

# Analyzing concept for Developing STEM-based Integrated Science Teaching Materials Themed "Blood"

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**Abstract**—Innovations in learning science is needed to answer the needs of the paradigm in 21<sup>st</sup> century. Innovation in learning science can be achieved with STEM education because STEM education can accommodate STEM literacy and 21<sup>st</sup> century skills learning. Teaching and Learning involves three important components, namely teachers, students, and teaching materials. Teaching materials is one of the important components in implementing teaching and learning because learning materials provides knowledge and skills that suits with the needs of students. The purpose of this research is to analyzing concept for developing a STEM-based integrated science teaching materials themed blood. This research is using descriptive methods, we did some survei to get an information about mastering concept related to blood themed. The result showed that students had mastered almost all the material related to the theme of blood, but there were several concepts of integration that had not been mastered by students. In the future, hoped students will be more involved in learning that give integrated concept so students can master the concept as a whole.

**Keywords**—*teaching materials, mastery concept, blood, STEM education.*

## I. INTRODUCTION

In the 21st century, fast development is happening very fast, especially in the field of science and technology. This kind of development is the way of humans can solved a wide range of issues such as quality of life, development, and human resource development. Education is the primary field to develop human resources who have global competitiveness. Thus, the Science Education building learning areas in developing science literacy ability, critical thinking ability, creative, logical, and initiatives in response to the problems in the community caused by the impact of the development science and technology [6].

In Indonesia, the science learning which was originally only monodisiplin then become multidisciplinary learning. In accordance from [7] stated that multidisiplin can accommodate learning literacy and competence development of students. Multidisciplinary learning innovation in science learning that are being discussed in many different parts of the world today is STEM education. STEM education is education that pack the science, mathematics, engineering, and technology into one integrated learning that can can push students to learn [5].

STEM Education has a big purpose ie make students become STEM literate individually. STEM literacy is literate against fourth field contains an interdisciplinary as integrated STEM skills, concepts, and processes [11] [9] define STEM literacy is the ability to know, understand, use, evaluate concepts, principles, practical, artifacts, and the phenomenon of STEM is going or studied. [10] added, students who apply STEM contextually in the environment, the science community, and global company allows the development of literacy in the world competition and STEM which undergoes very rapid changes in the field of science and technology.

Learning has three key components, namely teachers, students, and learning materials. Learning materials are a set of materials that contain material or content on the design of learning to achieve learning objectives [2]. Learning materials contains concepts, messages or contents of the subjects in the form of ideas, facts, concepts, principles, rules, or the theory of subjects covered in the appropriate disciplines as well as the other information in the learning. Currently outstanding teaching materials quality is very doubtful because of the teaching materials is not developed in accordance with the curriculum, the psychological level of students, and the student's needs. Whereas learning materials is an important component in learning because learning materials contains knowledge, skills needed by students to learn.

Teaching materials contains a set of related concepts and organized in accordance with the interconnectedness and the depth of the concept of making it easier for students to master the concepts. Mastery is a student's ability in understanding the concepts. Understanding the concept of students not only in the understanding of scientific concepts, but also its application in everyday activities [1].

According to Bloom, the mastery concept is the ability to capture the sense or being able to disclose a material presented into a more comprehensible form, capable of providing interpretation and be able to apply them. Moreover, the concept of mastery can be measured through levels of thinking cognitive domains in the taxonomy of bloom. Bloom's taxonomy of the cognitive domain which has been perfected by Anderson have

levels of C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C5 (evaluate), and C6 (created). Each of these levels has indicators that can measure the mastery concept [1]. From this description of the background research, this study aims to look at the student's mastery of the concepts related the theme of blood for developing teaching materials STEM-based.

**II. METHOD**

The research method used is descriptive research with survey method [4]. The survey is carried out using instruments that are arranged based on the analysis of curriculum related themes of blood to create indicators. These indicators are then used to compile the draft materials themes of blood and the details of the question.

This research was conducted to grade 10 high school to see the mastery concept on the theme of blood that's been studied in grade 8 middle school. Activities is conducted with students reading the draft materials on the theme of blood then the students answer questions related concepts about themes of blood. At the end of the activities, we conducted a short interview to the students

to know how to learn and learning difficulties are experienced.

