. In the first meeting, each group is invited to conduct a normal finger flora practicum according to the work steps in the practical worksheet, then the results of the practicum are incubated at room temperature. In the second meeting, each group observes the results of the incubated normal finger flora practicum, then makes a temporary report and group representatives present it in front of the class. The third homework assignment for each group is to make learning media that has been determined in the Electronic Practical Worksheet. Based on the results of the psychomotor assessment, the data collection at the experimental stage by conducting practicums in the Electronic Practical Worksheet based on the PBL model has been effective in measuring students' psychomotor skills. This is in line with researchThe Fate of the Furious (2019),which states that the application of the PBL model can improve learning

outcomes in the psychomotor domain in conducting practical experiments.

Electronic LKPD for Practical Work is systematically arranged based on the instructions for using electronic LKPD for practical work, the grid for implementing the PBL model in LKPD, concept maps, KI, KD, GPA, learning objectives, learning materials, learning materials, LKPD learning activities, bibliography, author biography, and LKPD cover. Learning activities are adjusted to the syntax of the PBL learning model, namely: 1) Problem orientation; 2) Organizing students; 3) Guiding investigation groups; 4) Developing and presenting work results; and 5) Analyzing and evaluating.

The PBL model is a learning model that challenges students by applying real problems or everyday problems as a context to train students in developing critical thinking skills through stages of direct observation and group work to encourage students to be more active and creative. So that it opens up opportunities for students to ask questions, find out, find answers based on existing evidence because the problems given are used as learning resources.(Indriani & Gularso, 2022; Mareti et al., 2021).

At the beginning of the activity, the teacher begins the learning activity by explaining the learning objectives, learning indicators and basic concepts related to bacteria. After that, the first syntax of the teacher asks students to watch a video about good habits of washing hands before eating. After watching, students are asked to identify the main problem and choose one of the main problems available in the LKPD. Then students are asked to write a problem formulation of at least two questions that must be made by students.

The second syntax, students are asked to divide the practical tasks together with the groups that have been formed, then determine the time they will work on. Each group works on the tasks they have divided each and listens to the directions given by the teacher. The third syntax guides the investigation group, the teacher directs students to answer each problem formulation that has been made according to the main problem that has been chosen by each group through the normal flora practical activity on the students' fingers. The second meeting is still in the same syntax, students are asked to observe and identify the results of the practical activities that have been carried out previously based on the instructions in the Electronic Practical Worksheet.

The fourth syntax develops and presents the results of students' work, they are asked to discuss and write down the results of their group's practical observations and then present the results of their group's representative practical observations in front of the class. The fifth syntax analyzes and evaluates the problem-solving process after the discussion, students are asked to work on self-reflection related to the practical work that has been done. Based on the self-reflection that has been done, students are able to write down the main problems in the LKPD that are interesting to students, then students are asked to create learning media according to the choices in the electronic LKPD for practical work.

The difficulty experienced by students in completing the work is that students still feel that they are doing itsomething new and unfamiliar in using the practical tools but after being informed the students were able to overcome the difficulties and obstacles they experienced. The students felt satisfied and enthusiastic with the results of the practical activities that had been presented by the group representatives and were able to understand what they were doing during the practical work.

Data Analysis of the Implementation of Electronic LKPD Practical Work with the PBL Model

The results of observations of the implementation of the PBL model by collecting observation data during 2 meetings in the learning process in the classroom. The observation process was carried out by observers at each meeting in the experimental class in two classes X MIPA B and X MIPA C. The results of the observation data can be seen in Table 6.

Table 6. Results of Analysis of the Implementation of Electronic LKPD Practical Work with the PBL Model

The 2nd Meeting	Experimental Class		
	Score	(%)	Criteria
1 (X MIPA B)	21	100	Very Well Done
2 (X MIPA B)	21	100	Very Well Done
1 (X MIPA C)	21	100	Very Well Done
2 (X MIPA C)	21	100	Very Well Done

The results of the analysis at each meeting in the experimental class show that the implementation of learning has reached very good criteria. Electronic LKPD Practicum is able to foster critical thinking skills in students, where the learning process in the classroom is supported by the implementation of the PBL model which shows a percentage of 100% with a very implemented category. The implementation of PBL is carried out very well and is able to improve student learning outcomes. Involving students in the learning process makes students more active and able to think critically. This is reinforced byNurlaila et al., (2017),which states that critical thinking skills in the learning process can increase enthusiasm for learning, make learning more active, gain broader knowledge, and be able to select the right information or learning sources.

