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Teaching Materials Based on Elaboration Strategies for Physics Learning Subject Thermodynamics in Senior High School

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ABSTRACT

The available teaching materials still need to follow the characteristics of students. It causes students to find it challenging to understand the concept. One alternative to overcome this problem is to make teaching materials based on elaboration strategies. This research aims to produce teaching materials based on elaboration strategies, especially thermodynamics materials that have good validity, practicality, and effectiveness. This type of research is Research and Development (R&D). To achieve the above objectives, the steps taken were 1) identifying potentials and problems, 2) gathering information, 3) designing products, 4) validating designs (with five experts), 5) revising products, and 6) testing products. Based on the data analysis that has been done, the research results could be presented. First, teaching materials have validity with an average value of 84.32 experts. Second, the practical value of teaching materials based on elaboration strategies was 85.87 based on the physics teacher's assessment and 83.97 based on student assessments. Third, the use of teaching materials in effective learning was characterized by increased student physics learning outcomes from 45.57 to 76.43.

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INTRODUCTION

Physics is part of Science that examines natural phenomena (Kurniawan & Syafriani, 2021). Physics is a field of study described in the form of facts, concepts, principles, and procedures, and their truth can be tested through a series of scientific activities (Widya et al., 2020). Learning Physics is essential to teach because it can be a place to grow students' critical thinking skills. The ability to think critically is one of the 21st-century skills students need to compete in the global era (Chiruguru, 2020). Physics plays an essential role in life, so improving the quality of learning in schools is necessary. Improving the quality of learning is the main point in improving the quality of education in Indonesia (Lubis, 2019).

The government has made efforts to improve the quality of learning by improving the curriculum. In the last 15 years, Indonesia has undergone several curriculum changes, namely, the Competency-Based Curriculum (KBK), Education Unit Level Curriculum (KTSP), then refined through the 2013 Curriculum, and since a few years ago, the Ministry of Education and Culture of the Republic of Indonesia introduced an independent curriculum to teachers. , lecturers, and related parties

(Santika et al., 2022). Curriculum implementation can be through how schools as academic units can optimize the learning process, optimal management of learning resources, and the professionalism of teachers as teaching staff (Indarta et al., 2022). Teachers are expected to be able to innovate in accelerating the planting of concepts in their students. Teachers are also expected to be able to adapt to all forms of change that are currently happening (Rahayu et al., 2022). Teachers must be able to facilitate students in the learning process (Sri Mujiwati et al., 2017). One form of facility that the teacher can provide is preparing teaching materials according to the needs and characteristics of students (Widya et al., 2021). Teaching materials are all materials and tools teachers use in learning activities that function as guidelines and evaluation tools for teachers and students (Nurhamdiah et al., 2020). Teaching materials developed by teachers should be able to activate student learning and develop students' critical thinking skills (Nurfarida et al., 2021).

The availability of teaching materials that can explore students' critical thinking skills still needs to be improved. Based on interviews the author conducted with three physics teachers in the city of Padang Panjang, West Sumatra, information was obtained that the teaching materials currently available are generally suitable, do not consider students' character and learning styles, and have not been able to develop students' critical thinking skills. Students often feel bored and not interested in reading the source books used.

For teaching materials to enable students to think critically, teaching materials need to be developed based on elaboration strategies (Akhfar & Saputra, 2020). The elaboration strategy is a learning model that can improve students' thinking skills. Elaboration is part of a learning organization strategy at the macro level (Peranginangin et al., 2020). The elaboration strategy describes how to organize learning content with general-specific rules. There are seven components of the strategy that are integrated into the elaboration, namely: 1) elaborative sequence, 2) sequence of learning prerequisites: a learning structure that shows a sequence of concepts, procedures, or principles, 3) summary, 4) synthesizer: shows the links between material taught, 5) analogy: similarities between new knowledge and other knowledge, 6) cognitive strategies: skills needed by students to regulate their internal processes when learning, remembering, and thinking, 7) learning control: students' freedom in making choices and sequencing material (Thaariq et al., 2021)(Anthonysamy et al., 2020). The advantages of the elaboration strategy include: 1) providing opportunities to think, analyze, and solve problems; 2) facilitating students in cooperative and collaborative learning; 3) facilitating healthy competition to improve learning achievement; 4) facilitating students to carry out activities that foster pride and self-confidence of students(Stark, 2019)(Biwer et al., 2020).

Based on the problems above, the authors developed physics teaching materials for thermodynamics material based on elaboration strategies. This elaboration-based teaching material can improve students' thinking skills. Learning using these teaching materials is expected to increase students' understanding of physics material. This research aims to produce teaching materials based on elaboration strategies that are valid, effective, and practical to use in learning Physics. Teaching materials based on this elaboration strategy are a source of learning for students to achieve attractive, compelling, and meaningful learning. This thermodynamics teaching material was

developed according to the elaboration strategy flow: epitomizing, providing analogies, and learning prerequisites, complemented by four stages of elaboration.