**III. RESULT AND DISCUSSION**

The preparation of the instrument is done by analyzing related curriculum development theme of the blood. The analysis is done by determining the basic competencies, indicators, and related concepts blood theme. The following results are presented in table 1. From indicators and concepts, then we made questions to test the student's mastery concepts after read teaching materials themed blood. The questions is presented in the table 2.

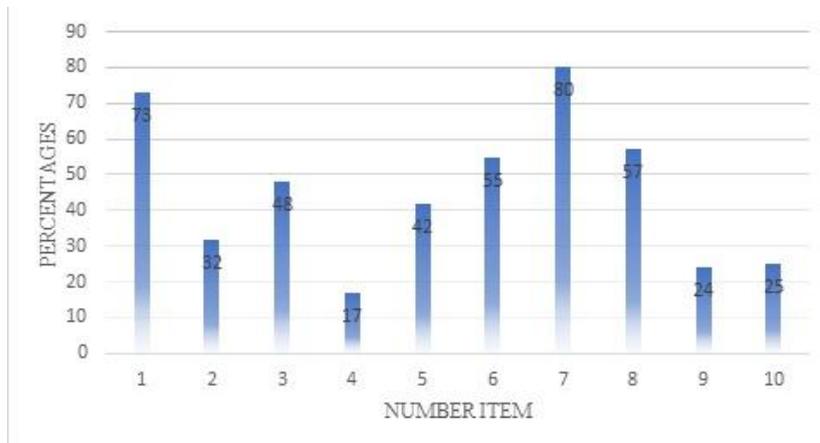
The results of the analysis using Anates, question items have a score of 0.91 reliability which means reserved has very high reliability. It also obtained from data that there is 1 item question categories very difficult, 2 item question categories is difficult, 6 item question category medium, and 1 item question categories very easily. Overall data acquired mastery of the concepts students presented at figure 1.

**Table 1.** The results of the analysis of curriculum related themes of blood

Basic Competence	Indicators	Concepts
3.7 Analyzing the human circulatory system and understanding the disorders of the circulatory system, as well as the efforts of maintaining healthy circulatory system	3.7.1 Explain the function of each constituent of the blood (blood cells, white blood cells, platelets, plasma and blood).	Blood Blood Plasma, Red blood cells Hemoglobin White blood cells Platelets Phagocytosis Blood clotting (hemostatis)
	3.7.2 Explains the difference in the process of blood circulation for small and large blood circulation.	Small and large blood circulation  Diffusion of oxygen and carbon dioxide in the lungs
	3.7.3 Analyzes the structure of the heart-pumping as a tool in the circulation of blood.	Structure of the heart (the Pericardium, the heart of the layers of the skin, heart, heart valves)
	3.7.4 Explain the difference of blood vessels arteries, veins, and capillaries.	Structure of the blood vessels (arteries, veins, and capillaries)
3.8 Understand pressure and its application in everyday life, including blood pressure, osmosis, and capilarity transport chain in plants	3.8.1 Explain the concept of active and passive transport in the process of circulatory and excretory systems	Osmosis Diffusion
3.10 Analyze human excretion system and understanding the disorders of the excretory system as well as the efforts of maintaining health system excretion	3.10.1 Analyze the structure of the kidney as an organ of excretion	Process of excretion in the kidneys (filtration at the glomerulus in tubular reabsorption, secretion, in tubular)

**Table 2.** List question test mastery of the concept

Indicators	Type item	Question Item
Explain the function of each constituent of the blood (blood cells, white blood cells, platelets, plasma and blood).	C3	How blood can maintain the balance of the body's acidity?
	C3	How the body protects itself from attacks by viruses, bacteria and foreign objects that can cause disease?
	C3	Why does the color of blood in some people have a slightly different red color?
Explain the difference in the process of blood circulation for small and large blood circulation.	C4	How does the oxygen we breathe enter into blood vessels?
Analyzes the structure of the heart-pumping as a tool in the circulation of blood.	C3	Why does the heart have a heart valve?
Explain the difference of blood vessels arteries, veins, and capillaries.	C2	What vascular lines appear on the surface of the athlete's skin?
Analyze the structure of the kidney as an organ of excretion	C2	Why the kidneys can produce urine?
Explain the concept of active and passive transport in the process of circulatory and excretory systems	C3	If the kidney is a screening organ that produces urine. Then urine is referred to?
	C3	Substance A can enter and exit cells through a special pathway that is on the cell membrane. What is the phenomenon?
	C3	When in a hypertonic environment, cells tend to release water into the environment to balance the concentration of the solution. What is the phenomenon?



