The Development of Teaching

by Ani Sutiani

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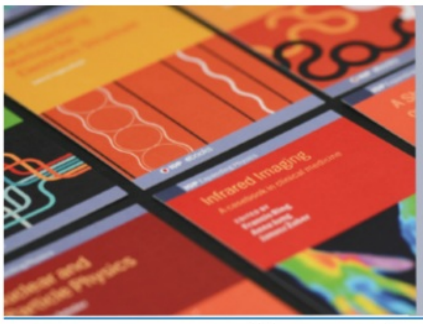

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The Development of Teaching Material Based on Science Literacy In Thermochemical Topic

A Sutiani, Zainuddin, A Darmana, F T M Panggabean

Chemistry Department, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, Jl. Willem Iskandar, Pasar V, Medan, 20221, North Sumatera, Indonesia

* anisutiani@unimed.ac.id

Abstract. Teaching materials are one of the components for improving students' scientific literacy skills, but teaching materials that exist today, especially about thermochemical materials do not yet have the maximum content of scientific literacy. Through the research design of research and development, scientific literacy-based teaching materials have been developed in thermochemical material. The stages of research include needs-analysis, product design development, validation and analysis. Therefore, the product result and testing phase are limited to effectiveness testing. From the results of the study, it was found that science-based thermochemical teaching materials for general chemistry courses had been successfully developed with the existence of scientific literacy aspects. Moreover, the aspect are the knowledge of thermochemical material which is the aspect of science as a torso, thermochemistry in context which is an aspect of science as a process of inquiry, the high level thinking skills which is science as a way of thinking, and attitude which is an aspect of interaction between science, technology and society. The overall feasibility validation result is 86.42%, which means the teaching material is in the valid category without revision. Moreover, the readability of teaching material products has an average readability percentage of about 83.79%, which means that teaching materials are included in the criteria to be easily understood.

1. Introduction

Science education has an essential role in preparing qualified human resources in the face of the globalization era. The potential of science education can be seen from the ability to communicate, critical thinking, problem-solving, mastery of technology and the ability to adapt to changes and times. Liliasari states that the process and learning of science can produce a quality of human beings with the demonstrated awareness of science (scientific literacy) and high-level thinking skills that can bring up human resources capable to thinking critically, thinking creatively, making decisions and solving problems [1].

Science literacy is defined as the ability to use scientific knowledge, identify questions and draw conclusions based on facts to understand the universe and make decisions about changes that occur due to human activities [2]. Indonesian literacy skills are in a low category based on the 2015 Program for International Student Assessment (PISA) study report. For scientific literacy, Indonesian students are ranked 62nd out of 70 countries with a score of 403, for math literacy, Indonesian students are ranked 63rd of 70 countries with a score of 386 even for reading literacy were ranked 64th out of 70

states with a score of 397 [2]. The results of these achievements indicate that the average scientific literacy ability in Indonesia is only able to recognise basic facts, but has not been able to communicate and link these abilities to various scientific topics, especially to apply concepts in life [3].

The development of scientific literacy skills is not only influenced by learning models but also textbooks used. It is consistent with the research of Rusilowati and Safitri et al. who show that the use of books with scientific literacy can improve scientific literacy skills. [4][5]. But in reality, the textbooks used have not yet supported the development of scientific literacy skills. It is following the results of research by Yuliyanti and Rosilawati who showed that the science textbooks used did not yet contain a balanced component of scientific literacy [6].

Science literacy ability is one of the capabilities that must be possessed and developed in studying thermochemistry. It is intended that students can have scientific information and scientific thinking to solve a natural phenomenon related to the concept of thermochemistry. Science literacy is one of the parameters in determining the human development index which is strongly influenced by the quality of education [7]. According to Schwartz, a must-have indicator of scientific literacy in the field of chemistry covers aspects of the process, context, content and attitude of science [8]. Thermochemical material is one of the materials in the General Chemistry Course whose real studies are under the KDBK Physics Chemistry. Based on the material review, this course has a quite strategic contribution in the planting of basic concepts to master enrichment material at the advanced level. One way that can be done to optimize the ability of students to face competition in the era of globalization is to provide science-based textbooks. Textbooks with scientific literacy content will encourage students to have critical thinking skills and information literacy skills so that they can analyses, evaluate and synthesis information to sort and determine information that is relevant to their needs [9]10]. Therefore, science literacy-based textbooks are textbooks that contain the scope of scientific literacy which includes science as a body of knowledge, science as a way to investigate, science as a way of thinking and interaction between science, technology and society.