METHODS

The type of research conducted is Research and Development. The procedures for R&D research are as follows: 1) identifying potentials and problems: analyzing problems and potentials through literature studies; 2) collecting information: collecting preliminary information through classroom observations and teacher interviews; 3) product design: teaching materials are developed based on the steps of elaboration theory: (study instructions, competencies to be achieved, content, information support, exercises, worksheets, test sheets, answer keys, and feedback); 4) perform design validation: using a questionnaire with the help of three validators, validation results processed using descriptive analysis techniques:

$$Value = \frac{\text{the score given by the validator}}{\max score}\ x\ 100 \quad (1)$$

5) product improvement: revise the product based on the validator's suggestions; 6) product trials: conducted on a limited basis to test the practicality and effectiveness of the product (Sugiyono, 2013). Research and development steps:

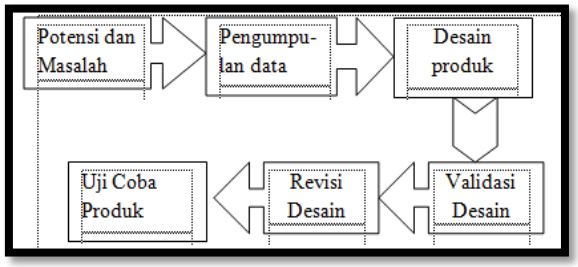

Figure 1. Research and Development Steps

The first object is teaching materials based on elaboration strategies and class XI IA students of SMA Negeri 2 Padang Panjang (28 students). The research instruments consisted of expert validation sheets, practicality test sheets, and effectiveness tests through learning achievement tests. Validation indicators are content feasibility, use of language, presentation of material, and completeness of teaching material components. Practicality test sheets consist of three types, namely: 1) practicality test sheets according to the teacher as a practitioner consisting of four indicators: the content of teaching materials, presentation in teaching materials, benefits of teaching for teachers, and opportunities for implementing teaching materials, 2) practicality test sheets according to students which consists of three indicators: benefits obtained, ease of use, and effectiveness of time, 3) practicality test sheets in the learning process which are divided into three activities, namely: preliminary activities, core activities, and closing activities. The results of validity and practicality were analyzed using a Likert scale with a range of 0-100. The effectiveness of teaching materials can be seen from student learning results using the pretest and posttest.

The product analysis technique is carried out by the description method. Data analysis techniques are carried out in three ways, namely: 1) descriptive analysis includes the average value, variance, standard deviation, lowest value, highest value,

median, mode, and range of values; 2) the graphical method helps describe the results of validation and testing practicality, 3) correlation comparison analysis using the t-test to analyze the results of the pretest and posttest experimental designs for one group(Arikunto, 2021).

RESULTS AND DISCUSSION

1. Description of Teaching Materials Based on Elaboration Strategy

The instructional material design consists of a cover, table of contents, study instructions, material characteristics, epitomizing, order of learning prerequisites, stages of elaboration (analogy, internal summary, synthesizer, example questions, exercises, activation of cognitive strategies, learning control and supporting information), summary external data, student discussion sheets, evaluations, evaluation keys, feedback, and references.

The cover of teaching materials based on elaboration strategies consists of exciting pictures and questions that motivate students to take lessons.

Figure 2: Cover Display of Teaching Materials

The author displays a picture of a refrigerator; then presents questions about images related to the material to be studied.

At the beginning of the teaching material, a table of contents is presented, which contains all the sections in the teaching material. On the following pages are presented study guides: instructions for students and teachers. In the next section, the author presents the characteristics of the subject matter, which consists of competency standards, essential competencies, indicators, and learning objectives. The characteristics of this subject matter are presented at the beginning of the teaching material so that it can be used as a benchmark for students in learning the material.

Before starting the elaboration stage, the epitomizing stage and the order of learning prerequisites are presented:

