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Designing Teaching Material Oriented Towards Inquiry-Based Learning in Biology

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***Abstract*—The inquiry-based learning model is the model suggested for learning in the 21st century. This learning process will succeed if supported by teaching material that prepares students for real-life situations. This research aimed to design and develop valid teaching material that is oriented towards inquiry-based learning. The research method used was a 4-D model. The process started with the defining stage and the design and development of teaching material (included validation and small group trials). A pilot project consisting of data from 14 students was conducted. Three experts validated teaching materials using focus group discussion (FGD) technique. The result of the research shows that the created teaching material obtained a validity value of 87.01% with a reliability score of 0.69. Five aspects assessed in teaching material obtained good validation values. Values obtained show that teaching material oriented towards inquiry-based learning was a very valid category and response of students was excellent. Teaching material was theoretically feasible for use in biology lessons**

Keywords—Biology lesson, Feasible, Inquiry-based learning, Reliability, Teaching Material, Validity.

I. INTRODUCTION

Biology is a subject taught in high school (SMA). In Indonesia, the subject of biology is taught by following worldwide curriculum development. Currently, Curriculum 2013 (K13) is employed. This curriculum is implemented to support 21st-century learning. It works well if supported by teaching materials that bring students into real-life situations. The learning environment, the teachers' teaching style, and the learning selection process can all inadvertently damage students' ability and desire to learn [1]. Teachers are expected to teach meaningful content. Therefore, it helps students to meet their learning objectives in the context of authentic activities and ensure that all students can succeed [2].

In teaching science, teachers need to use different strategies. These must be in accordance with the evaluation results of the learning style that has been implemented, the needs of students, the diversity of the class, and an understanding of the various types of learning [3]. To teach science, like biology, teachers need a learning process that confronts students with authentic issues, guiding and facilitating them in understanding the data, and supporting them in developing their understanding of the concept of learning [4].

Today the learning process is required to be dynamic and enable students to be active and creative [5]. The students' understanding of material can be found through interaction with the environment [6]. In science education such as biology, three main things should be considered: namely intellectual development, personality development, and social value [7]. Therefore, the provisions of the biology curriculum in Indonesia are to enhance understanding of concepts, attitudes, problem-solving, and skills such as thinking skill, science process skill, metacognitive, and other skills. To train in this situation, the learning process should adapt to the theory of constructivism. This approach is based on the assumption that knowledge gathering is an individual process, where learning is achieved by building new concepts through the integration of prior knowledge with new knowledge and not just by adding new knowledge to existing knowledge [5]. There is a strong linkage to constructivism-based learning and learning motivation [8].

One of the learning model that follow the theory of constructivism is inquiry-based learning. Many educators believe that inquiry-based learning is efficient in developing inquiry and critical thinking skills [9]. Several studies have concluded that inquiry learning has an influence on learning outcomes and critical thinking skill [10–12]. In inquiry, students work with science process skills and engage in higher-order thinking [13,14]. Effective inquiry learning for all types of students, from the weakest to the most intelligent, takes into account skills, gender, and all students' grades [15]. Inquiry learning has been implemented in junior and senior high schools since the last century [16].

Teaching is a system in which there are various components working together for the creation of quality learning. One of the components is teaching material. Teachers should start as early as possible to exercise well preparation in improving learning for their students [17]. Learning planning can begin with the development of teaching materials that involve students directly in the learning process, encouraging them to interact with the environment and practice their thinking skills. In the senior high school in Manokwari, there is no inquiry-oriented teaching material made by the teachers, so

they need to develop teaching material oriented towards inquiry-based learning to the fulfillment of the availability of teaching material in the school library, and overcome the difficulties of students to obtain teaching material. In addition, the teacher has to revise the material based on the basic competence being in line with the revised 2017 edition of K13, because author founded that the biology teacher used old basic competence.

