KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

Development of Student Worksheets on Biosorbent Synthesis from Papaya Seeds (Carica papaya L) for Dye Absorption in Batik Industry Liquid Waste

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Abstract.
One of the causes of environmental pollution in Indonesia is inappropriate waste treatment, particularly batik industrial wastewater. Lack of awareness and public knowledge regarding waste management are things that support pervasive pollution. One way to educate students about this issue is through worksheets that teachers can use to teach how to treat waste properly and correctly. This study aimed to describe the arrangement of student worksheets and to analyze the results of a validation test. The steps used in the student worksheets on the manufacture of biosorbents from papaya seeds (*Carica papaya* l) for the absorption of dyestuffs from the batik industry's liquid waste were based on guided inquiry. The method used is Design-Based Research (DBR) in three stages: analysis, design, and development. The instruments used were a validation questionnaire using correlation analysis techniques and a student worksheet based on guided inquiry. The results of the student worksheet validation test obtained an average value of 0.80, which states that the student worksheets are valid and can be used as a medium for learning or practicum activities.

Keywords: environmental pollution, wastewater, biosorbents, papaya seeds

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Published: 3 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

1. INTRODUCTION

Environmental pollution is one of the problems that occur in the world and is not a new thing in the environment around us. There are so many impacts resulting from environmental pollution, such as contamination of springs, soil and air which makes the environment unhealthy [1]. Considerable pollution results from waste disposal that is not carried out in accordance with the disposal procedures [2]. There are still many people who are not aware of environmental sustainability with the presence of a lot of waste in nature. In addition, there is not enough knowledge for the public to know this. So, people think that the problem of pollution due to this waste is a common

thing. Therefore, education is needed for the community that it is necessary to study waste management so as not to pollute the environment [3]. Education about waste management can be done by teachers through learning. Therefore, teacher graduates are needed who understand the science of proper and correct waste management for the natural environment [4].

So far, several companies have carried out waste treatment to minimize the impact of the waste pollution by using adsorbents from synthetic materials [5]. However, the use of adsorbents with synthetic materials results in re-waste and new problems for the environment [6]. Therefore, natural materials are needed that can be used as adsorbents to overcome the waste treatment [7].

The use of natural adsorbents or often called biosorbents can be used as an alternative for the community to overcome environmental problems by learning how to process them. So, we need learning media that can be used by teachers to assist learning in studying waste treatment with biosorbents, one of which is a worksheet [4].

Many studies have discussed LK about environmental pollution, such as research conducted by Khusna et al., [4], regarding the use of LK in waste processing. In addition, the research conducted by Latifah [8] is regarding the development of guided inquiry-based worksheets for environmental pollution due to household waste. The research conducted by [9] is the development of an inquiry-based worksheet for qualitative analysis of heavy metals in laboratory waste. However, no one has discussed pollution due to batik industrial wastewater and how to process it.

Waste is one of the major pollution problems [10]. There are two types of waste, namely organic waste and inorganic waste [11]. Organic waste is waste that comes from nature and can be decomposed by bacteria in the environment chemically. Meanwhile, inorganic waste is waste generated from environmental or human activities that are not easily or even biodegradable in nature [12].

One of the environmental activities that produce waste is industry [13]. Various types of industries produce various types of waste, starting from waste in the form of liquid, solid and even gas or air pollution. Waste can produce substances or compounds that are dangerous and toxic because they contain large enough heavy metals [14]. One of the substances or compounds that are toxic or toxic is dye in batik industrial wastewater [15].

The characteristics possessed by the batik industry wastewater are cloudy, foamy and have a pungent odor seen from their physical properties [16]. Meanwhile, if viewed from the chemical nature, the waste has the characteristics of the concentration value of BOD *(Biochemical Oxygen Demand)* which has a high pH, high pH and contains

methylene blue substances [17]. Heavy metals contained in methylene blue dye are Lead (Pb) and Chromium (Cr) derived from $PbCrO_4$ and $K_2Cr_2O_7$ [18].