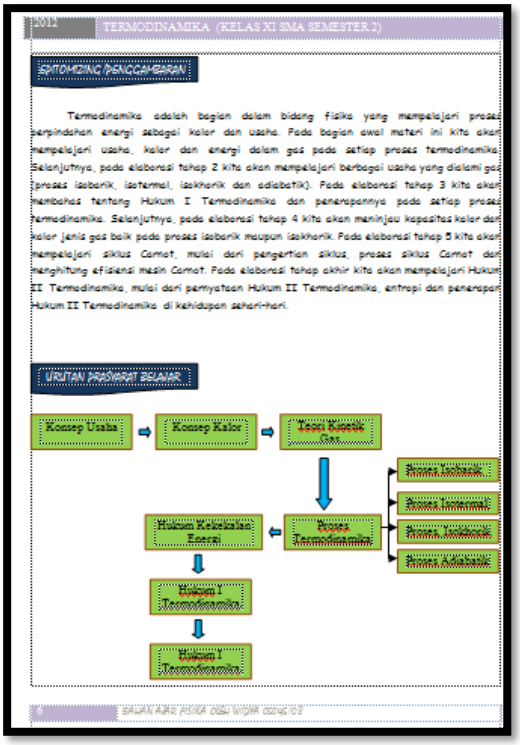

Figure 3. Display of Epitomizing and Order of Learning Prerequisites

Epitomizing contains an overview of the content/material in the teaching materials. The order of learning prerequisites determines the sequence of concepts/material be learned. After presenting epitomizing and the order of learning prerequisites, the writer presents learning materials arranged systematically and interestingly.

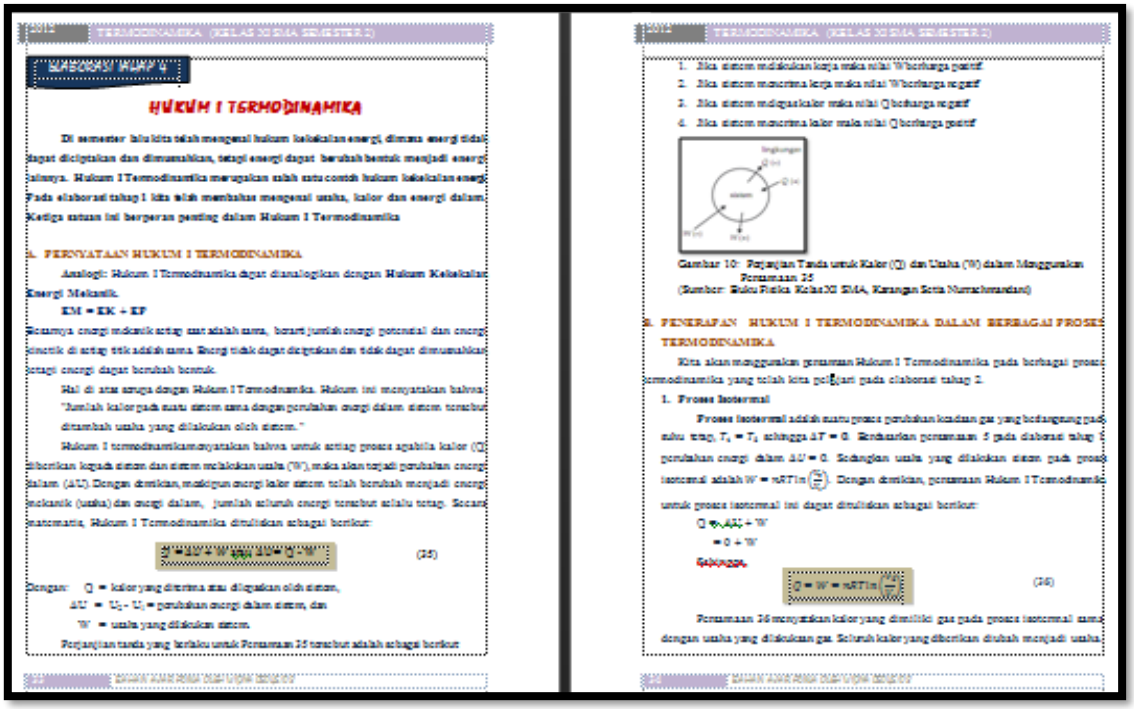

Figure 4. Display of teaching materials

At several stages of elaboration, the author presents an analogy. In addition, the author also provides examples of questions regarding the material just presented. Examples of questions are presented in order to increase students' understanding of the material just studied. Each stage of elaboration should end with an internal summary and synthesizer.

