UNIVERSITAS SEBELAS MARET
BIOEDUKASI: JURNAL PENDIDIKAN BIOLOGI
https://jurnal.uns.ac.id/bioedukasi
1693-265X (Print) | 2549-0605 (Online)

Development of Biology Learning Devices with Problem Based Learning in Biodiversity Materials in the Middle School of the State 1 Batudaa Pantai

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Submission : 21/01/2022
Revision : 28/02/2022
Accepted : 26/02/2022

ABSTRACT

This study aims to produce problem-based learning biology learning devices on biodiversity material in class X. This research is research and development to adapt the 4-D development model by Thiagarajan and Semmel (1973), which consisted of the defining stage, the design stage The development stage, and the dissemination stage. This development research includes the development of learning devices consisting of Lesson Plans (RPP), Student Worksheets (LKPD), and Learning Outcomes Test (THB) on Biodiversity class X material in high schools. The data collected through non-test techniques and test techniques and data analyzed through descriptive statistical analysis, which consists of: (1) validity data analysis (2) practical data analysis (3) effectiveness data analysis (4) Analysis of student response data (5) Analysis of learning outcome test data. The results of validation and testing indicate that the developed learning tools meet the criteria of validity, practicality and effectiveness.

Keywords: Biology Learning Devices, *Problem Based Learning*

Introduction

The importance of improving the quality of education is something that must be considered by all parties, especially education practitioners. In education field, the development of learning devices is common. Santrock (2008) states that teachers must have classroom management skills, teachers must build and maintain a conducive learning environment, organize learning procedures, organize groups, monitor and activate classes. Apart from that the teacher must have a good strategy to motivate students in learning.

Some of the obstacles faced in learning biology are the preparation of learning devices that have not led students to finding problems, formulating hypotheses, designing data collection procedures, collecting data, solving problems. Learning activities have not optimized the ability of students to do scientific work to solve a problem. Learning resources are also not in accordance with the environmental conditions around the students so that students have difficulty understanding the material. Some of the phenomena displayed have not been fully associated with everyday life so that students have not received meaning from the learning process that has been carried out (Alwi et al, 2017)

In addition, several types of biology learning difficulties experienced by students include; 1) Characteristics of the topic; 2) The teaching style of the biology teacher is less creative; 3) The learning habits of students who are not disciplined; 4) The negative feelings and attitudes of students towards the topic; 5) lack of resources and time; 6) Unsupportive economic, psychological and physical conditions of students; 7) negative assessment of students towards teachers. Ways to overcome learning difficulties according to students include; Teachers should make interested learning and teachers should teach biology through practicum-based activities (Mardin, H., 2017). Student experience misconceptions on biological material such as biodiversity (Yunanda, I., Susilo, H., & Ghofur, A., 2021) and Learning biology should also use visual materials and connect biology topics to everyday life (Cimer, A., 2011). The process of learning biology is a complex process regarding the problem and requires deep thinking skills to understand it. Students must become reliable problem solvers in solving difficult problems related to everyday life. For that we need learning strategies that can train students in solving problems. Metacognitive ability is actual condition (Herlanti, Y., 2015), an activity to consciously control one's own cognitive processes. Metacognitive strategies or regulations are processes that focus on planning, monitoring, controlling and evaluation. This ability is needed by students in solving problems. Students who are aware of their own thinking or learning activities are students who have metacognitive skills (Listiana, L., Daesusi, R., & Soemantri, S., 2019). Students who have metacognitive abilities, then students are aware of the thinking process and its ability to control thinking processes, so that students are able to consider what to do in learning and solving problems (Suprayogi, H., 2021).

Various obstacles faced in learning biology, so efforts were made to overcome these obstacles. One of them is by developing learning devices to improve the meta-cognitive abilities and problem solving of high school students. The results of research

conducted by (Paidi, 2011) show that problem-based learning devices can improve meta-cognitive abilities, problem solving, and mastery of biological concepts for high school students. In addition, other efforts could also be through analyzing teacher needs, feasibility, practicality and effectiveness in developing Problem Based Learning devices to improve performance in preparing student reports in Senior High School (Ningsih et al., 2016).

Based on the previous research that has been stated above regarding the problems faced by students in the biology learning process, one of the efforts made is to develop problem-based learning tools. The development of learning devices is part of planning aimed to achieve a competency. The development of learning devices can provide higher quality documents for teachers and students, integrated each other and have been validated so that they can be used in the learning process any time (Alwi et al, 2017). This is an impetus for researchers to develop problem-based biology learning tools on biodiversity materials that meet valid, practical, and effective criteria that can improve student learning outcomes.