Processing of batik industrial wastewater can be done using biosorbent media for dye absorption. Biosorbent is one of the media for the absorption of hazardous substances in liquid waste derived from natural or organic materials [19]. Materials that can be used as biosorbents must contain active compounds and contain carbon compounds [20].

Several natural materials have been used as biosorbents, such as the use of biosorbent from papaya seeds which was carried out in research [7], optimal results were obtained for the absorption of dyes in textile industry wastewater. Papaya seeds contain active compounds, namely flavonoids, alkaloids, tannins, saponins, anthraquinone glycosides and steroids that are able to absorb dyes in liquid waste. In addition, research conducted by [21] is the absorption of heavy metals from dyes in batik industry liquid waste using palm wood solid waste. The results showed that the dye in the batik industry liquid waste could be absorbed, but the palm wood solid waste was easily brittle when mixed.

Based on previous research, it can be concluded that papaya seeds are considered to be more effective as biosorbents for dye absorption in batik industry liquid waste compared to palm wood solid waste. This is because papaya seeds contain more active compounds and have wider pores that are able to absorb stronger dyes. Thus, the biosorbent from papaya seed waste will be used in this study. The method that will be used in this waste treatment is biosorption.

The biosorption method is an adsorption process for metal ions that utilizes biological materials by means of reduction, utilizing the active site and functional groups in the carboxyl group found on the bacterial cell wall that is able to bind to dyes [22].

Based on the study contained in the background, there has been no research that has developed a worksheet for processing batik industrial wastewater using biosorbent as a purification medium in the absorption of dyes. So that researchers need to develop student worksheets on the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater.

2. RESEARCH METHOD

The method used in this research is Design Based Research (DBR) with the aim of developing and producing a product in the form of student worksheets on the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater. The ADDIE model is used in this study as a step to be carried

out. The stages in the ADDIE model design according to Branch are as follows: 1) Analysis (Analysis); 2) Design (Design); 3) Development (Development); 4) Implementation (Implementation); 5) Evaluation [23]. However, this research was carried out only until the Development stage because in this study it only focused on LK development. The research procedure to be carried out consists of three stages, namely the analysis stage, the design stage and the development stage. Following are the steps of the procedure to be carried out:

Analysis Phase. At this stage an analysis of the problems that will be developed in the research is carried out, starting from an analysis related to the concept of waste treatment materials. Then, an analysis of relevant journals related to student worksheets, guided inquiry learning models, and the manufacture of biosorbents from papaya seeds was carried out for the absorption of dyestuffs from the batik industry wastewater.

Design Phase. This stage is in the form of a design process that will be carried out such as designing experimental procedures, tools, materials and steps that will be used on student worksheets.

Development Stage. At this stage, the preparation of student worksheets, manufacture of research instruments and validation of student worksheets on the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry liquid waste were carried out by validators (expert lecturers). The student worksheets compiled are the result of the development of references from relevant journals.

The types of data that will be used in this research are qualitative and quantitative. Qualitative data is data generated in the form of sentences or pictures. Meanwhile, quantitative data is data collected in the form of numbers or numbers that are processed with statistics. In this study, qualitative data was generated from the preparation of worksheets based on stages according to the learning model used. So as to produce a student worksheet format on the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater. Meanwhile, to produce quantitative data, a validation and feasibility questionnaire instrument was used to assess the LK that had been made. Then quantitative data is generated in the form of data from the validation test of student worksheets on the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater.

The tests carried out on this validation refer to the rating scales criteria. The results obtained in the form of data from questionnaires and student worksheets. Data collection for all measuring instruments was checked by a team of experts, namely chemist lecturers who were selected as validators for validating student worksheets. Aspects

assessed in the validation include aspects of language, materials, illustrations, and student worksheet formats [24].

