

How Do Students Understand the Material of Animal Kingdom?

(Development Invertebrate Learning Material Based on Students' Prior Knowledge)

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Abstract—Learning the materials about Animal Kingdom tends to be memorizing activities. Students assume that the materials are difficult to be understood because the characteristics of this materials are descriptive and full of anatomy and morphological terms in order to eliminate the students' difficulties regarding the material about the Animal Kingdom. This research aimed to obtain learning materials of animal kingdom topic which was prepared based on students' prior knowledge. Research and Development method was used to develop this learning materials. This learning material is made based on students' prior knowledge and developed in accordance with propositions from the main references. There are 9 main propositions found from the references. Then the sub propositions made and developed into some sentences that is easily to be understood by students. The trial was conducted on 30 tenth-grade students. The research subjects were the tenth-grade students consisting of two classes, but were not separated in the discussion and data analysis because this research did not compare understanding and skills between one student and others in another class. The result showed that students as the user of these learning materials were interested in invertebrate topic and also the exercises. The integration of learning materials and computer-based quiz are important to facilitate students' meaningful learning in 21st century.

Keywords: *invertebrates, 21st century skills, prior knowledge, learning materials*

I. INTRODUCTION

Research on the development of learning materials is important to be carried out continuously because there are many facts in the field showing that there are still concepts inappropriate and not easily understood by students in terms of both diction and the relationship with everyday life felt to be lacking. Entering the 21st century, biology textbooks and classroom laboratory activities utilize high technology such as microscope images (micrographs) in presenting essential concepts of biological teaching from cytology to systematics. However, research shows that students often ignore micrographs in their textbooks as they do not understand them and knowledge about micrographs is rarely tested on biology tests or practicums [1].

There are some problems in teaching about animal kingdom. An animal rights philosophy often underlies these objections, but many people are unaware of the logic of the animal rights position, which is often dismissed as sentimentalism or anthropomorphism [2]. Most of the dissections were performed by 16–17-year-old students, and teachers believed that dissections should be restricted to this age group [3].

Science education undergoes reform and emphasizes: 1) conceptual value compared to facts; 2) the importance of using open questions, inquiry-based problem solving, rather than a single answer; and 4) the importance of a multidisciplinary approach in teaching that is not caught up in departmental boundaries [4]. Problem-solving skills in the 21st century require educational paradigm changes in the classroom teaching [5]. It has been recommended to use educational methodologies such as conceptual learning, hands-on study, problem-based learning, and student-centered learning, but they have not universally implemented [6].

Constructivism-based learning materials mean the preparation of learning materials considering the aspect of students' prior knowledge. The limitations that can be included in the learning material are set based on what students already know and lead to new concepts they do not know [7,8]. Basically, students actively build their own knowledge. Learning is an active mental work, not accepting teaching from the teacher passively. In this students' mental work, the teacher plays an important role by providing support, the challenge of thinking, serving as a trainer or model, but students remain the key to learning [9].

The problem to be revealed in this study is to reveal students' understanding of invertebrate materials by using learning materials that have been prepared to make student categorization. This research aimed to develop invertebrates learning materials arranged based on students' prior knowledge.

II. METHODS

This study used a research and development method with a quantitative approach. The participants were tenth-grade

students of an International Secondary School, amounting to 30 students from two classes. The participants were the students who had not studied the material about the animal kingdom. The instrument used in this research consisted of 9 reasoned multiple-choice questions. Questions items are based on the main propositions contained in the reference book, so that there are 9 main propositions used as references in making this learning material. The questions were arranged in a form that allows students to answer questions by choosing the answer choice. Then, they chose the degree of confidence in deciding their answer (sure or unsure). Then, they provided a reason of choosing the answer choice. This form of questions allows students to choose the answer by involving their beliefs and reasoning behind the answer. This can reveal the students' understanding categories, which are grouped into four, namely: 1) the students' understanding is correct; 2) their understanding is incomplete; 3) they have misconception; and 4) they have no idea about the answer or just guess it.

The data of multiple-choice questions were analyzed by determining the students' answer categories according to the four categories. The data were then accumulated for each item and calculated to get the percentage.