2. Materials and Methods

The design of developing textbooks based on scientific literacy that will be carried out in this study adopts the development of the Dick & Carey model which has become 4 (four) stages. The first stage in developing teaching books based on scientific literacy is the analysis-need step. This stage aims to examine the objectives of the book to be established. The second stage is the design of teaching book products. Product design must be realized in the form of a chart, and it can be used as a reference for making products. The activity at this stage is to make textbooks through material descriptions through the KKNI curriculum. Also, book pricing instruments were also prepared, as well as supporting components and textbook layout/designs.

The third stage is the validation and analysis. This stage is a series of product development assessments. The validation stage of the teaching book is carried out by the validator, the results of the validation will be analyzed and revised based on input/suggestions. Then, the developed textbook becomes feasible to use. The fourth stage is the final product stage. At this stage, the final product will be produced in the form of a science-based thermochemical textbook that has been revised based on suggestions and criticisms from the steps of validation and analysis.

3. Result and Discussion

3.1 Teaching Material Description

The description of science-based teaching materials for thermochemical material has four aspects of literacy. First is the knowledge of thermochemical material which is an aspect of science as a torso. Second is thermochemistry in a context of science as a process of inquiry. The third is high-level thinking skills as a way of scientific thinking. Fourth is attitude is an aspect of the interaction of

science, technology and society. Moreover, the element of thermochemical knowledge as a body of scientific knowledge has a percentage of about 40%, while the other three aspects have a portion of around 20%.

The stages of developing teaching materials consist of the analysis stage and the steps of design development. The analysis phase consists of 2 stages, such as (1) analysis of concepts and the developing of thermochemical concept maps based on the study of learning syllabus, and (2) discourse analysis of thermochemical concepts adapted to chemical literacy to be developed. Therefore, a summary of the material analysis and scientific literacy skills in thermochemical material is presented in Table 1.

Table 1. Summary of material analysis and literacy ability

Material	Purposes	Science Literacy Ability
System and Environment	Based on the video about the living environment, students can explain the concepts of systems and the environment and provide examples in daily life.	Process: Identifying skills. Context: Environmental video Content: System and environmental material Attitude: Realizing the importance of interactions between systems and the environment
Endotherm and Exotherm Reaction	Based on animation in the form of images, students can distinguish exothermic and endothermic reactions.	Process: Interpreting skills Context: given an animated image of a chemical reaction. Content: Material about exothermic and endothermic reactions Attitude: Realizing the relevance of the concept of accepting and giving in life.
Heat Reaction	Based on the calorimetry experiment, students can predict the heat reaction.	Process: Observing and predicting skills Context: Calorimetry experiments are carried out Content: Material about heat reaction Attitude: Develop an honest and thorough attitude in Verbal communication and writing.
Determination of Hear Reaction	Based on the learning video for determination of heat reaction, students can calculate the enthalpy changes of various reactions by standard enthalpy or bond energy.	Process: Interpreting and analyzing skills Context: given a video about the determination of heat reaction Content: Material about the determination of heat reaction (standard enthalpy and bond energy) Attitude: Choose and respect the opinions of others to determine the right way to achieve goals.

In general, the teaching material consists of 8 parts, from the title page or identity to the bibliography. The details of the teaching materials section are (1) the initial page containing the material identity, (2) instructions on how to use teaching materials, (3) learning objectives, (4) environmental discourse related to thermochemical article, (5) content that contains thermochemistry based on learning objectives that refer to indicators of scientific literacy, (6) evaluation of learning, (7) evaluation of attitudes related to thermochemical phenomena, (8) bibliography that refers to the sources used in making teaching materials.

