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The Innovation on Biological Learning with Science Process Skills using Student Worksheet

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***Abstract*—This study aims to develop Student Worksheets (SW) based on Science Process Skills (SPS) in ecosystem material that using a development research model that refers to the four D (4D) model initiated by Thiagarajan. This model consists of the define phase, design phase, develop stage, and disseminate stage. The subject of research is students in class X at Senior High School in Makassar city, South Sulawesi, Indonesia. The results based on the analysis of the data obtained that the first is Student Worksheets based on Science Process Skills are in the "Valid" category. The second is the practicality of Science Process skill (SPS)-based Students Worksheet (SW). After limited testing, this research showed that both teacher and student responses are in the "Very positive" category." The results of the N-Gain analysis in the experiment using the Students Worksheets based on Science Process Skills was in the" High "category. This research found that "Students Worksheets based on science process skills" could be developed in the valid, practical, and effective category. Thus, learning using Students Worksheets based on Science Process Skills comprises an innovation in Biology learning especially in Ecosystem materials.**

Keywords—innovation, student worksheets, biology, ecosystems, science process skills

I. INTRODUCTION

Quality education can be achieved if the education process is also of high quality. Improving the process of learning means an effort to build quality human resources. Thus the development of education in Indonesia must be a top priority. This is in line with the vision of education listed in Law No. 20 of 2003 concerning the National Education System, stating that the realization of the education system as a strong, authoritative social institution to empower all Indonesian citizens to develop into quality human beings, and able to respond ever-changing times. In realizing the educational goals, the efforts made by the government are to improve the quality of human resources that will build the nation. Thus education must be directed to produce human beings who are qualified, able to compete, possess good character, and have good morals.

In the learning process, students are subjects who can set themselves to be able to study well. Therefore students learn to be involved physically and mentally so that in the learning process produces not only cognitive skills but also competent or skilled in psychomotor and affective aspects or positive attitudes towards Biology subjects. For this reason, in preparing a learning experience for students, teachers not only emphasize the product but also pay attention to the aspects of the process, attitudes related to everyday life.

Based on preliminary observations made at the school regarding biology learning, it is known that students still consider Biology to be a tedious and complicated subject. They assume that Smart students can only do biology subjects. Difficulties of students learning Biology subjects can be caused by teachers implementing learning in the classroom using only textbooks and student worksheets (SW), which do not involve students in using process skills and there are no worksheets designed based on science process skills. Also, the learning process is still more teacher-centered, where the teacher only delivers material as a product and students memorize factual information. If the teacher only teaches the facts, without regard to the process of how the facts are revealed, then the facts shown are not fully understood by student's even students can assume that science is only a storehouse of information. This is in line with the opinion of [1], biology learning is still dominated by a paradigm which considers knowledge as facts that must be memorized and the teacher as the main source of knowledge.

To be able to understand a fact, students can develop their competence in science learning by focusing on direct experience in exploring and understanding the natural environment scientifically. Therefore, students are expected to move as much as possible both through observation, experiments, and discussions to find answers to various phenomena that occur in the surrounding environment. For this reason, learning science needs a process approach. The process approach in science learning is based on observations of what scientists do. The processes described

from all activities carried out by a scientist to find a theory or law are what are called science process skills [2]. The best way to learn science is to use science process skills [3].

Learning carried out using science process skills means giving students the opportunity to carry out scientific activities to gain knowledge. This means that students do natural science activities and the teacher does not provide natural knowledge for free. Instead, students must do the scientific process with science process skills such as observation, measuring, classifying, making conclusions, making predictions, etc., to find facts, build concepts, and principles in the field of science. In summary, each student must act like a scientist. The use of Student Worksheet is one solution that can be used by students to carry out the investigation or problem-solving activities [4]. Student worksheets can be in the form of guides for training the development of cognitive aspects as well as for all aspects of learning in experiments or demonstrations.

Biology is part of science, so biology is one of the subjects that must be studied by students of class X high school for science. One material in biology is an ecosystem. In biological matter, ecosystems are materials that are most closely related effectively in helping to develop science process skills, because students can find out their essential concepts in ecosystem material. For example abiotic components and biotic components, various interactions between ecosystem components, and energy flow and biogeochemical cycles. Physical and mental student involvement in these subjects, especially when working on student worksheets (SW) based on science process skills (SPS) is needed to build students' good understanding of these subjects. Science process skills consist of basic science process skills and integrated science process skills. Basic science process skills consist of several activities, namely: observing, measuring, classifying, inferring, and predicting. While integrated science process skills include activities: identifying variables, defining operational variables, connecting variables, designing investigations, composing hypotheses, conducting studies, obtaining and processing data, compiling data in tables, making graphs, analyze the research [5]. This is in line with several examples of science process skills that can be integrated into learning such as: observing, observing, designing, drawing, classifying, writing, measuring, predicting, drawing conclusions, analyzing, applying, summarizing, communicating, evaluating, synthesizing, creating, and solving problems [1]. These activities can involve students physically and mentally, so students do not feel forced to memorize, but lessons can be understood through the activities of science process skills.

