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The development of students worksheet on immune system topic based on PBL

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ABSTRACT

The immune system is a biological topic that is commonly discovered in daily life. This study aims to develop Problem Based Learning-based student worksheets on immune system material for SMA/MA that are valid and practical which is crucial to enhance student's problem-solving skills. This type of research is development research, using 4D-Models. The instruments of this research are teacher interview sheet, validity test questionnaire sheet and practicality test questionnaire sheet. The worksheet was validated by two lecturers of the Department of Biology FMIPA UNP and one biology teacher of MAN 2 Padang City. Worksheet was tested on one biology teacher of MAN 2 Kota Padang and 36 students of class XII IPA 9 MAN 2 Kota Padang to test the practicality of the developed product. The object of research is Problem Based Learning based worksheet on immune system material for SMA/MA. The data used are data from the validity test and the practicality test. The data analysis technique is qualitative analysis for the define and design stages while quantitative analysis for the develop stage. Based on the research that has been done, the average validity value is 86.48% (valid). Practicality test of worksheet by teachers obtained results of 90.62% (very practical) and practicality test of worksheet by students obtained results of 94.31% (very practical). It can be concluded that the Problem Based Learning-based student worksheet on immune system material for SMA/MA developed is valid and very practical.

Keywords: Immune system, problem based learning, student worksheet

INTRODUCTION

Problem-solving skills are one of the most essential aspects of studying science (Norman, 1988; Syafii & Yasin, 2013). One of the learning models that can be integrated to develop students' problem solving skills is the Problem Based Learning model. According to Hasanah, et al. (2018), Erwanto (2020), and Khovivah, et al. (2022), the Problem Based Learning model can be used as a solution in learning because this model helps students to deal with real problems that are close to everyday life.

One of the subjects at school that gives students an overview of real events in everyday life is biology. According to Triyanti & Nulhakim (2018), biology is a science that investigates real events that occur in nature and the relationships that exist in it. In line with that, Tanjung (2016) said, biology is learning related to how to find out and understand about nature in a structured manner so that learning biology is not only mastery of a collection of knowledge in the form of facts and concepts, but also in the form of a discovery process, so that students are required to be able to think critically. Therefore, to develop thinking skills and fulfill curiosity, an innovative media is needed in learning so that the quality of learning can improve. One of them can integrate the problem-solving learning model in a learning media.

Learning media is one of the factors that determine the success of learning in the classroom. Learning media helps teachers in presenting subject matter to students effectively (Pratama & Saregar, 2019). In addition, Istiqlal (2018) adds that the use of appropriate media will increase students' attention to the material being studied. Learning media makes, students' interest and motivation can increase and it is hoped that the learning process will be better so that students' understanding of learning materials is more optimal. One of the learning

media that can be used to help students understand learning material is student worksheets. This is in line with the results of Danty's (2022) research which states that the use of student worksheets will involve active students in the learning process so that learning is not only centered on the teacher.

Student worksheets according to Prastowo (2014) are printed teaching materials in the form of sheets of paper containing material, summaries, and instructions for implementing learning tasks that must be carried out by students who refer to the basic competencies that must be achieved. Using student worksheets in the learning process, students do not just receive knowledge through teachers or other learning media such as modules and handbooks, but by using student worksheets it makes it easier for students to interact with the material provided because the student worksheet can be presented tasks and questions according to the situation of the learning activities at hand.

Based on observations made by researchers when carrying out educational field practices from August to November 2022 at MAN 2 Padang City, it shows that teachers have used learning media such as power points, student handbooks, modules and student worksheets on certain materials such as cell material, plant tissues and animal tissues. Based on the results of the analysis of student worksheets used by teachers, they are still in the form of questions and filling in questions without explaining how the answer to the question is obtained. Some student worksheets provided already contain pictures but the questions are still related to the name and function of certain materials presented in a table. As a result, when answering questions on the worksheet, students only answer briefly, copying the contents of the book and their friends' opinions without including their own opinions. The inadequate student worksheets provided by the teacher have not optimized efforts to develop students' problem-solving skills which have caused the implementation of the 2013 Curriculum to not be implemented properly because the active role of students in the learning process is not optimal.

Based on the results of interviews, students still tend to be passive and less active in the learning process. In addition, the results of the interview with biology teacher also said that in the material of the immune system, the learning process is often not optimal due to the limited time of the material which is in the last chapter of learning. The teacher's effort in overcoming these time constraints is to give assignments such as taking notes and answering questions in the students' handbooks. However, the efforts made by the teacher do not necessarily achieve learning objectives because it is only limited to taking notes and doing assignments that students can get by copying their friends' opinions. If this continues, learning will not be achieved in accordance with the learning objectives.