3.2 The Validation Eligibility of Teaching Material

The feasibility analysis of thermochemical teaching materials for general chemistry courses is carried out through reviewing teaching materials by 3 (three) KDBK lecturers in Physical Chemistry in the department of chemistry who teach in general chemistry courses. Validation tests were carried out using a validation instrument in the form of a checklist sheet that contained the quality of teaching materials that referred to the components of scientific literacy-based teaching materials. Feasibility validation is filled by three validators, which include the criteria for good teaching materials following the standards of feasibility and determined by the BSNP. It is equipped with literacy aspects that must be contained in the teaching material. The results of the feasibility test are also to get advice from the validator which is used to make improvements to teaching materials. Suggestions for validators regarding the appearance or design of teaching materials and the material and aspects of literacy must be developed. One important part that needs to improve such as the literacy-based teaching material development must be derived from the competencies achievement. It can be seen in the indicators or learning objectives. Furthermore, the teaching materials development has meaning for students who discover them. Therefore, attitude competency in scientific literacy aspects is suggested to be integrated directly in the form of discourse that is inserted in teaching materials. The data obtained from the validator's assessment of thermochemical teaching materials are presented in Table 2.

Table 2. The validation eligibility of thermochemistry teaching material based on literacy

Component	**Validator Value Percentage (%)**			
	1	**2**	**3**	**X**
Content (Material)	87	87	83	85.67
Language and Figure	90	90	90	90.00
Presentation	85	80	80	81.67
Science Literacy	85	85	80	83.33
Chart	88	96	88	90.67
Average	**87.00**	**87.60**	**84.20**	**86.27**

Based on the results of the feasibility of teaching materials, each aspect of feasibility generally has a value between 81 and 94. This means that the aspects of presentation and scientific literacy include entirely valid categories with small revisions (70<P≤85%) while for the other 3 aspects, such as content (material), Language and images and graphics included in the category of valid without revision (85<P <100%). Overall the average percentage is approximately 86.27%, which means that the teaching material is in the correct category without revision.

3.3 Readability Validation of Teaching Material

Teaching materials development for thermochemical material is given to students to be tested for the readability of the product. Data on the readability of teaching materials are presented in Table 3. Based on the data in Table 3, it can be seen that the readability of teaching material products based on literacy in thermochemical material included in the criteria is easy to understand, with the average openness of about 83.79%. The highest percentage of openness was around 91.67%, while the lowest was about 77.78% — variation in the readability percentage by various factors, such as text appearance, text structure, reader knowledge, reading ability of the reader, the difficulty of vocabulary, coherence and syntax.

A good readability level besides showing that the teaching material language is easy to understand also has good quality. It is similar with Devetak and Vogrinc which states that the quality

of science teaching materials depends on the quality of the language used because the text is the basis of the content in science teaching materials [11]

Table 3. The data of readability of thermochemistry teaching material

No	Student Group	Percentage (%)
1	KA_1	86.11
2	KA_2	91.67
3	KA_3	80.56
4	KB_1	83.33
5	KB_2	77.78
6	KB_3	86.11
7	KC_1	83.33
8	KC_2	86.11
9	KC_3	83.33
10	KD_1	80.56
11	KD_2	83.33
12	KD_3	80.56
Average		**83.79**

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4. Conclusion

Based on the research result and analysis, thermochemical science-based teaching materials for general chemistry courses have been successfully developed with the existence of scientific literacy aspects. It is such as knowledge of thermochemical material which is the aspect of science as the torso, thermochemistry in context science as a process of inquiry, high-level thinking of science skills as a way of thinking, and an attitude that is an aspect of the interaction between science, technology and society. The overall feasibility validation result is approximately 86.42% which means that the teaching material is in the valid category without revision. Therefore, the readability of teaching material products has an average percentage of about 83.79%, which means that teaching material which is included in the criteria easily tounderstand.

Acknowledgement

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