II. EXPERIMENT METHOD

This research uses a method of a research and development using a 4-D model. This model consists of 4 stages, including Define, Design, Develop, and Disseminate [18]. The research is limited to the define, design, and development processes up to the expert test validation stage and small group trial in the first year, and for the next stage will be carried out in the future in the second year. The research process starts from the define stage to analyze the characteristics of the students, the learning objectives, and the tasks, as well as the design and development of the teaching materials (including validation and small group trials). The small group contained 14 students. Three experts validated the teaching materials using focus group discussions (FGD) technique. The percentage of validity and adaptation from Akbar [19] is classified as follows: 85.01 - 100% is declared very valid or can be used without revision; 70.01 - 85.00 is declared Valid, or may be used but needs to be revised slightly; 50.01% - 70.00% is declared invalid, and it is inadvisable to use it without major revisions; 01.00% - 50.00%, is declared invalid, and may not be used. Reliability is measured using Cronbach's alpha formula with reliable criteria falling in the range of 0.6 - 1. In small group trials, student response is calculated using the following formula:

$$\text{Percentage of students response (PSR)} = \frac{\text{Number score obtained}}{\text{Maximum score}} \text{X} 100\% \quad (1)$$

Student response criteria used a range of percentage. 85 – 100 is excellent, 70 – 84 is good, 55- 69 is enough, 50 – 54 is less, and < 40 is very less.

III. RESULT AND DISCUSSION

The define stage examined these analyses, and it showed the process of learning in school is good. This means that not only is the learning process teacher-center, but students are invited to be directly involved. However, it is still often observed that students play during the learning process. Furthermore, students also do not have their own handbooks. The book used in the biology learning process comes from the school and is used only when there is a biology lesson. For tasks assigned by teachers, students are allowed to borrow books from the library. However, not all students want to borrow the books the library provides. This makes the learning process difficult for students. In the basic competence analysis, it was found that the basic competence used had not followed K13 revised edition 2017. Therefore, changes were made to the existing basic competence.

The teaching materials developed in this research focus on ecosystem material. The results of the design and validation of said teaching materials by experts are shown in Figures 1 and 2 as follows:

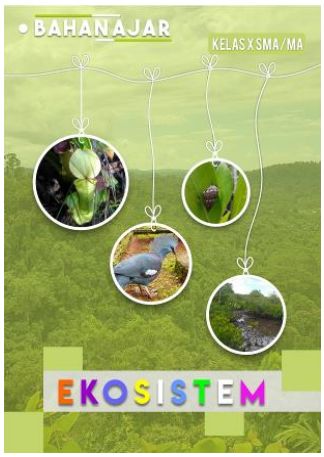

Figure 1: Front Cover of Teaching Material

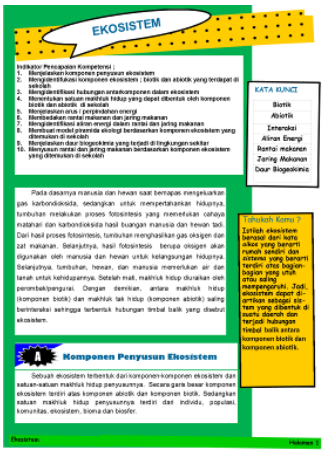

Figure 2: The Introductory Section of Teaching Material

Figure 1 shows that teaching materials are designed to meet the needs of learners based on the results of the initial learner analyses. The background on the cover of the teaching material uses a picture from the forest of Meja Mountain. This forest is behind the campus of University of Papua. The lecturer often uses it for animal and plant ecology practicum activities. This background is used to further introduce the existing ecosystem around the student's residence. The Nepenthes plants used are native plants located in the Botak Mountain of Manokwari. The bird used is a native Papuan bird, documented in person at the time of practicum activity on the island of Biak. To reduce the basic understanding gap of students to nature, different sources of information are needed [20,21]. This information is detailed on the cover and concerns the diverse nature of Papua. This can be used by the teacher as a reference to introduce the students to their natural surroundings.

Figure 2 shows the introductory section of teaching materials containing key information, as well as supplemental information to support student learning activities. The cover design and content of the teaching materials use the picture taken directly from the natural landscape of Papua. This is done to teach students about the ecosystem there. Students can overcome the dilemmas of everyday life if they are taught about the environment within their lives [22]. The Biology curriculum aims to enable students to apply its lessons in everyday life, after studying the material. Surely, to support this situation the students should learn about their native environment. In the content of teaching materials, students will investigate how the condition of ecosystems in the school environment and human behavior within that environment affect the ecosystem.