**Figure 1.** Student mastery concept themed blood

On the figure 1 can be seen the elusive concept of students, namely concept in the process of displacement of oxygen and carbon dioxide through the process of diffusion and active passive transport of substances in the process of excretion. In contrary, the concept is easy to grasp by students is the function of blood plasma, white blood cells and antibodies, the structure of the blood vessels, heart valve function, the function of hemoglobin, and the process of kidney filtration. From those results look that students could not master the concepts that involved various concepts especially if the concept is derived from the other chapters who have studied such as diffusion and osmosis. In addition, the students also have yet to understand the full readings on blood circulation as well as in relation to the role of the organs involved.

While reading the draft materials blood theme, students have difficulty understanding the use of the word, such as:

1. Prevalence
2. Distribution
3. Unit of measure ( $\mu\text{m}$ )
4. The meaning of writing ion charges (1+,2+,3+)
5. Cell elements
6. Sphygmomanometer
7. Conversion

These words need to be simplified to make the students become easier and fit with the level of thinking students.

The results of the interviews is the reason they are difficult to answer questions related to the theme of blood because they had been studied the blood that is in the 8th grade. In addition to that from the interview note that the learning science style of students are tend to only read and worked on the questions test so that students are not trained to solved problems that need apply integrated concepts. They usually studied the concepts as a separated so they did not understanding the linkages of concepts as a whole. This is a concern, in the future hoped the students get more engaged in learning are

integrated in the concept as well as practical so that students can master the concepts thoroughly.

A through understanding of the concepts are needed by students to make learning has been done into a meaningful learning [8]. The mastery concept is very important so that the concepts learned not only became a memory but can be applied ideally to solve the problem in real life [1].

#### IV. CONCLUSION

Mastery concept is needed to make students capable of providing interpretation and be able to apply them. The results showed that students already mastered almost the entire material related blood theme but there are some concepts of integration have not yet mastered the students.

It is expected that in the future, students are more engaged in learning that serves integrated concepts so that students can master the concepts thoroughly. One of solution is developing a teaching materials that are contains multidiplinary learning such as STEM-based teaching materials.

#### REFERENCES

- [1] Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*. Longman.
- [2] Anwar, S. (2017). Pengolahan Bahan Ajar 4S TMD. Four Steps Teaching Materials Development. Bandung: Tidak Dipublikasi.
- [3] Bloom, B. S. (Benjamin S. (1956). Taxonomy of educational objectives; the classification of educational goals,. New York: Longmans, Green.
- [4] Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). How to design and evaluate research in education (8th ed.). New York: McGraw-Hill Humanities/Social Sciences/Languages.
- [5] Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, 3(1), 11. <https://doi.org/10.1186/s40594-016-0046-z>
- [6] Kemendikbud. (2016). Lampiran Peraturan Menteri Pendidikan Dan Kebudayaan Nomor 22 Tahun 2016 Tentang Standar Proses Pendidikan Dasar Dan Menengah. Jakarta: Kementerian Pendidikan dan Kebudayaan Republik Indonesia.
- [7] National Research Council. (2014). *STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research*. (M. Honey, G. Pearson, & H. Schweingruber, Eds.). Washington, DC: The National Academies Press. <https://doi.org/10.17226/18612>
- [8] Novak, J. D. (2011). A theory of education: Meaningful learning underlies the constructive integration of thinking, feeling, and acting leading to empowerment for commitment and responsibility. *Meaningful Learning Review*, 1(2), 1–14.
- [9] Reeve, E. M. (2015). STEM Thinking!. *Technology and Engineering Teacher*, 75(4), 8–16.
- [10] Tsupros, N., Kohler, R., & Hallinen, J. (2009). STEM education: A project to identify the missing components. *Intermediate Unit*, 1, 11–17.
- [11] White, D. W. (2014). What is STEM education and why is it important. *Florida Association of Teacher Educators Journal*, 1(14), 1–9.