II. Research Method

This research applied Research and Development to develop Ecosystem materials of Senior High School student majoring in Natural Science using Student Worksheets with Science Process Skills. The development model used in this research is the four D (4D) design introduced by Thiagarajan [6]. This research was conducted in three places, namely the Biology Department of Natural Science Education faculty of Universitas Negeri Makassar and two other public schools in Makassar city, South Sulawesi province, Indonesia.

A. Research Procedure

This research and development refer to the Four D (4D) development model which consists of four stages, namely define, design, development, disseminate.

1) Define Phase: This defining stage aims to establish and determine the conditions in learning, namely learning objectives and restrictions on learning materials. This stage consists of five main steps, namely (1) preliminary analysis, (2) analysis of students, (3) task analysis, (4) concept analysis and (5) formulation of learning objectives.

2) Design Phase: The design phase is a series of product design activities that are by what is needed and adjusted to the results of the analysis at the define stage. The design phase consists of four steps, namely determining the process of designing an SPS-based SW that is by learning indicators, media selection, format selection and initial design of SPS-based SW, as well as research instruments. The research instrument used in this study is an instrument for validating student worksheets which includes: Expert validation instruments, practitioner validation, teacher responses, and student responses as well as student learning outcomes test to determine the effectiveness of SPS-based SW.

3) Develop Phase: The development phase aims to develop the final product in the form of a Science Process Skills-based Student Worksheet. The validator validates this stage. The validation process is carried out by two expert validators, and practitioner validators, namely teachers, and limited field trials, namely Class X students. The validator is asked to validate the SPS-based SW and the instruments that have been produced at the design stage that was done before. Suggestions from expert validators are used as a foundation in product development improvements made. This validation process takes up to the an-eligible product produced validity.

4) Disseminate Phase: This stage is the last stage of the four D (4D) research model. The dissemination phase aims to distribute products to other schools. Product distribution is targeted at teachers as instructors and students who experience learning difficulties. In conducting this research, the dissemination stage is carried out by providing research products of Student Worksheets that have been developed to teachers and students to be used in learning on ecosystem material in schools that are not used as a place of testing.

B. Analysis of the Data Validity

Analysis of the data used is a descriptive statistical analysis that aims to process research data development of the student worksheets based science process skills and instruments. The validation results from the validator are used to analyze the validity of the products and instruments used. Validation data from expert validators and practitioners' validators were analyzed in the following ways: (1) recapitulate the results of the validator's assessment, (2) search for the average results of the assessment, (3) search for an average for each study area, (4) search for an average for all aspects, and (5) determine the validity of each indicator, field of study, and all aspects using the guidelines according to [5] for the validity categories as follows Very Valid (4.50-5.00), Valid (3.50-4.49), Enough Valid (2.50-3.49), Less Valid (1.20-2.49), and Invalid (1.00-1.49).

C. The Practicality of the Data Analysis

The practicality of Science Process Skill based student worksheet through Biology Teacher response and students majoring in Science was measured using the following formula.

$$TR = \frac{\sum x}{n} \quad (1)$$

TR: Teacher Response
∑x: the total number of respondents' answers
n: number of teachers (respondents)

The category of teacher questionnaire responses to Student Worksheets used are 85 - 100 as Strongly Agree, 68 - 84 as Agree, 52 - 68 as Simply Agree, 36-52 as Less Agree, and 20-36 as Disagree.

The percentage of student responses is calculated using the formula:

$$SPS = \frac{f}{n} \text{ x } 100\%, \quad (2)$$

SPS = the percentage of student responses
f = the number of students who answered agreed
n = number of students (respondents)

After calculating the percentage of teachers who respond according to specific criteria, then determine the response criteria given by students to a criterion by matching the percentage results with the criteria as follows as 85% -100% is Very Positive, 70% - 84% is Positive, 50% - 69% is Less Positive, and <49% is Not Positive (Adaptation from [7]). SPS-based SW is stated to be practical if the teacher's response is at least 70% which agrees, and 70% of student responses are positive.