Methods

This type of research is development research. According to Sugiyono (2010), research and development or research development (R&D) is a basic research activity to obtain information user needs (needs assessment), then continued activities development (development) to produce products and assess the effectiveness of the product. The development of problem-based learning of biology learning devices with research subjects were class X students of SMA Negeri 1 Batudaa Pantai using the 4- D model development procedure developed by Thiagarajan and Semmel (1973), which consisted of the defining stage, the design stage The development stage, and the dissemination stage. This development research includes the development of learning devices consisting of Lesson Plans (RPP), Student Worksheets (LKPD), and Learning Outcomes Test (THB) on Biodiversity class X material in high schools.

According to Aida et al. (2016) the 4-D model is compatible with the development of biology learning devices, namely (1) The development steps are very clear, systematic and directed to guide each user of this model until the final process resulting product (2)) Combining aspects of rational and empirical validity clearly by experts or practitioners with the results of empirical development tests (3) This model development study leads to teacher productivity by producing complete learning device products (4) Relevant learning development procedures in accordance with development principles learning devices of national education curriculum. At the stage of the 4-D model development procedure, it was adapted to the development stage of Thiagarajan and Semmel (1973) by conducting limited trials and product revisions which were the stages of the development model of Thiagarajan and Semmel (1973). The stages of developing a 4-D model can be seen in the following figure.

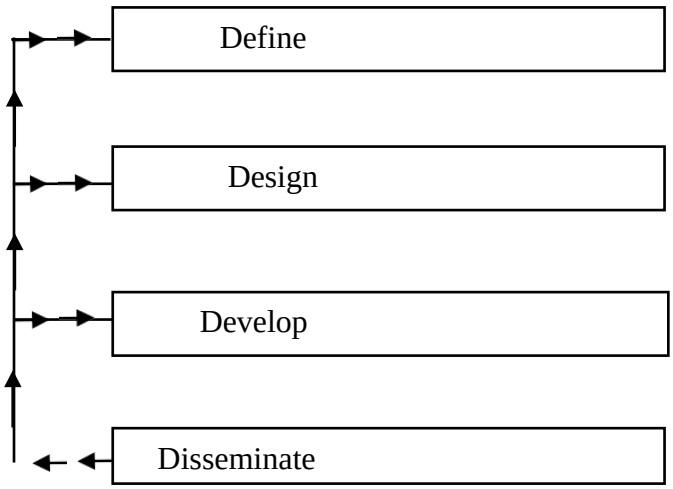

Figure 1 Stages of the 4-D Development Model Source: Aida et al (2016)

Results and Discussion

The development stage aims to produce learning devices that have been revised and worthy to be tested. Activities carried out for the development stage are: (1) validation of experts and practitioners on learning devices, (2) revision of learning devices, (3) limited trials. The description of the results of the activities at the development stage can be described below. The lesson plans developed using a Problem Based Learning (PBL) based learning model were validated by expert validators. Based on previous research conducted by Lestari, HN, Suganda, O., & Widiantie, R., (2017) explained that there is a relationship between students' metacognitive knowledge and problem solving abilities through PBL learning models and applying problem-based learning tools can improve students' abilities solve biological problems for students (Paidi, 2011)

The learning devices that have been validated can be described in Table 1.

Table 1. Expert Validation Results on the Lesson Plan

No .	*Assessment Aspects*	*x*	*Validation*
1	Identity of the lesson plan	3.63	Very Valid
2	The accuracy of translating Basic Competencies into indicators	3.92	Very Valid
3	Learning Materials	3.56	Very Valid
4	Learning Activities	3.71	Very Valid
5	Assessment	3.80	Very Valid
6	Learning Resources	3.72	Very Valid
7	Time Usage	3.57	Very Valid
8	Language Usage	3.75	Very Valid
	Reliability	0.92	Reliabel

The aspects that are considered in the validation of the lesson plan are the identity of the lesson plan, the accuracy of the translation of basic competencies into

indicators, learning material, learning activities, assessment, learning resources, time use and language use can be seen in table 1. Based on table 1 above, it shows that all aspects of the lesson plan (RPP) are considered very valid ($3.5 \leq M \leq 4.0$) because the average is 3.71 and the lesson plan (RPP) is classified as reliable because the reliability score is 0.92 (≥ 0.75) thus the lesson plan can be used with minor revisions.

