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The Effectiveness of Student Worksheets (LKPD) Based on Problem-Based Learning on Critical Thinking Skills in the Topic of Human Reproductive System

Tri Wahyu Subekti, Eling Purwantoyo[1]✉

[1]Departement of Biology, Faculty of Mathematics and Natural Sciences, Semarang State University, Indonesia

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Abstract

The critical thinking skills of 11th-grade students at SMA Negeri 10 Semarang are still low when using the Cooperative Learning teaching model. This is attributed to time constraints. The Cooperative Learning teaching model has drawbacks, as students tend to be passive and solely receive knowledge from their teachers. The learning process is not entirely innovative, as it primarily focuses on textual material presentation, causing students to struggle with its application in daily life. This research aims to test the validity, determine the effectiveness, and assess the responses of students and teachers after using PBL-based Worksheets on the topic of the human reproductive system. This study adopts the ADDIE model for Research and Development. The research subjects include 11th-grade students of MIPA 1 as the experimental class and MIPA 3 as the control class. Sample selection is conducted using purposive sampling technique. The results of this study indicate that the total percentage of material expert validation is 97.91%, categorized as highly valid, while the total percentage of media expert validation is 90%, also categorized as highly valid. These results demonstrate that PBL-based Worksheets on the human reproductive system are suitable for use in the learning process. The effectiveness test of PBL-based Worksheets is declared effective, with an average N-gain score of 0.74 in the high category for the experimental class. There is a significant difference in the average pretest-posttest scores for each critical thinking ability indicator, and the classical completeness of the class is 86.11%. Student responses obtained an average score of 79.65% with effective criteria. Meanwhile, teacher responses obtained an average score of 85% with highly effective criteria. In conclusion, PBL-based Worksheets on the human reproductive system are suitable for use, effective in improving the critical thinking skills of 11th-grade students at SMA Negeri 10 Semarang, and receive positive responses from both students and teachers.

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✉**Correspondence Address:**
D6 Building, Faculty of Mathematics and Natural Sciences (FMIPA), Sekaran, Gunungpati, Semarang, 50229

E-mail: eling_purwantoyo@mail.unnes.ac.id

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INTRODUCTION

Teaching materials are a crucial component of structured learning aimed at achieving the expected competencies (Magdalena, Sundari, et al., 2020). Teaching materials encompass all forms of resources utilized by teachers during classroom instruction (Syaifullah & Izzah, 2019). These materials can also be interpreted as tools or means to support the systematically organized learning process (Magdalena, Prabandani, *et al.,* 2020). The use of teaching materials in learning is one of the determining factors for the success of the learning process (Husada Puspita *et al.,* 2020). Well-crafted teaching materials that align with the basic competencies contribute to the creation of effective learning experiences (L. Sari et al., 2020). If the teaching materials used do not meet the demands of basic competencies, it can lead to issues in the learning process (Lestari *et al.,* 2017). Teaching materials are divided into two types: print and non-print. Print materials are paper-based sheets containing content aimed at achieving learning objectives. Common examples of print teaching materials include modules, handouts, and student worksheets. Non-print teaching materials are learning resources that are not printed, including videos, audio, display materials, and internet-based content (Heryani & Rustina, 2018).

Currently, the Merdeka Curriculum has been initiated as a transformative step from the 2013 Curriculum (Angga *et al.,* 2022). The Merdeka Curriculum is a learning concept that emphasizes freedom and self-directed learning for both students and teachers (Rindayati *et al.,* 2022). It is one of the curricula introduced by the Ministry of Education and Culture to address the ongoing educational crisis in Indonesia that has not shown improvement over the years (Tiyas *et al.,* 2023). Lembar Kerja Peserta Didik (LKPD) is a teaching material commonly used by teachers in both the 2013 Curriculum and the Merdeka Curriculum. LKPD is defined as instructional sheets containing questions designed to guide students in understanding the concepts covered in the material (Diani *et al.,* 2019). LKPD can also be interpreted as a teaching aid to assist both teachers and students during the learning process (Gusti & Ratnawulan, 2021). As one of the teaching materials employed in the 2013 Curriculum, the use of LKPD does not replace the teacher's responsibility but aims to expedite the achievement of learning objectives and engage students more actively in exploring and developing material concepts. In addition to its use in the 2013 Curriculum, LKPD is also employed in the Merdeka Curriculum. LKPD in the Merdeka Curriculum includes the profile of a Pancasila learner, which serves to shape students' character in accordance with the foundation of the Indonesian state (Angraeni *et al.,* 2019). Biology is a subject that can be related to daily life (Darmayanti *et al.,* 2022). Direct experience is emphasized in biology learning, enabling students to easily comprehend the concepts being studied and achieve the learning objectives (Yanti, 2019).