After obtaining the results of the validation test, the next step is to conduct an analysis by comparing the results of the calculation of the feasibility value with the predetermined critical value. The critical value is usually used as the limiting value of a research instrument validation result with a value of 0.30 at a standard significance level of 0.05 or 5%. The feasibility value (r) is calculated using the interpretation formula proposed by Sudjana, namely r = x/NXn where r is the validation value, x = the weight of the respondents' answers, N = the number of items, and n = the number of respondents [25].

The focus of this research is the development of student worksheets that are used as learning media in the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater. The procedure for making biosorbents from papaya seeds was reviewed from several sources, namely relevant previous research journals. One of the journals used is research which describes how to manufacture papaya seed biosorbents for the absorption of textile wastewater dyes [7]. Meanwhile, in this research, a biosorbent from papaya seeds will be made for the absorption of dyes in the batik industry wastewater. Papaya seeds were washed and dried until no water remained in them, then activated using 5%, 10% and 15% H_2SO_4 solutions with the aim of biosorbents absorbing dyes. Then, the activated biosorbent was put into the batik industry waste liquid and stirred using a magnetic stirrer for 30 minutes.

3. RESULT AND DISCUSSION

3.1. Worksheet Validation Result

The student worksheets that have been compiled are validated by 3 expert lecturers. The first validator is a chemist lecturer whose job is to assess chemical content or material, while the second validator is a chemist lecturer in the field of learning who conducts an assessment for the suitability of the stages of the learning model applied in the worksheet format for waste treatment materials. The third validator is a lecturer of linguistics and worksheets, tasked with assessing the suitability of the language and the composition of the worksheet format.

The data for the validation results were obtained from filling out a validation questionnaire which had a value range of 1-5. Validation questionnaires were given to three

expert lecturers in the field of chemistry who were selected as validators to assess student worksheets on the manufacture of biosorbents from papaya seeds for dye absorption in batik industry wastewater.

The validation results obtained are r calculate (r cal) values with 14 aspects that are assessed in the validation including aspects of language, material, illustrations and student worksheet formats can be seen in Table 1.

Table 1: Aspects assessed in validation.

No	Aspects	r Cal
1.	The accuracy of the language of discourse on student worksheets is appropriate	0.86
2.	The accuracy of the material and concepts used in the worksheet is appropriate	0.80
3.	The command sentences used in reading the discourse are appropriate	0.73
4.	The command sentence used in making the hypothesis is appropriate	0.73
5.	The command sentence used to make a hypothetical answer is appropriate	0.73
6.	The language used to collect experimental data is appropriate	0.93
7.	The command sentences used to write down the objectives and principles of the experiment are appropriate	0.80
8.	Procedures are easy to find and perform	1
9.	The tools and materials used are easy to find and obtain	0.80
10.	The language used in the worksheet at the experiment stage is appropriate	0.73
11.	The accuracy of the language used to write down the observational data is appropriate	0.73
12.	The questions used in analyzing the results of the experimental data are appropriate	0.93
13.	The language used in the worksheet to make conclusions by reporting the results of the experiment is appropriate	0.73
14.	The language used in presenting the experimental results is appropriate	0.73
Average		0.80

The results obtained based on the validation questionnaire there are 5 values with r cal of 0.73, 0.80, 0.86, 0.93, and 1. Based on the results of the validation test, it can be stated that the lowest r cal value is 0.73 while the r cal value is the highest is 1. The average value of r cal obtained from the validation results is 0.80. The results obtained from the validation test stated that the highest r cal value was 1 which was located at the stage of collecting data, namely the statement “The experimental procedure used can be easily understood and carried out”, then the selected experimental procedure can be used and carried out easily by students. The results of the validation test with an r cal of 0.93 are located at the stage of analyzing the experimental data with the statement

"Problems are made easy to understand and answer", thus the validator's response is good to questions made to assist students in analyzing experimental data. So the questions made can be used in student worksheets on the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater.