D. The Effectiveness of the Analysis

The effectiveness of the Science Process Skills-based Student Worksheet which is the product of this research is that student learning outcomes are analyzed using the Normal Gain formula (Meltzer, without years in [8].

$$N - Gain = \frac{Spostest - Spretest}{Smaksimum - Spretest} \quad (3)$$

The interpretation of the N-<Gain score category as follows 0.70 < G ≤ 1.00 as High; 0.30 < G ≤ 0.70 as Medium; and 0.00 < G ≤ 0.30 as Low. The use of Science Process Skills-based Student Worksheets is declared effective if the average student N-Gain learning outcomes are in the "Medium" and / or "High" categories.

III. RESULT

A. Define Phase

The defining stage consists of five steps, namely front, and end analysis; student needs analysis, concept analysis, task analysis, and specifying instructional objectives. The five stages are described as follows.

1) Front - End Analysis: Based on the results of observations, it is known that the learning resources used for ecosystem material are only in the form of printed textbooks with limited availability and the lack of development of Student Worksheets carried out by teachers in schools, so there is no additional information material for students who can stimulate their curiosity. SW is available is still very simple, the image is colorless, so it is less supportive for improving student learning outcomes.

2) Student Need Analysis: Based on the results of the analysis of student needs it is known that the SW they use has not been effective. During the learning process, students only use biology textbooks, and SW provided only as a question sheet containing theoretical assignments. The SW has lest instructions/guidelines and not yet based on Science Process Skills (SPS).

3) Concept Analysis: Based on the results of concept analysis, the ecosystem material developed was adjusted to the 2013 curriculum.

4) Task Analysis: Based on the results of the task analysis, in the SW ecosystem there are no tasks based on science process skills in each subject matter. Each sub-subject matter also has no evaluation of students, to remember the learning that has been done by students.

5) Specifying Instructional Objectives: The learning objectives are prepared based on the 2013 curriculum which will become a reference in the development of SPS-based SW. SW to be developed is expected to help students to achieve essential competencies 3.9 Analyze information/data from various sources about ecosystems and all interactions that take place in it, and 4.9 Design charts of interactions between ecosystem components and food networks that take place in ecosystems and present the results in various forms of media.

B. Design phase

The second stage of the four D (4D) development research model is designed. The design phase consists of four stages, namely the preparation of tests, media selection, format selection, and initial design.

1) Preparation of Tests: This stage is the beginning of the design stage to be able to develop Student Worksheets (SW) based on Science Process Skills. The learning objectives that have been formulated at the next defining stage are adjusted to the SW components and determine the learning indicators so that development is carried out systematically and directed.

2) Media Selection: The media used are adjusted to the learning activities that students will do and are listed in the SPS-based SW, the activity of observing biotic and abiotic components utilizing the environment around the school. Furthermore, for the activity of making food webs, media is used in the form of pictures of several types of animals and props for animals and plants — the learning materials submission using laptops and projectors.

3) Format Selection: The format of the design is the application of the results of the analysis carried out at the defining stage. The format of the design is in the form of a student worksheet based on science process skills. The product is an additional learning resource for students and teachers. The availability of SPS-based SW helps students to understand ecosystem material.

Initial Design: The initial design includes the design of learning devices and the design of instruments used to obtain data needed in the development process. The results of the design of the student worksheet are presented in Figure 1.

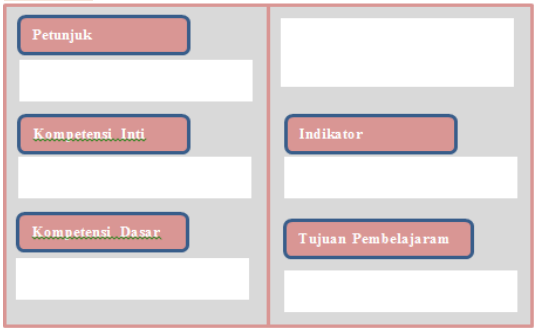

Fig. 1. Design of the student worksheet

C. *Develop phase*

The development stage is the stage to develop products that have gone through the stages of defining and designing. Produced in the form of Science Process Skill-based Students Worksheet as presented in Figure 2.