In a teaching material that has been designed with these criteria, the inquiry stages are adapted according to questions about their observations, hypotheses, experimentation, measuring, interpreting data, drawing conclusions to answer questions, and attempts to test hypotheses and communicate

their experimental results. In addition, teaching material is also designed to gather information about the curiosity of students in the "Did You Know" column, as well as several scientific facts and keywords that students should know. The color selection focuses on yellow and green, where green becomes the dominant color. This is because it symbolizes the green forest, and encourages the students to become interested in reading the teaching materials.

TABLE I. THE RESULT OF VALIDITY AND RELIABILITY

Item	Validity		Reliability	
Lesson Plan	97,69	Valid	0,72	Reliable
Student Worksheet	93,52	Valid	0,77	Reliable
Teaching Material	87,01	Valid	0,69	Reliable

Table 1 shows that the lesson plan, student worksheet, and teaching materials are valid and reliable for use in the learning process. The validity obtained does not reach 100%, which indicates that there are some things that need to be revised. Teaching materials that need to be revised require more recent references and images taken directly from the natural environment of Papua.

In the teaching material validation sheet, the assessed aspects in the form of the accuracy of the content obtained 88.89%, digestibility obtained 86.90%, language usage obtained 83.33%, obtained 84.26%, and illustrations obtained 91.67%. The five aspects assessed, the three aspects that are the accuracy of the content, digestibility, and illustrations, obtained validation was very valid, and the other aspects that are language usage and design arrangement obtained validation was valid. The five aspects considered to have good results. In addition, qualitative data in the form of descriptive input from the validator, which is the basis for improving learning devices, is shown in Table 2.

TABLE II. DESCRIPTION OF VALIDATOR COMMENT AND REVISION

Item	Validator Comment	Revision
Lesson Plan	Formulation of indicators and achievement of indicators to adjust to Basic Competencies	Indicators have been adjusted to the achievement of basic competencies
Student Worksheet	Student worksheets must follow the Inquiry Steps	Inquiry steps have been clarified in student worksheet with six steps
Teaching Material	- The examples used in textbooks are not contextual. Use examples of animals and plants around the student environment	Examples of animals and plants have been revised using animals and plants known to students
	- Use of language should be communicative and adapt to students' thinking skills and distinguish textbooks from textbooks	The language used has been corrected according to its function as a textbook
	- Presentation of non-sequential concepts. Create a concept map	Presentation of concepts has been written based on the sequence of concepts and paying attention to the relationships between concepts

Based on the suggestions given by the validator, a valid teaching material has been produced which is in accordance with the steps of inquiry-based learning. Each chapter begins by presenting phenomena or problems explored from the surrounding environment. Then, the students are asked to find problems. Continued by training students to formulate hypotheses. The next step is to prove the hypothesis with experiments or observations in the surrounding environment. The students are asked to collect data and analysed guided questions that direct students to think about the analysis and conclude with conclusions. Thus, the superiority of the teaching material developed is an teaching material oriented inquiry-based learning by using contextual problems that occur around the environment and using real examples in their own environment. Students can investigate the state of the ecosystem in their environment. This has the advantage of being understood carefully by students because the problems discussed are real problems. This data shows that teaching material is theoretically feasible and can be tested in the classroom. The valid and reliable teaching materials, furthermore, are examined within a small group. This is to see the students' response to what they learned in their ecosystem material.

The small group trial showed that students' response to teaching materials oriented towards inquiry-based learning was 89.58%. The percentage obtained shows that students approve of learning biology using inquiry-based learning. To achieve optimal learning, the learning method should not only be determined by the teacher but also the students should contribute to determine it. Students as recipients of material given by the teacher will receive it well if they feel that the teaching style is interesting and motivates them to learn.

Teachers who use inquiry-based learning in teaching show a high level of energy and confidence. This motivates students to find the differences in data and to ask questions of their own will [23]. Analysis of the survey data found that 90% of students understood the inquiry process and 88% felt comfortable in understanding the science materials [24]. The data shows that students who are taught through inquiry learning become motivated and comfortable, can find ideas to solve problems, are able to express opinions, exhibit skillful thinking, are skilled in experiments, formulate problems and hypotheticals well, are able to form conclusions, and are interested and active in learning and better understanding the material.

IV. CONCLUSION

Based on the results, the teaching materials oriented towards inquiry-based learning are feasible for use in learning biology. Students' response to inquiry-based learning is excellent

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