The human reproductive system is one of the biology topics included in both the 2013 Curriculum and the Merdeka Curriculum. This subject is studied in the second semester of grade XI. In the 2013 Curriculum, there are two basic competencies (KD) that students must achieve in this topic. These two KDs are KD 3.12, analyzing the relationship between the structure of the tissues composing the human reproductive organs and their functions in the human reproductive system, and KD 4.12, presenting the results of an analysis of the impact of free association, diseases, and abnormalities on the structure and function of organs causing disturbances in the human reproductive system, as well as reproductive system technology (Kemendikbud, 2016). The human reproductive system is one of the biology topics that relate to the students' surrounding environment, being tangible, real, and complex, making it challenging for students to grasp the concepts (Tahir & Marniati, 2022). Contextual case studies are one approach to understanding the human reproductive system as the topic is not directly perceptible but can be encountered in the students' environment (Alimah & Utami, 2019). Critical thinking is the ability to analyze systematically organized data or facts based on logic to draw conclusions. Critical thinking demands rigorous efforts to examine beliefs grounded in supporting evidence and rational conclusions (Rachmantika & Wardono, 2019). This skill is crucial in the learning process as through critical thinking, students can connect their knowledge to daily life (Rachmawati & Nurhamida, 2018).

Enhancing critical thinking skills in students is important as it is a key skill required for 21st-century learning. Efforts to improve critical thinking skills should be accompanied by innovative teaching strategies and model applications. Problem-Based Learning (PBL) is one such model that employs a problem-based learning approach, enabling students to construct their own knowledge. PBL is considered effective in enhancing students' critical thinking skills (Sulaiman & Azizah, 2020). This model is characterized by using real-life problems as the basis for student learning, with the teacher acting as a facilitator (Lidinillah, 2020). Interviews with Biology teachers in Grade XI at SMA Negeri 10 Semarang revealed that Cooperative Learning is the current teaching model employed. The drawback of Cooperative Learning is that students tend to be passive, merely receiving knowledge from their teachers. This method lacks full innovativeness as it primarily focuses on textual material presentation, potentially making it challenging for students to apply the knowledge in daily life. Despite various teaching methods available for the human reproductive system, students' critical thinking skills remain low when using the Cooperative Learning model, mainly due to time constraints. Critical thinking skills can be enhanced through the use of teaching materials. LKPD is one such teaching material that can support the learning process. The relevant use of LKPD is expected to improve students' critical thinking skills. Based on the outlined description, the researcher will develop a learning tool in the form of LKPD based on the Problem-Based Learning (PBL) model for the human reproductive system to encourage students to be more active, think critically, and facilitate easier learning of the material. The PBL model was chosen because it employs a student-centered learning approach to real-world problems.

RESEARCH METHOD

The product developed in this research is an LKPD (Student Worksheet) based on Problem-Based Learning (PBL) for the topic of the human reproductive system. The LKPD based on PBL is created using the Research and Development (R&D) method. In this study, the ADDIE model is utilized as the development model. ADDIE comprises five stages: analysis, design, development, implementation, and evaluation (Branch, 2009). The method employed in this research is quasi-experimental design, specifically using the Nonequivalent Control Group Design, which involves selecting experimental and control groups non-randomly. In the implementation, each class is initially given a pretest to assess the students' baseline critical thinking abilities. Subsequently, both classes undergo different treatments: the experimental class uses the PBL-based LKPD, while the control class follows the Cooperative Learning model commonly employed by teachers. After the instructional treatment, students take a posttest. Pretests and posttests are administered to observe the students' performance before and after receiving the instructional treatment. The research design pattern is presented in Table 1.