The validation of Student Worksheet (LKPD) learning devices can be described in Table 2.

Table 2. Expert Validation Results of Student Worksheets

No .	*Assessment Aspects*	*X*	*Validation*
1	Content Quality	3.88	Very Valid
2	Accuracy Concept	3.52	Very Valid
3	Depth of Concept	3.59	Very Valid
4	Language Eligibility	3.38	Very Valid
5	Quality of completeness / supporting materials	3.57	Very Valid
	Reliability	0.89	Reliabel

The aspects that are considered in the validation of student worksheets are the quality of the content, the accuracy of the concept, the depth of the concept, the eligibility of the language and the quality of the completeness / supporting material of the participant worksheets can be seen in table 2. In problem-solving-based worksheets, students are presented with examples of problems that students will seek to solve, questions that must be solved and conclusions drawn. This makes students must have metacognitive abilities and problem solving skills to be able to solve the problems presented in the LKPD.

Based on table 2 above shows that all aspects of Student Worksheet (LKPD) are considered very valid ($3.5 \leq M \leq 4.0$) because the average is 3.59 and aspects of Student Worksheets are classified as reliable because the reliability score is 0.89 (≥ 0.75) thus, this Student Worksheet can be used with minor revisions.

The validation of Learning Outcomes Test (THB) learning device is described in Table 3.

Table 3. Expert Validation Results of Learning Outcomes Tests

No .	*Assessment Aspects*	*X*	*Validation*
1	Instructions Aspect	3.84	Very Valid
2	Coverage Aspects of the Questionnaire Components	3.81	Very Valid
3	Language Aspects	3.75	Very Valid
	Realibility	0.90	Reliabel

The aspects that are considered in the Learning Outcomes Test (THB) validation are the aspects of the instructions, the coverage aspects of the questionnaire

components and the language aspects of the Learning Outcomes Test (THB) can be seen in Table 3.

Based on table 3 above, it shows that all aspects of the Learning Outcomes Test (THB) are considered very valid ($3.5 \leq M \leq 4.0$) because the average is 3.80 and the Learning Outcomes Test (THB) are classified as reliable because the reliability score is 0.90 (≥0.75) thus the Learning Outcomes Test (THB) can be used with minor revisions. A valid and reliable learning outcome test (THB) is used to measure the cognitive learning outcomes of students. There is a correlation between student learning outcomes and metacognitive awareness (Fitria, L., Jamaluddin, J., & Artayasa, I. P., 2020), so that student learning outcomes can be used as a benchmark that shows their metacognitive abilities.

After all the validation processes for learning devices have been carried out, limited trials are carried out to obtain data on the practicality and effectiveness of the developed learning devices. Practicality data were obtained from observations of the implementation of learning devices in the classroom, while the effectiveness data were obtained through (1) giving learning outcomes tests, (2) observing student activity during the limited trial process, (3) students' responses to the learning process.

Practicality analysis was carried out to determine the level of practicality of the learning devices that had been tested. The results of the analysis can be seen in the observation of the learning syntax implementation as follows.

Table 4. Observation Results of Learning Syntax Implementation

No	Observational Aspects	Observation result				Average
		Lesson Plan 1	Lesson Plan 2	Lesson Plan 3	Lesson Plan 4	
1	Delivering learning indicators (basic competencies and indicators) and providing motivation	2	2	2	2	2
2	Providing students orientation to the problem	2	2	2	2	2
3	Organizing students to learn	2	2	1.5	2	1.88
4	Guiding individual and group investigations	2	1.5	2	2	1.88
5	Developing and presenting the work	2	2	1.5	2	1.88
6	Analyzing and evaluating the problem solving process	2	2	2	2	2
7	Giving awards to the best students / groups	2	2	2	2	2
8	Class situation	2	2	2	2	2
	Observation average	2	1.94	1.87	2	1.96

Generally, table 4 above shows that the average observation of problem-based learning syntax is 1.96. This score is in the $1.5 \leq M \leq 2.0$ interval, it means that the learning syntax is carried out entirely.