III. RESULTS AND DISCUSSION

This research emphasizes the role of learning materials developed based on students' prior and the main proposition elements contained in the reference book [10]. The book regarding the introductory material of animal and invertebrates diversity states that there are 9 main propositions [10]; (1) Animals are heterotrophic multicellular eukaryotes with tissues that develop from the embryonic layer; (2) During their lives, animals undergo larval to juvenile stages through metamorphosis; (3) Animal diversity comes from evolutionary changes in genes for billions of years; (4) Bilateral symmetry animals are differentiated into protostome and deuterostome; (5) Sponges are sessile basal animals and suspension eaters; (6) Cnidaria has a radial diploblastic body and diversifies into polyps and medusae forms; (7) Lophotrochozoa has the widest range of animal forms with the characteristic of having trochophore larvae; (8) Ecdysozoa are the most species-rich group of animals including nematodes and arthropods; and (9) sharp-skinned echinoderms have a vascular system and a tube leg that functions in locomotion through madreporite. They also have a central disc that radiates into the arm and reproduces sexually through internal or external fertilization.

Instrument results can categorize students into four groups based on their material understanding. Based on the explanation above, invertebrates learning materials based on students' prior knowledge showed good results and were suitable to be applied to the tenth-grade students of upper secondary school who study the materials about the animal kingdom, especially invertebrates. The results of the trial of learning materials can be seen in table 1.

TABLE I. TRIAL RESULTS OF BIODIVERSITY AND INVERTEBRATES QUESTIONS

Categories	Percentage (%)
Correct understanding	46.7
Incomplete understanding	10.4
Misconception	31.6
No idea or guessing	13.3

From the results of trials using reasoned multiple-choice instruments, it was found that the students' prior knowledge shows differences. This becomes the basis for the preparation of the main propositions as the main points in developing learning materials in the form of invertebrates modules. 46.7% of students have a correct understanding of the introduction of animal diversity and invertebrates materials, especially regarding animal characteristics in general with a percentage of 86.7% and an understanding of Cnidaria or the Coelenterata group. Based on the interview results, it was stated that there are other learning resources that support the students' understanding. 78% of students stated that they knew about the animal kingdom from television shows in the form of films, cartoons, or news. This is an interesting finding because it turns out television and internet media can also help students learn to understand the concepts of animal characteristics, especially invertebrates.

At the end part of this learning material, there is a set of exercises and material summaries to support student reflection activities after completing studying the material. One part of the evaluation or exercises is the existence of the internet-based game, namely 'memrise.com', which was created by the researcher specifically regarding the invertebrates material and introduction to animal diversity. There are a number of terms and definitions in the game. Several terms will be displayed for a while and the students are asked to read and memorize them. Then, there will be an evaluation that requires students to choose the right definition of a term or to match. The main purpose of this section is to train students to remember and facilitate retention so that information in the short-term memory is converted into the long-term memory [11].

Based on the data obtained from the results of in-depth interviews to the research subjects, it was found that the presence of images and captions in textbooks helps students to understand the content. Hence, it is imperative for modern learning materials, especially in biology, to emphasize the existence of the image aspect in order to help students develop the cognitive scheme when studying a material [1].

Apart from the effectiveness of learning materials to be measured in this follow-up research, they have also been tested on students regarding the online-based game integrated with the learning materials. Based on the questionnaire results, 93% of students stated that the game increased their motivation to learn and could be an alternative in remembering and memorizing terms related to biology, especially in the introductory material of animal diversity and invertebrates. One of the important points found in the trial research on the learning material development is the compatibility between the language use with the cognitive level of students, because at the beginning of each material or sub-material is given

illustrations that are contextual and able to lead students to be aware of their daily life context. Apart of their function as a book, textbooks also have the following functions [12]: 1) the material and program development facility in the education curriculum; 2) means of facilitating the academic assignment of teachers; 3) the facility to help achieve learning objectives; and 4) the facility for streamlining the efficiency and effectiveness of learning activities.

IV. CONCLUSIONS

Learning materials circulating in schools, especially in schools of the research subjects, are still categorized not easily understood by the students. Therefore, the learning material development based on students' prior knowledge can reduce students' burden in analyzing information with words tailored to their cognitive levels.

Learning materials should include the practical activities that contain the rules for developing student worksheets, in which there is an introduction. The 21st century skills discussed in this research have not been able to describe every aspect of the skills. They only cover technological literacy and thinking skills through understanding abstract concepts. It is also important that teachers consider the allocation of learning available and determine when students use this module and how they are assessed. Basically, the learning material development based on students' prior knowledge is important to be carried out and implemented by teachers, both science and non-science teachers because it can provide a positive effect and pay more attention to the knowledge aspect that the students already have.

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