Table 1 Nonequivalent Control Group Design Grouping

Class	Pretest	Treatment	Posttest
Experiment	O1	X	O2
Control	O1	Y	O2

Note:
O1: Pretest administered before students receive treatment in the experimental and control classes.
O2: Posttest given after students receive treatment in the experimental and control classes.
X: Treatment using LKPD based on Problem-Based Learning.
Y: Treatment using the Cooperative Learning instructional model.

RESULT AND DISCUSSION

1. Validity of PBL-Based LKPD on the Human Reproductive System

The validation of the PBL-based LKPD was conducted by subject matter experts and media experts, both of whom were Biology Education lecturers at Universitas Negeri Semarang with competencies aligned with the validated object. The validation process by subject matter experts was carried out to ensure that the content and assignments presented align with the learning objectives. The results of the subject matter expert validation for the PBL-based LKPD are presented in Table 2.

Table 2 Results of Validation Assessment for PBL-Based LKPD on the Human Reproductive System by Subject Matter Expert

No	Criteria	Score	Maximum Score	Percentage (%)
1.	Feasibility of Content	20	20	100
2.	Feasibility of Language	8	8	100
3.	Feasibility of Presentation	30	32	93,75
	Total score	58	60	
	Score Percentage	97,91		
	Criteria	Very Valid		

The subject matter expert validator provided suggestions for improving the questions in each PBL syntax. The validator also recommended adding questions for each PBL syntax to stimulate students in answering presented problems, ensuring they do not contain task instructions according to the PBL syntax. Additionally, improvements were suggested for sentence structure to be more effective, alongwith the use of correct language rules. The next product validation was conducted by the media expert validator. Media validation aimed to assess the feasibility of the PBL-based LKPD developed before implementation. The assessment for media expertise was based on aspects of cover design, presentation, and content design of the LKPD. The results of the media expert validation for the PBL-based LKPD are presented in Table 3.

Table 3 Results of Validation Assessment for PBL-Based LKPD on the Human Reproductive System by Media Expert

No	Criteria	Score	Maximum Score	Percentage (%)
1.	Cover Design	6	8	75
2.	Presentation	12	12	100
3.	Content Design of PBL-Based LKPD	18	20	90
	Total score	36	40	
	Score Percentage	90		
	Criteria	Very Valid		

The media expert validator suggested improvements to the LKPD cover and suggested changing the term "kata pengantar" (preface) to "prakata" (foreword). After obtaining validation from subject matter and media experts, identified areas for improvement were addressed. The PBL-based LKPD product was revised according to the feedback provided by subject matter and media experts. Table 2 and Table 3 sequentially show the results of LKPD validation by subject matter and media experts. The assessment by the subject matter expert validator indicates that the developed product is highly valid with a percentage of 97.91%. The assessment by the media expert validator shows highly valid results with a percentage of 90%. These results indicate that the PBL-based LKPD on the human reproductive system is applicable in the learning process. Overall, the results of the product validation by the subject matter expert are highly valid. Therefore, it can be stated that the PBL-based LKPD on the topic of the human reproductive system is valid and can be used in Biology education. The validity criteria for a product with a percentage range of 81%-100% are considered highly valid, indicating that the developed LKPD is suitable for application in student learning (Riduwan, 2013). The next validation was conducted by the media expert. The assessment by the media expert served as a reference for improving the LKPD before being tested. Validation assessment data were obtained by providing validation sheets covering aspects of cover design, presentation, and content design. The media expert evaluated the PBL-based LKPD on the human reproductive system and provided feedback in the form of comments and suggestions to the developer, serving as a guide for revising the developed product.