The results of the validation test with an r cal of 0.86 are in the orientation stage, namely "the discourse that is made is in accordance with the objectives to be achieved in the experiment". Based on the r cal value obtained, the discourse can be used in the worksheet as basic information that is used to help work on student worksheets.

In the validation test results with a value of 0.80 obtained at the stage of collecting data with the statement "the tools and materials used are easy to obtain and use", judging from the validator's response, the tools and materials used for the experiment are relatively easy to obtain. The results of the validation test with the lowest value were obtained at 0.73 at the stage of drawing conclusions with the statement "Withdrawing conclusions by making experimental reports is easy to do", thus making experimental reports can be carried out for the stage of drawing conclusions on student worksheets. After obtaining the results of the validation test, namely the assessment and suggestions from the validator, the next step was to revise the student worksheet on the manufacture of biosorbent from papaya seeds for the absorption of dyestuffs from the batik industry wastewater.

The results of the validation test with an average r cal value of 0.80 can be declared valid because r cal > critical is in accordance with the statement Sudjana, namely r Observe is 0.80 while critical is 0.3 [25].

3.2. Preparation of Student Worksheet

The preparation of this student worksheet begins by analyzing the concepts and materials that will be used in the form of waste treatment. The stages in this research refer to the ADDIE research model but only reach the development stage because this research only focuses on developing worksheets.The display of the worksheet that will be developed refers to the learning model that will be used, namely guided inquiry with the following stages: 1) Orientation; 2) Formulate the problem; 3) Conducting hypotheses; 4) Collecting data; 5) Analyze data/verify results; 6) Draw conclusions [8]. The orientation stage contains a discourse about the phenomenon of waste pollution and its handling. Meanwhile, the next stage contains questions according to the stages of the guided inquiry learning model.

The student worksheets that have been compiled are validated by 3 expert lecturers. The advice given by the validator is that the written discourse should be shorter, in writing the observation table it is better not to provide an observation table, and drawing conclusions is enough just to make a report. Thus the researchers improved the appearance of the worksheet based on suggestions from the validator, namely as follows:

Discourse is corrected by summarizing. In the discourse there is an explanation of the phenomenon of environmental pollution by waste, how to treat waste, and materials that can be used as waste treatment media.

In the observation phase, the command to make an observation table and eliminate the table is to “Write down observation data on making biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater by making observation tables for organoleptic tests, pH values and changes that occur at each stage of the experiment. !”.

In the conclusion drawing phase, it is corrected by deleting the presentation order in front of the class, replaced with an order for making an experimental report. “Make a report on the results of the experiments you have done!”

Based on this study, the composition and appearance of student worksheets on the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater are as follows.

3.3. Identity of Student Worksheet

The identity of the student worksheet consists of the title, student identity column, practicum objectives, subject matter and instructions. The written title is a student worksheet on the manufacture of biosorbent from papaya seeds for the absorption of dyestuffs from the batik industry wastewater. In addition, the student identity column contains the name, group, practicum date, and class. The purpose of including the identity of this LK is to have a sign or characteristic of individuals or groups in the ownership of the LK and the didactic requirements in the preparation of the LK to help pay attention to the differences of each individual or group [26]. The student worksheet identity display can be seen in Figure 1.