Fig. 2. Cover of Student Worksheet Based on Science Process Skills

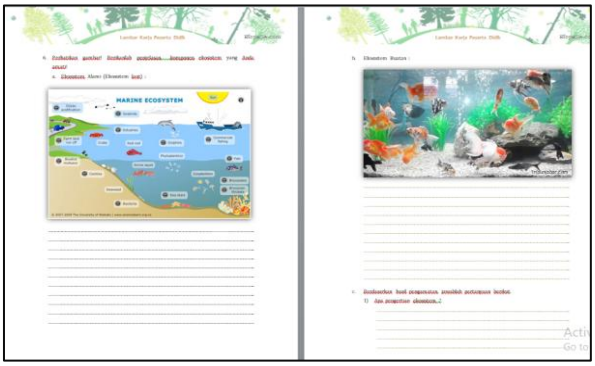

Fig. 3. Fill out the Student Worksheet

The student worksheets developed in the second validation have no longer changed after a re-assessment has been carried out by the two expert validators. Both validators only suggest correcting writing errors.

1) Validity Test: The average results of the analysis obtained the results of the assessment of aspects of the learning material for the first validation with a score of 3.37. The score is categorized as "Less valid" with the average value of the teaching material being 0.80. This value belongs to the category of high reliability. The results of the analysis of the second validation obtained an average validation score of 4.35 which belongs to the "Valid" category with an average reliability value of 0.86 which is classified as a very high-reliability category. The results of the assessment of the aspects of the writing rules on the PPP-based SW, for the first validation the average score of 3.37 was obtained as "Less valid" category, and the average score of the SW was 0.72. This value belongs to the category of high reliability. Furthermore, the results of the analysis of the second validation obtained an average score: 4.38 belonging to the category "Valid" and the average score of reliability 0.90 which is classified as a very high-reliability category. Based on the results of two validations for both aspects, it can be said that the SPS-based Student Worksheet (SW) is valid.

2) Practical Test: The practicality of SPS-based SW is determined based on the results of teacher and student responses. The teacher's response to the SPS-based SW is a score of 92.63 belonging to the "Strongly Agree" category. The student worksheet is declared feasible to use and without revision. Likewise, the results of student responses to student worksheets based on science process skills were obtained scores of 89.12 in the "Very Positive" category. Thus the SPS-based SW of science ecosystem material is appropriate for students to use in Biology learning.

3) Effectiveness Test: The results of this study indicate the average N-Gain of student learning outcomes in the High category, so the Use of SPS-based SW are declared "Effective" as well as an innovation in Biology learning especially on Ecosystem material.

IV. Discussion

The development of student worksheets (SW) based on science process skills is part of the development of learning resources that adapt to the characteristics of students, learning objectives, and learning environments. According to [9] this skill can be used as a vehicle for discovery and development of concepts, principles, or theories that have been found or developed that will strengthen understanding of the process skills.

The development of student worksheets based on science process skills needs to be developed because there are two important reasons why process skills are important to be taught and developed to students. The first reason is that with the development of science and technology, the rate of growth of scientific and technological products is central, so it is not possible to present everything to students. The second reason is that Natural Science including Biology can be viewed from two dimensions, namely the product and the process dimension. For a long time, the experience of learning and teaching of Natural Science was seen as a product and not as a process. The result is that we only arrive at the ability to use science and not produce Natural Science products [4].

The validity test and the practicality of student worksheets based on science process skills aim to see the shortcomings of these products, both in terms of content and display of student worksheets based on science process skills. The validity of student worksheets based on science process skills is a requirement that must be met before the

student worksheet on ecosystem material based on science process skills is implemented to the research subject. The assessment criteria used to determine the validity of student worksheets based on science process skills in ecosystem material consists of five aspects of assessment, namely biology learning using SPS-based SW can improve student learning outcomes because they experience a learning process that involves the five senses thoroughly both physically and physically mentally. So learning using SPS-based SW is an innovation in learning Biology. This research is in line with the results of a study [5] who concluded that learning tools based on science process skills, making students directly involved with real objects to facilitate students' understanding of subject matter. Learners find concepts that are learned, and train students to think critically so that the learning objectives of science can be achieved which make learning science as a product and process for students.

There are several advantages gained by utilizing science process skills-based learning, namely (1) students are directly involved with real objects to facilitate students' understanding of the subject matter, (2) learners discover the concepts learned autonomously, (3) learners could practice how to think critically, (4) Train students to ask questions and engage more actively in learning, (5) Encourage students to discover new concepts, (6) Give students the opportunity to learn to use the Samatowa scientific method [10]. One approach that can be used to activate students optimally in biology learning is the use of science process skills [5].

V. Conclusion

Based on the results obtained, it can be concluded that the development of Science Process Skills based Student Worksheets are in the valid, practical, and effective category. Biology learning by using the Science Process Skills based Student Worksheet is one of the innovation in Biology learning specifically in Ecosystem material.

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