After validation by subject matter and media experts, the LKPD that has been declared valid is then tested on a small scale. After the small-scale test, the average score of student responses obtained is 78.89%, categorized as acceptable. Therefore, the product can be used in the learning process. The student responses in the small-scale test indicate that students are able to understand the activities presented in the PBL-based LKPD on the topic of the human reproductive system. The PBL model can have a positive impact on problem-solving skills because in their learning, students are required to understand the content by solving a problem. While solving these problems, students exchange ideas and share thoughts with their groupmates, thereby developing their critical thinking skills (W. R. Sari *et al.,* 2022).

2. Effectiveness of PBL-Based LKPD on the Human Reproductive System

The improvement in students' critical thinking skills can be observed through the comparison of N-gain between the pretest and posttest results of the experimental class and the control class. Before the start of the learning process, students took a pretest to evaluate their initial abilities. After all learning sessions were completed, the researcher administered a posttest to measure the progress and final abilities of the students. Based on the pretest and posttest results of student learning outcomes in the experimental class and the control class, the data calculations are obtained as shown in Table 4.

Table 4 Learning Outcomes (Critical Thinking Skills) of Students based on the Average Pretest and Posttest Scores in the Control Class (XI MIPA 3) and Experimental Class (XI MIPA 1) at SMA Negeri 10 Semarang

Data	Control		Experiment	
	Pretest	Posttest	Pretest	Posttest
Number of students	36	36	36	36
Minimum value	22	43	20	70
Maximum value	55	97	57	100
Mean	37,75	77,69	38,67	84,50

The N-gain formula is used to analyze the pretest and posttest scores in the experimental and control groups with the aim of assessing the extent of improvement in abilities after the implementation of the Problem-Based Learning Worksheet (LKPD). The calculation results of the average N-gain value for the experimental group are 0.7, more precisely 0.74, categorized as a high improvement in critical thinking abilities. The calculation results of the average N-gain value for the control group are 0.6, more precisely 0.63, categorizing the improvement in critical thinking abilities as moderate. The analysis results of the average N-gain value for the improvement of critical thinking abilities in the control and experimental classes of XI MIPA at SMA Negeri 10 Semarang are presented in Figure 1.

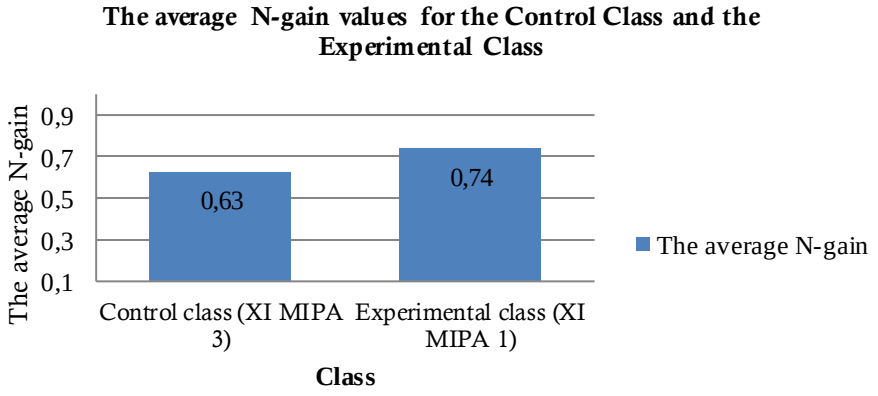

Figure 1 Graph of the Average N-gain Scores for the Improvement of Critical Thinking Skills in Control Class (XI MIPA 3) and Experimental Class (XI MIPA 1) at SMA Negeri 10 Semarang.

Furthermore, the effectiveness of the LKPD is supported by the test of the mean difference using the t-paired test with the assistance of SPSS. The results of the test of the mean difference using

the t-paired test with the assistance of SPSS are presented in the table 5.