The effectiveness analysis was carried out to determine the level of effectiveness of the tested devices. The data from the observation of students' activities in following the learning process in the classroom which consists of aspects (1) providing students with orientation to problems, (2) organizing students to learn, (3) guiding individual and group investigations, (4) developing and presenting work, (5) analyzing and evaluating the problem-solving process. Observations were made by one observer and carried out during the learning process. Problem Based Learning (PBL)-based learning model can develop students' thinking skills because by using the PBL model, students are invited to think critically and logically as well as develop independent, confident focus on challenges that make students think at a higher level, develop their metacognitive abilities to find solutions of problems (Lestari, H.N., Suganda, O., & Widiantie, R., 2017).

The results of the students' activities analysis in the trial can be described in the following bar chart.

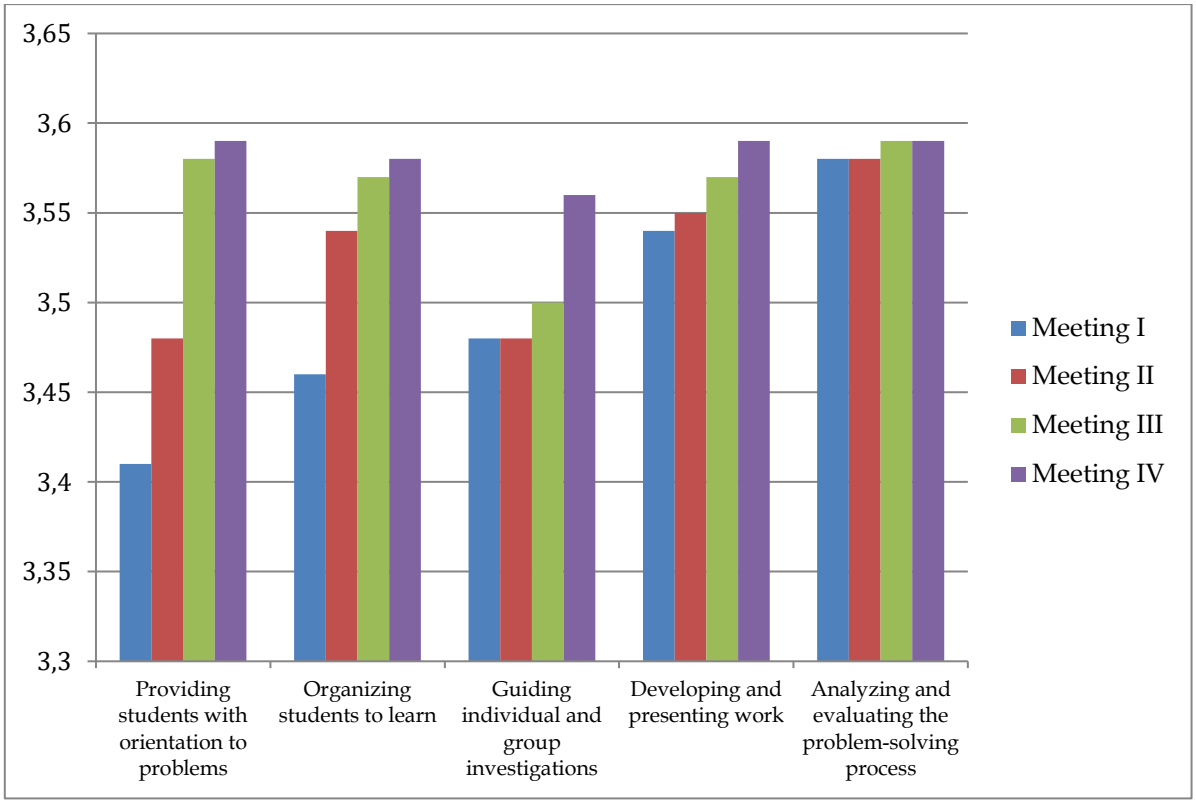

Figure 1. Results of Student Learning activities

Generally, it can be argued that in the trials above, all aspects observed had a high frequency and percentage. It means that the activities of students were as expected and the learning activities of students increased.

The learning device developed is valid if the results of the validator's research shows overall score of the minimum aspects is in valid enough category and the value for each minimal aspect is valid category. Thus the learning devices developed have been based on strong theoretical rationale and have internal consistency. Validity

analysis results of the learning devices which include the Lesson Plan (RPP), Student Worksheets (LKPD) and the Learning Outcomes Test (THB). The validation score is within the interval limit ($3.5 \leq x \leq 4$), which means that the average the whole validated learning devices are "very valid" category, and the reliability criterion of the instrument is declared reliable if the reliability value (R) is ≥ 0.75. In this study, the instrument used was in the reliable category, with its reliability value (R) ≥ 0.89

Revisions that must be made to learning devices that have been developed are in accordance with the suggestions and input from validator, these are clarifying the editorial of sentences in student worksheet (LKPD). Based on these suggestions and input, revisions were made to the intended learning device, so that the learning device could be used in the research trial phase.