The immune system is one of the important subjects in biology. Immune system material is a material with a very broad learning object and is often found in real life such as when the body is attacked by disease. In the material of the immune system, there are many interesting facts and need the right way of learning to shape students' understanding, so teaching materials are needed that can attract the attention of students so that the learning process in this material can run optimally. Therefore, it is necessary to design and develop learning media using student worksheets with a problem-solving learning model so that students' understanding of the material and students' problem-solving skills can increase. Based on the problems found, the research on development of problem based learning-based student worksheet on immune system topic was conducted.

METHOD

This study is a research and development study, using the 4D development model limited to 3D. This research was conducted at the Department of Biology FMIPA UNP and MAN 2 Padang City. The implementation time is June-August 2023. The product is a problem-based

learning worksheet on immune system material that has been tested on teachers and students of class XII MAN 2 Padang City odd semester of the 2023/2024 academic year.

The subjects of this study were 36 students of class XII IPA 9 MAN 2 Padang City. The object of this research is a problem-based learning worksheet on immune system material. Problem-based learning worksheets were validated by two lecturers majoring in Biology FMIPA UNP and one Biology teacher MAN 2 Padang City.

This research data comes from the results of interview sheets, validity questionnaires and practicality. The instruments used to collect data are interview sheets, validity questionnaires and practicality questionnaires. There are 4 aspects measured in validity according to Depdiknas (2008) including content, language, presentation and graphical feasibility. The validity and practicality test questionnaires were arranged based on a Likert scale with 4 alternative answers as follows.

STS = strogly disagree with weight 1
TS = disagree with weight 2
S = agree with weight 3
SS = strogly agree with weight 4

The student worksheet was developed using the 4-D model developed by Thiagarajan (1974), which consists of define, design, develop and disseminate stages. Due to time constraints, this research only reached the develop stage.

Define

This stage is carried out to determine and define the requirements of the student worksheet. This stage includes 5 main steps, namely (a) front-end analysis; (b) learner analysis; (c) task analysis; (d) concept analysis; dan (e) specifying instructional analysis.

Design

This stage is carried out to design a prototype or draft of the student worksheet to be developed. This stage consists of 3 steps, namely: (a) media selection; (b) format selection; dan (c) initial design.

Develop

a. Student worksheet validity test

The validity test aims to evaluate the student worksheets that have been developed. This test was carried out by checking the suitability of the student worksheet with the 2013 Curriculum, content aspects, linguistic aspects, presentation aspects, graphical aspects and the application of the problem-based learning model. The validity test was carried out by two lecturers majoring in Biology FMIPA UNP and one Biology teacher MAN 2 Padang City. Validators who are willing to validate the student worksheet can be seen in Table 1.

Table 1. Validator name list

No	Name	Description
1	Dr. Heffi Alberida, M.Si	Lecturer of Department of Biology FMIPA UNP
2	Relsas Yogica, M.Pd	Lecturer of Department of Biology FMIPA UNP
3	Murniwati, S.Pd	Biology Teacher MAN 2 Padang City

Data from the validity test results of the student worksheet is obtained based on the formula.

$$Percentage\ of\ validity = \frac{Total\ score}{The\ highest\ score}\ x\ 100\%$$

The validity score given is modified from Purwanto (2009), namely:

90%-100% = very valid
80%-89% = valid
60%-79% = moderately valid
0%-59% = not valid

Student worksheets that meet the valid criteria will then be tested for practicality in terms of the feasibility of the student worksheet.

b. Student worksheet practicality test

The practicality test aims to determine the level of practicality of the student worksheet when used in the learning process. The practicality test was carried out by giving a questionnaire to one biology teacher of MAN 2 Padang City and 36 students of class XII IPA 9 MAN 2 Padang City.

Data on the results of the practicality test of the width of the learner's work is obtained based on the formula.

$$Percentage\ of\ practicality = \frac{Total\ score}{The\ highest\ score}\ x\ 100\%$$

The percentage of data obtained will be grouped according to the criteria modified from Purwanto (2009) as follows.

90%-100% = very practical

80%-89% = practical

60%-79% = practical enough

0%-59% = impractical

If the student worksheet produced is valid and feasible to use, then development can be carried out.

RESULTS AND DISCUSSION

The define stage

a. Front-end analysis

At this stage, researchers conducted interviews and document analysis of student worksheets made by biology teachers at MAN 2 Padang City. Based on the results of the interview, it was revealed that the learning process had not used the Problem Based Learning model, the teacher had tried to use the lecture, discussion, and question and answer methods. The results of interviews with teachers mention the material that has not been optimal in the learning process is the immune system.