Table 5 The results of the t-paired test for the mean difference in Critical Thinking Ability between the Control Class and the Experimental Class

	Ngain_Score
Mann-Whitney U	456.000
Wilcoxon W	1122.000
Z	-2.163
Asymp. Sig. (2-tailed)	.031

The overall average N-gain scores indicate that the experimental class is higher than the control class. The difference in the average N-gain scores between the control class and the experimental class is due to the different treatments given to each group. The experimental class received special treatment, namely using PBL-based worksheets during the learning process, while the control class used conventional learning models. In other words, PBL-based worksheets on the human reproductive system are effective in improving students' critical thinking skills compared to conventional learning models. This statement aligns with the findings of Sopiana *et al.*, (2022), stating that the implementation of worksheets in learning is effective in enhancing critical thinking skills, as evidenced by increased N-gain between pretest and posttest results.

The analysis of scores on each indicator of critical thinking skills can be determined through the use of posttest questions. The average posttest scores between the control group and the experimental group based on the indicators of critical thinking skills are presented in Figure 2.

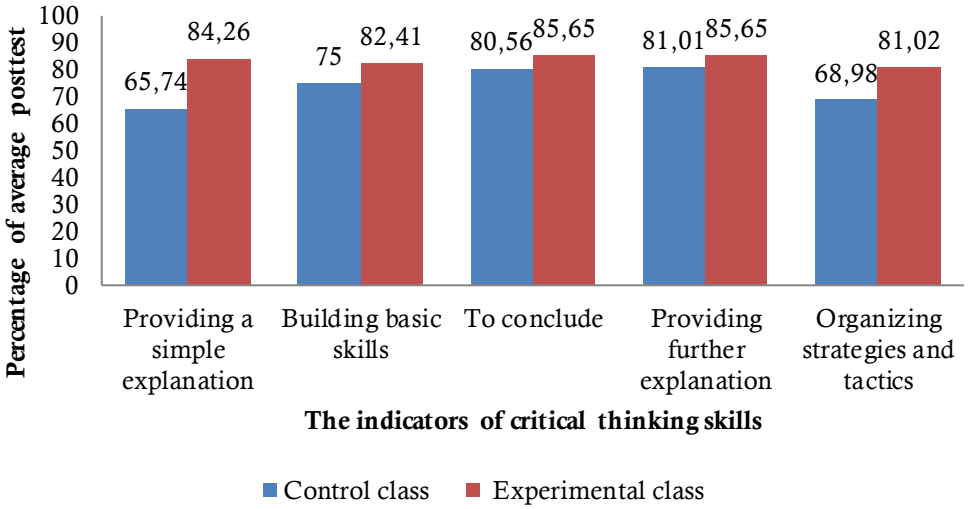

Figure 2 Graph of Average Posttest Scores for Critical Thinking Skills of Students in Control Class (XI MIPA 3) and Experimental Class (XI MIPA 1) on Each Indicator of Critical Thinking Skills.

The effectiveness indicators of PBL-based worksheets on critical thinking skills are further measured by the difference in the average achievement posttest scores for each critical thinking skill indicator between the control class and the experimental class. The research results indicate that the posttest scores for each critical thinking skill indicator in the experimental class are higher than the posttest scores in the control class for each critical thinking skill indicator. This is attributed to the role of PBL-based worksheets provided in each meeting. The use of PBL-based worksheets in the learning process can stimulate students' curiosity to solve problems presented in the worksheets. The worksheets include PBL syntax, consisting of student orientation to the problem, organizing students, guiding individual and group investigations, developing and presenting results, as well as analyzing and evaluating.

The effectiveness of these five stages of PBL in improving students' critical thinking skills is evident in the achievement of critical thinking skill indicators by students. This supports the assertion that the developed product is effective in enhancing students' critical thinking skills. This statement aligns with Saputri (2020)research, stating that the PBL model is effective in improving critical thinking skills because it is problem-based, encouraging students to identify and solve problems, organizing students through related learning tasks, motivating them to gather information, and

enabling them to conduct experiments by preparing appropriate works, ultimately evaluated by teachers as assessments.

The completeness of students' learning outcomes is obtained from the posttest scores, which are ≥75 in accordance with the KKM at SMA Negeri 10 Semarang. Based on the classical completeness of students' learning, the classical completeness of students' critical thinking skills in the posttest can be seen in Table 6.