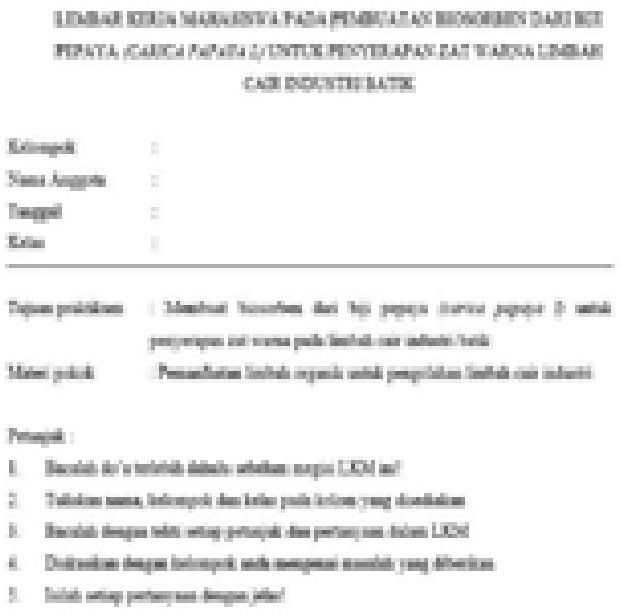

Figure 1: Display of identity sheet.

3.4. Discourse on Student Worksheet

Discourse is a structured language unit that is presented in a complete, orderly and meaningful way that is conveyed both in writing and orally [27]. The purpose of the discourse on this worksheet is to provide information about the phenomenon of environmental pollution by batik industry wastewater [28]. The information contained in the discourse regarding papaya seed waste can be useful for processing batik industrial wastewater.

The discourse in the first paragraph contains information about the many benefits of papaya fruit and the phenomenon of the abundance of papaya fruit in Indonesia. Meanwhile, the second paragraph contains the content and benefits contained in papaya seeds in the form of flavonoids, alkaloids, glycosides that can function as biosorbents. The discourse in the third paragraph explains information about biosorbents which are media that can be used for industrial wastewater treatment. The explanation of the method used in industrial wastewater treatment using biosorbent is biosorption. The last paragraph explains the phenomenon of batik industry wastewater pollution which causes natural damage because it contains hazardous substances such as heavy metals that are not easily decomposed by nature. In addition, there is an explanation regarding the processing of batik industrial wastewater before it is channeled into nature or rivers. The display of the discourse on student worksheets can be seen in Figure 2.

Bacalah dengan seksama wacana dibawah ini!

Coba perhatikan gambar disamping merupakan gambar buah yang sering kita gunakan di kehidupan sehari-hari yaitu buah pepaya. Buah pepaya sudah terbukti banyak sekali manfaat bagi kesehatan jika mengkonsumsinya, namun bagian apa sih yang sering digunakan? Sering dijumpai bahwa pepaya hanya digunakan daging buahnya saja yang mengakibatkan kulit dan bji pepaya menjadi sampah. Pada tahun 2014 Indonesia merupakan penghasil buah pepaya yang cukup besar yaitu 840,112 ton/tahun. Dengan begitu, semakin banyak penumpukan sampah atau limbah kulit dan biji pepaya.

Namun, tak hanya daging buahnya saja yang dapat digunakan tetapi banyak hal yang dapat dilakukan untuk mengurangi limbah biji pepaya. Biji pepaya merupakan sampah pertanian yang bisa dijadikan sebagai biosorben dengan biaya yang sangat murah. Nilai ekonomis dari limbah biji pepaya sampai saat ini masih sangat kurang efesien, padahal biji pepaya mengandung beberapa senyawa-senyawa aktif seperti alkaloid, flavonoid, glikosida antrakinon, tanin, triterpenoid/steroid, dan saponin.

Biosorben merupakan suatu zat padat yang dapat digunakan untuk menyerap komponen tertentu dari suatu fasa fluida. Biosorben dapat dibuat dari bahan yang mengandung karbon. Biosorben sangat banyak digunakan dalam skala industri sebagi purifikasi atau pemisahan gas atau cairan dan juga sebagai katalis maupun katalis pedukung.

Berbicara dengan industri, coba kalian perhatikan gambar yang merupakan pencemaran lingkungan yang dihasilkan dari limbah cair industri batik. Limbah cair industri batik merupakan salah satu masalah pencemaran lingkungan yang cukup besar dikarenakan mengandung logam berat yang terdapat pada zat warna yang digunakan dalam proses produksi. Permasalahan limbah cair industri batik dapat diatasi dengan penggunaan biosorben, salah satunya adalah biosorben dari biji pepaya. Pengolahan limbah cair indutri batik dengan biosorben dapat digunakan prinsip kerja dari biosorpsi dengan metode filtrasi.