Based on the results of the analysis of student worksheets used in Biology learning only on certain materials and contains questions that are memorized so that it causes a lack of problem solving skills in students. In the material of the immune system, there is no worksheet for students that can help teachers.

b. Student analysis

Analysis of students is obtained from the results of interviews with biology teachers. The results of the analysis obtained by students are less actively involved in the learning process. This can be used as an illustration to develop Problem Based Learning based Learner Worksheets to support learner involvement in learning.

c. Task analysis

This analysis is carried out by identifying and analyzing Core Competencies, Basic Competencies, Competency Achievement Indicators based on the 2013 Curriculum Competency standards to determine and detail the material and tasks on the worksheet, so that the developed worksheet can help students in the learning process.

d. Concept analysis

Concept analysis is done by identifying the main concepts in the immune system material. The concepts are arranged systematically so that they are easily understood by students. Concept analysis is carried out by adjusting between core competencies (KI), basic competencies (KD), indicators, objectives and learning materials whether in accordance with the 2013 Curriculum.

e. Specifying instructional analysis

The analysis of learning objectives is carried out by summarizing the results of task and concept analysis which are adjusted to the learning objectives in Curriculum 2013: (1) Learners can explain the function of antigens and antibodies in body defence, (2) Learners can explain the structure of cells/tissues related to the body's defence system, (3) Learners can analyse the mechanism of body defence in humans, and (4) Learners can analyse the types of immunisation, how they are provided and their purposes and conduct a campaign on immunisation programmes.

The design stage

Learner worksheets are designed using the Canva application. The components of problem-based learning worksheets on immune system material include cover, author identity sheet, learner identity, preface, table of contents, list of images, Problem Based Learning stages, instructions for use, competency review, concept map, activities carried out based on problem-based learning stages and bibliography.

Figure 1. Student worksheet cover display

Figure 2. Problem based learning stages on student worksheet.

The develop stage

a. Validation of student worksheet

This research produces Problem Based Learning-based student worksheets on immune system material. The resulting student worksheet is valid. There are 4 aspects measured in validity according to Depdiknas (2008) including content feasibility, language, presentation and graphics. The results of the validity test can be seen in Table 2.

Tabel 2. Validity test results by validators

No	Aspects	Validity Score (%)	Criteria
1	Content Feasibility	85.71	Valid
2	Language	91.7	Very Valid
3	Presentation	85	Valid
4	Graphics	85	Valid
5	Components of Problem Based Learning Model	85	Valid
	Average	86.48	Valid

The results of the validity test data analysis show that the Problem Based Learning-based student worksheet developed has met the valid criteria with an average validity value of 86.48%. In terms of content feasibility, the value of 85.71% is classified as valid. This means that the material in the Problem Based Learning-based student worksheet is in accordance with the 2013 Curriculum and in accordance with the Core Competencies and Basic Competencies which are translated into learning indicators and in accordance with the needs of students and the needs of learning media. The valid criteria on the students' worksheet also indicate the correctness of the substance of the material on the students' worksheet is good. This is in line with Fajri's (2018) research, good and correct teaching materials are teaching materials that are in accordance with the Curriculum, KI, KD and in accordance with the characteristics of students.

In terms of linguistic aspects, the score was 91.7% so that the resulting worksheet was classified as very valid. This means that the language selection and sentences used in the worksheet are clear, good and do not cause difficulties so that the learning material is easily understood by students. This is in accordance with Depdiknas (2008) which explains to pay attention to the use of easy language, clear sentences and not too long and structured so that it is easy to read.

Regarding of presentation aspect, it obtained a value of 85% so that the worksheet of students produced was classified into valid criteria.

This shows that the worksheet of students produced has contained indicators and is in accordance with the learning objectives to be achieved so that it makes it easier for students to learn in a directed manner. In accordance with Depdiknas (2008) where the presentation aspect consists of the title, student learning instructions, competencies to be achieved, supporting information, tasks and work steps and assessment.

In terms of the graphic aspect, a value of 85% was obtained so that the resulting student worksheet was classified into valid criteria. This shows that the design of the student worksheets developed is good and interesting and has used the appropriate and appropriate fonts. The appearance of the students' worksheets, the systematic layout, the images used in the students' worksheets look attractive and the selection of colors is appropriate. Ilmi & Trimulyono (2018) explain that interesting teaching materials and appropriate color selection can cause students to feel happy in learning so that students' motivation to learn can increase.