Class	Completed	Not completed	Quantity	Percentage
Control class (XI MIPA 3)	25	11	36	69,44
Experimental class (XI MIPA 1)	31	5	36	86,11

The PBL-based worksheets on the topic of the human reproductive system demonstrate effectiveness in enhancing critical thinking skills. This is evident from the attainment of all effectiveness indicators used as references in this study. PBL-based worksheets on the human reproductive system can also be implemented in the Merdeka Curriculum, as worksheets play a crucial role in facilitating learning activities and achieving learning outcomes and objectives. Worksheets contribute to the effectiveness of learning and provide positive responses by improving understanding (Rosmana *et al.,* 2024)

3. Student Response After Using PBL-Based LKPD on the Human Reproductive System

Students' responses to the developed product were measured through a questionnaire to obtain relevant data. A total of 36 students in one experimental class filled out the questionnaire. The data on students' responses to PBL-based LKPD are presented in Table 4.

Table 4. Data of Student Responses After Using PBL-Based LKPD on the Topic of the Human Reproductive System

No.	Criteria	Percentage per aspect (%)	Category
1.	Language	83,33	Very effective
2.	Appearance	78,70	Effective
3.	Ease of use	76,67	Effective
	Total percentage (%)	79,56	
	Overall category	Effective	

The results of student responses after using the developed product indicate an effective category in each aspect of language, appearance, user-friendliness, content accuracy, and compatibility with PBL. The language aspect obtained a percentage of 83.33% with a category of highly effective. The obtained results indicate that the language used in the PBL-based LKPD on the topic of the human reproductive system is clear and understandable for students. A good LKPD is one that presents material in simple, effective, and communicative language, making it easily understood (Silvia, 2019). The appearance aspect obtained a percentage of 78.70% with an effective category. This result indicates that the appearance of the PBL-based LKPD is very appealing. The user-friendliness aspect obtained a percentage of 76.67% with an effective category. This result is because the PBL-based LKPD includes user instructions that facilitate students when using the LKPD. Overall, based on the average percentage score of student responses to the PBL-based LKPD on the human reproductive system, it received a score of 79.56% with an effective category. This indicates that students responded very well to the developed product.

4. Teacher Response to PBL-Based LKPD on the Human Reproductive System

The teacher's response to the developed product was obtained through the completion of a questionnaire by a biology teacher at SMA Negeri 10 Semarang. The evaluation results of the teacher's response to the developed product are presented in Table 5.

Table 5 Evaluation Results of Teacher's Response to PBL-based Worksheets on Human

Reproductive System Material

No.	Criteria	Percentage per aspect (%)	Category
1.	Language	100	Very effective
2.	Appearance	75	Effective
3.	Ease of use	80	Effective
4.	Content Accuracy	85	Very effective
	Total percentage (%)	85	
	Overall category	Very effective	

The results of the teacher's response to the PBL-based LKPD were obtained through a teacher response questionnaire. Based on the assessment using the teacher response questionnaire, an average percentage score of 85% was obtained, categorized as very effective. According to the existing criteria, it can be concluded that teachers gave a positive response to the PBL-based LKPD. All aspects questioned when using the PBL-based LKPD in learning activities received positive responses from the teachers. The PBL-based LKPD was effective in improving students' critical thinking skills in learning. Supported by the research findings of Sari *et al.*, (2016), which stated that the use of LKPD in learning would enhance the activities of both students and teachers, and teachers could make students more active during the learning process.

CONCLUSION

Based on the analysis of the results and discussions conducted, it can be concluded that:

1. The PBL-based LKPD on the human reproductive system is highly valid according to subject matter experts and media experts, making it suitable for use.
2. The use of PBL-based LKPD on the human reproductive system is effective in improving students' critical thinking skills.
3. Students respond effectively to the use of PBL-based LKPD on the human reproductive system.
4. Teachers respond very effectively to the PBL-based LKPD on the human reproductive system.

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