In addition, biology learning is closely related to solving problems that can require students to be able to think critically in finding solutions to the problems faced, closely related to biology material that is identical

to various confusing, unclear, or unstructured problem situations that will easily attract students' attention and curiosity (Palennari, 2018). So that by implementing learning using Electronic LKPD practicum integrated with the PBL model in biology learning can be an effective choice in developing and improving students' critical thinking skills (Agnesa & Rahmadana, 2022). Learning biology will be meaningful if students are actively involved intellectually, manually and socially. The development of science process skills as a process and product can foster students' critical thinking skills (Wulandari et al., 2021).

Student Response Data Analysis

Based on the results of filling in student responses via Google Form, this can be seen in Table 7.

Table 7. Student Response Analysis Results

Question	Response X MIPA B		Response X MIPA C	
	Yes	No	Yes	No
I easily understand the material on bacteria through the normal flora of the fingers practical using the Electronic Practical Worksheet.	30	4	32	2
I am able to formulate problems regarding bacterial material through the normal flora of fingers practicum after using the Electronic LKPD for Practical Work.	33	1	33	1
I am able to facilitate planning problem-solving activities starting from time management, task distribution, practicum after using the Electronic LKPD Practicum.	32	2	30	4
I was able to improve my skills in working with friends and groups after using the Electronic Practical Worksheet.	31	3	30	4
I am able to improve my skills in understanding a bacterial material problem through the normal flora of fingers practicum after using the Electronic LKPD Practicum.	30	4	31	3
I am able to complete the practical work to solve a problem after using the Electronic Practical Worksheet.	32	2	31	3
I am able to analyze bacterial material through the normal flora of fingers practicum after using the Electronic LKPD Practicum.	33	1	32	2
I am able to express my opinion on a bacterial material problem through the normal flora of the fingers practicum after using the Electronic LKPD for the Practical.	32	2	34	0
I was able to draw conclusions about the bacteria material through the normal flora of the fingers practicum after using the Electronic LKPD for the Practical.	34	0	33	1
I am able to facilitate reflection or evaluation of the problem-solving process, thus encouraging me to improve my learning process even better after using the Electronic Practical Worksheet.	33	1	32	2
Total	320	20	318	22
Average (%)	94	6	93	7

Based onTable 7shows the results of the analysis of student responses obtained in class X MIPA B, namely 94% and class X MIPA C, namely 93%, are categorized as very strong. This shows that overall students gave positive responses after they used the Electronic Practical Worksheet.Students expressed that learning about bacteria through practical activities made them more enthusiastic to participate in learning because it was not just theory like what they had learned before, so it was easy to understand, clear, and concise.

The packaging of the PBL-based Electronic Practical Worksheet is done by uploading the file to Heyzine Flipbook which will be shared in the form of a link and registered for Intellectual Property Rights (IPR). Furthermore, it is disseminated via the class WhatsApp group to be accessed by each student so that it can be understood and used by teachers and students. The PBL-based Electronic Practical Worksheet that has gone through the trial and improvement stages is then given to Biology teachers at SMA Negeri 4 for use.

Electronic LKPD PBL-based practical worksheets are very helpful for the continuity of the learning process in improving critical thinking skills. The application of the curriculum and learning models that already exist in LKPD, students' knowledge will increase with learning devices that are already integrated with models and learning using practical work, where activities are centered on students to develop process skills, motor skills, and scientific attitudes that they have never done before,material with a large capacity and limited learning time, then with the existence of LKPDThis is more effective and structured learning process that will be carried out because it is model-based and learning is more focused with the stages in LKPD, and can improve student learning outcomes with questions that have integrated critical thinking skills through pretests and posttests that have been proven by research conducted by researchers.

Conclusion

Based on the results of this study, it can be concluded that the use of PBL-based electronic LKPD for practical work has been proven effective in improving students' critical thinking skills, especially in bacteria material. This is because the Electronic LKPD for PBL-based practical work guides students to be able to solve problems by understanding the concept and linking it to practical activities. This is supported by the results of the N-Gain test analysis with an effectiveness value of class X MIPA B 0.72 and X MIPA C 0.75 high criteria.The learning outcomes of students in the psychomotor domain show that in all meetings there are different criteria and there is an increase from each meeting. The results of the implementation analysis at each meeting in the experimental class can be seen that the implementation of learning has reached very good criteria. And the results of the analysis of student responses obtained in class X MIPA B, namely 94% and class X MIPA C, namely 93%, are categorized as very strong. This shows that overall students gave a positive response after they used the Electronic LKPD for Practical Work.

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