Regarding of the components of the Problem Based Learning model, a value of 85% was obtained so that the resulting student worksheets were classified into valid criteria. These results show that Problem Based Learning-based student worksheets meet the activities of orienting students to the problem, organizing students to learn, guiding independent and group investigations, developing and presenting work and analyzing and evaluating related problem-solving solutions that have been carried out. In line with the opinion of Lase & Lase (2020) Problem Based Learning or learning based on problems is learning that presents problems and involves students actively in solving these problems so that students can gain knowledge and skills.

Based on the value of the five aspects of the validity test above, the overall validity value of 86.48% is classified as valid. This indicates that the Problem Based Learning-based student worksheet on immune system material for SMA/MA is valid and can be carried out to the next stage, namely the practicality test.

b. Practicality of student worksheet

The practicality test stage was carried out on teachers and students. There are 4 aspects measured in the practicality test which consist of ease of use, effectiveness and efficiency of learning time, attractiveness and benefits of Problem Based Learning model-based student worksheets. The results of the calculation of the practicality value by teachers and students can be seen in Table 3.

Tabel 3. Practicality test results by teachers and students.

No	Aspects	Result	
		Teacher	Students
1	Ease of Use	91,67% (Very Practical)	94,44% (Very Practical)
2	Effectiveness and Efficiency of Learning Time	83,33% (Practical)	92,59% (Very Practical)
3	Attractiveness	100% (Very Practical)	96,18% (Very Practical)
4	Benefits of Problem Based Learning model-based student worksheets	87,5% (Very Practical)	94,02% (Very Practical)
	Average	90,62% (Very Practical)	94,31% (Very Practical)

The results of the data analysis of the practicality test based on the criteria such as ease of use, effectiveness and efficiency of learning time, attractiveness, and benefits showed that the Problem Based Learning-based student worksheet developed had met the practical criteria with an average practicality score of 90.62% for teachers and 94.31% for students. In terms of ease of use, the value obtained was 91.67% by teachers and 94.44% by students so that it was classified into very practical criteria. This means that the student worksheet is considered practical and easy to use by teachers and students because it is presented clearly and simply by using an easy-to-read font size and type. This is in accordance with the opinion of

Marlina et al. (2021), student worksheets that use clear language and do not cause doubts or multiple interpretations make it easier for students to understand the content.

In terms of the effectiveness and efficiency of learning time, a score of 83.33% was obtained by teachers with practical criteria and 92.59% by students with very practical criteria. This shows that the student worksheets developed can be used in learning so that they are more effective and time efficient. This is in accordance with the opinion of Susanti et al. (2017) which states that student worksheets make it easier for teachers because they can make learning time efficient and easier to use, so that the teacher's role as a facilitator can run well.

In terms of attractiveness aspects, a score of 100% was obtained by the teacher and 96.18% by students so that it was classified into very practical criteria. Problem Based Learning-based student worksheets have an attractive appearance for students, colorful images and are in accordance with the activities of the Problem Based Learning model which are arranged systematically. This is in line with the opinion of Haryana et al. (2022), who say the use of colors, images and designs that vary on student worksheets gives attractiveness and arouses students' interest in learning.

In terms of the benefits of Problem Based Learning-based student worksheets, the scores of 90.62% by teachers and 94.31% by students were obtained in the very practical category. This shows that Problem Based Learning-based student worksheets can help students in learning and improving problem solving skills and student learning motivation. In line with the opinion of Zaraturrahmi et al. (2016) who said that by using Problem Based Learning-based student worksheets motivation, learning outcomes and student responses can increase on the material studied. Problem-based learning worksheets for teachers can help ease the teacher's workload in explaining the material, making it easier for teachers to supervise student activities and help teachers explain individual and group guidance in learning. In line with the purpose of preparing teaching materials according to Depdiknas (2008), namely teaching materials are prepared with the aim of making it easier for teachers to carry out learning.

From the four aspects of the practicality test, overall, the average result of the teacher is 90.62% and the average of students is 94.31% with very practical criteria. Furthermore, Helendra & Sari (2021) said that learning devices that qualify as very practical indicate that all components of the learning devices developed in this study are suitable for implementation in the classroom learning process. In addition, the results of this study are also in line with previous research with various subject matter (Isrokijah, 2015; Puspasari, & Puspasari, 2019; Maulidiya, & Mercuriani, 2023).

Based on the results of the validity test analysis and the practicality test of the student worksheet that has been carried out, it is known that the Problem Based Learning-based student worksheet on immune system material for SMA /MA developed is valid and very practical. So that this student worksheet can be used as a solution to overcome the problems in this study.

CONCLUSION

Problem-based learning students' worksheet on immune system material for SMA/MA is valid and very practical to be used as a medium for learning biology class XI SMA/MA. It is recommended to be able to develop Problem Based Learning based student worksheets on other biological materials.

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