Figure 2: Display of discourse.

3.5. Formulate the Problem

The next stage is to formulate the problem. According Sugiyono, the formulation of the problem is a question that seeks answers by collecting data in the form of various problem formulations based on research [24]. So the formulation of this problem is made to assist students in conducting research and as an important stage in research. At this stage students are required to be able to make a problem formulation from the

information that has been obtained from the available discourse [29]. The display for formulating problems on the worksheet is shown in Figure 3.

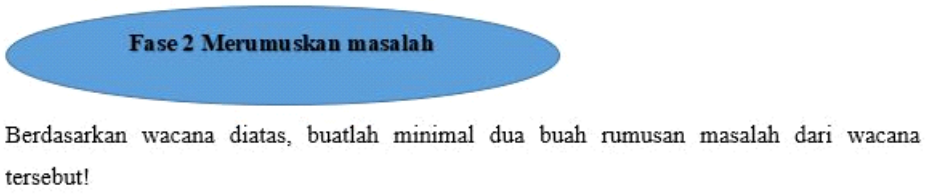

Figure 3: Display of figure out the problem.

3.6. Formulate the Hypothesis

At this stage, an order is presented to create a hypothesis which is a temporary answer to the problem formulation that has been made by students. Creating a hypothesis is an important element in scientific research that functions to test theories, encourage the emergence of theories, explain phenomena, as a guide to direct research and provide a framework for drawing conclusions that will be generated [24]. The display of making hypotheses on student worksheets can be seen in Figure 4.

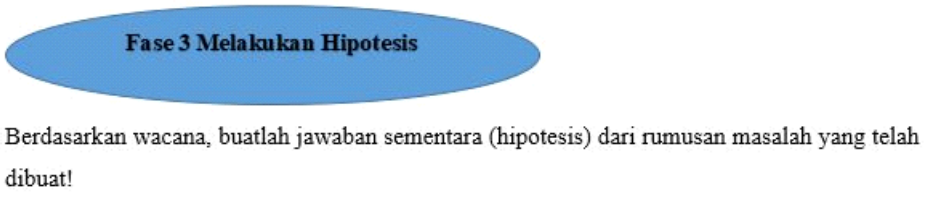

Figure 4: Display of making hypothesis.

3.7. Collect the Data

The stage of collecting data is the fourth stage that must be done by students on student worksheets. Collecting data in research is an important part of the process by which researchers look for data from primary and secondary sources for later analysis, either by conducting practicum or other ways to produce conclusions and become results [30].

At this stage, several instructions are presented for students to carry out practical activities. The data collected in the form of experimental objectives, experimental principles, tools, materials used in the experiment, experimental procedures and observational data. The results of the experiment will be recorded in the observation table to

make it easier for students to go to the next stage, namely analyzing data. The display for the data collection stage can be seen in Figure 5(a).

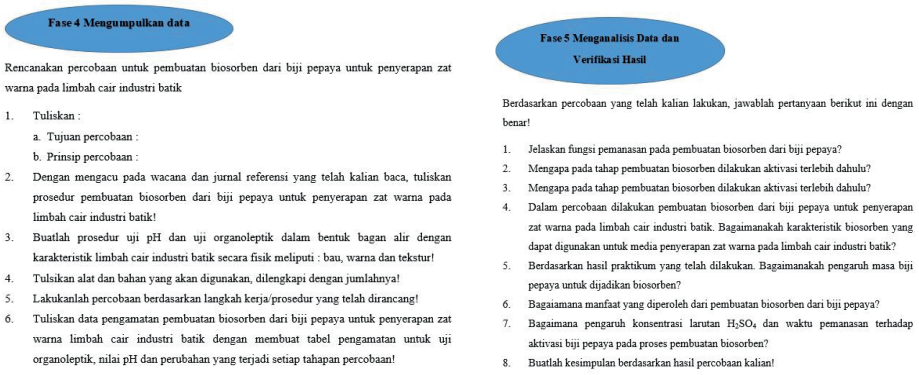

Figure 5: Display of collect the data (a), and analysis the data (b).