Learning devices are practical if the results of observations of the learning implementation in the classroom are fully implemented category (Nieveen, 1999 in Jaeng, 2007). Based on the results of observations by the observer, it was stated that the score of the learning devices implementation was as expected because all the instrument components of the assessment were carried out entirely with an average score of 3.82 with a reliability score of 100%. Thus the learning device developed is practical. Learning devices are effective if (1) at least 85% of students complete the KKM (Minimum completeness criteria) with individual completeness ≥ 73. (2) student activities are as expected, (3) more than 50% of students give a positive response to the learning process and student worksheet (LKPD).

Based on the results of the student learning outcomes analysis it is known that 13 students in the experimental class completed with an average score of 90.38 and 17 students in the control class completed an average score of 80.00. Furthermore, the results of the N-Gain analysis in the experimental class show that the students' scores are generally distributed in the high category with a score of 0.77 based on Meltzer (2002) which states that the distribution of gain scores g> 0.7 is in the high category and the percentage is 77 30% of the effective category based on Hake, RR, (1999) stated that the category of effectiveness of the N-Gain range> 76 was in the effective category. The results of the N-Gain analysis score in the control class are in the moderate category with a score of 0.56 based on Meltzer (2002) which states that the distribution of the gain score of $0.3 \leq g \leq 0.7$ is in the moderate category and the percentage is 56.02% in the sufficient effective category based on Hake, RR, (1999) that the category of effectiveness of N-Gainrange 56-75 was categorized as quite effective. Based on the results of this analysis, it is concluded that the learning completeness aspect is effective.

The average score of student learning outcomes is 85.19. It means that qualitatively this score is categorized as high. It must be related to the conditions of learning that have been carried out. Furthermore, fun learning according to the results of research by Meier (1999) in Tahmir (2008) can significantly improve learning outcomes.

The results the students' responses analysis to student worksheet (LKPD) shows that 94.50% gave a positive response. Based on the results of this analysis, it can be concluded that the responses of students to LKPD is effective. The high positive response of students to the learning process and learning devices developed is caused by the learning situation that leading students to actively participate in learning activities both in learning teaching materials, constructing knowledge and carrying out the tasks set out in the LKPD. In addition, the analysis of the results of the teacher's response to the LKPD also shows a positive response of 95.20% so that it could be concluded that the teacher's response to the LKPD is effective. From all the aspects that have been stated above (aspects of completeness of learning outcomes, aspects of student activity, aspects of student responses) based on the results of the analysis of each aspect, it is concluded that the learning devices developed are effective in supporting the metacognitive abilities of students and helping students in solving problems.

Based on the research results, test the validity, effectiveness and practicality of problem-based learning tools that have been developed to support students' metacognitive abilities and help students solve problems. This can happen because according to Listiana, L., Daesusi, R., & Soemantri, S. (2019) that the application of metacognition in biology learning has a very big influence in improving higher-order thinking skills, namely problem solving, decision making, thinking skills, critical and creative thinking of students

Conclusion

The process of learning biology is a complex process regarding the problem and requires deep thinking skills to understand it. Students who are aware of their thinking activities have metacognitive abilities. Metacognitive abilities are needed by students in problem solving. To support the metacognitive ability of students in solving problems, Problem Based Learning-based learning tools were developed. Development of learning tools based on problem-based learning on biodiversity material for class X which consists of Learning Implementation Plans (RPP), Student Worksheets (LKPD) and Learning Outcomes Tests (THB). The results of validation and testing show that the learning tools are valid, practical and effective so that the learning tools developed are able to support students' metacognitive abilities and problem solving abilities.

Acknowledgment

Thank you to the principal of SMA Negeri 1 Batudaa Pantai Mrs. Srito A. Musa, M.Pd and the Biology Teacher at SMA Negeri 1 Batudaa Pantai Mrs. Sri Rahayu C. Panai, S.Pd for helping and facilitating this research so that this research goes very well and smooth.

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