3.8. Data Analyze

At the stage of analyzing the data, several questions were presented regarding the experiments that had been carried out at the stage of collecting data. Data analysis is a method or way to process data into information so that the characteristics of the data become easy to understand and also useful for finding solutions to problems, especially problems contained in a study [24].

In this data analysis stage, students are expected to be able to analyze the experimental data that has been obtained by referring to relevant sources or references regarding the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater. The display for this stage can be seen in Figure 5(b).

3.9. Draw a Conclusion

The stage of drawing conclusions is the last stage in conducting research, which serves to summarize the final results of a study that can be used as the basis for formulating research decisions or as a reference for further research [30]. At this stage a statement of instructions is given to draw conclusions from the results of the experiments that have been carried out by making an experimental report according to a predetermined format as shown in the worksheet shown in Figure 6.

Figure 6.

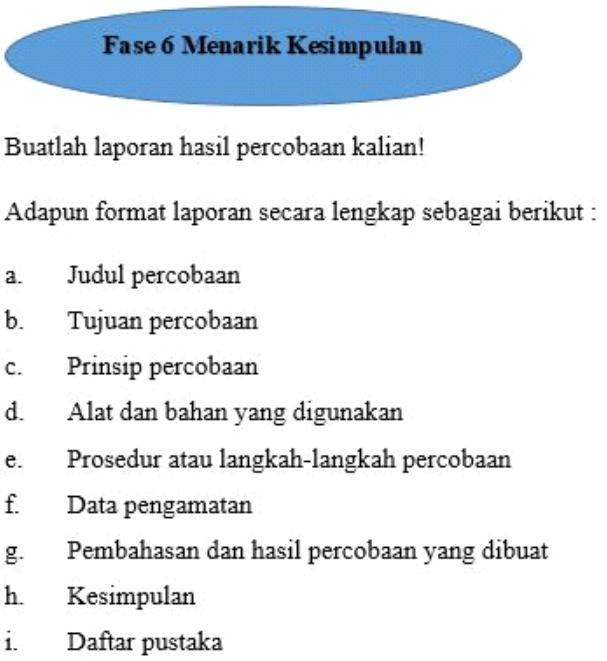

Figure 6: Display of draw a conclussion.

4. CONCLUSSION

The development of student worksheets on the manufacture of biosorbents from papaya seeds for dye absorption in the batik industry wastewater was carried out in several stages, starting from analyzing the concept of waste treatment materials, analyzing relevant journals on how to make biosorbents from papaya seeds, analyzing how to treat wastewater. batik industry using biosorbents, step-by-step analysis on guided inquiry-based worksheets and finally student worksheet validation tests.

In order to obtain the appearance of the worksheet in accordance with the stages of guided inquiry, namely 1) orientation containing discourse about the phenomenon of environmental pollution and its prevention, 2) formulating problems in the form of problems contained in the worksheet discourse, 3) making hypotheses, namely temporary answers from the problem formulations that have been made, 4) collect data, at this stage several statements are presented to assist students in collecting data on an experiment, 5) analyze data in the form of the results of experiments that have been carried out by being given several questions regarding the manufacture of biosorbents from papaya seeds for the absorption of dyestuffs from the batik industry wastewater, and the last 6) draw conclusions in the form of making an experimental report.

The validation results obtained by student worksheets on the manufacture of biosorbents from papaya seeds (*Carica papaya* l) for the absorption of dyestuffs from the batik industry wastewater have an average r-value of 0.80 so that it can be stated that student worksheets can be used to assist learning in class or otherwise. in practical activities.

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