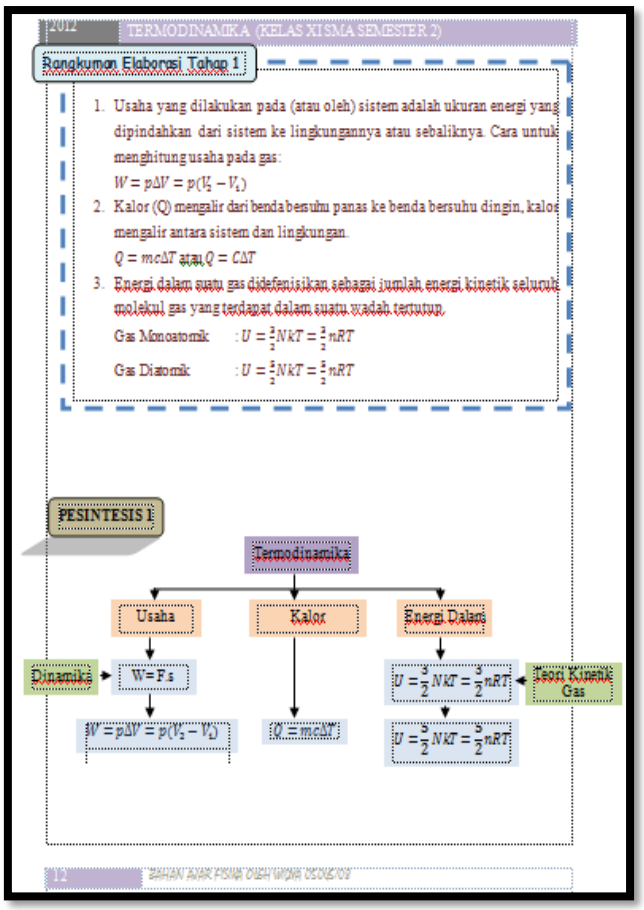

Figure 5. Display of Internal and Synthesizer Summary

Besides ending with synthesis and internal summary, cognitive strategy activation and training are also presented at each stage of elaboration. Activation of cognitive strategies serves to assist students in remembering the newly learned material. The exercises presented at each elaboration stage increase students' understanding of the material just learned.

The next part of the teaching materials is supporting information that broadens students' insight into the material just learned—learning control functions to give freedom to students in sorting learning content and learning speed. After all the elaboration stages have been described, it is followed by an external summary which includes all the material in the teaching material. The next part is a worksheet; there is no practicum in the developed material, so it is changed to a discussion sheet. If all the material has been presented, then at the end of this teaching material, an evaluation must be accompanied by the answer key to the evaluation.

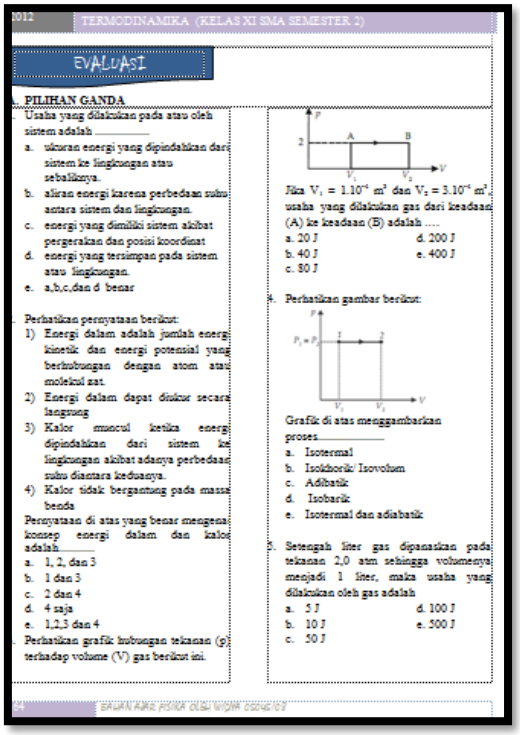

Figure 6. Display Evaluation of Teaching Materials

At the end of this teaching material, feedback and references are presented by the author in writing teaching materials.

2. Teaching Material Validation Results

The validation of teaching materials based on this elaboration strategy is seen from the validator's assessment of the four indicators. The four indicators are 1) the feasibility of teaching materials, 2) the use of language in teaching materials, 3) the presentation of teaching materials, and 4) the completeness of teaching materials. The number of experts who validate teaching materials is 5 Physics lecturers. The lowest score for each statement is 5, while the highest is 25. The score for each statement obtained can be converted into grades so that the lowest score becomes 20 and the highest score is 100. After obtaining each indicator's value, it is matched with the criteria to determine the validity value. One indicator's score and average value are determined from the score and average value of all statements contained in an indicator.

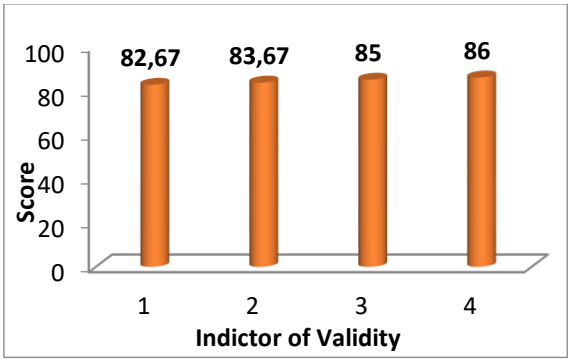

Figure 7. Teaching Material Validation Indicator Values

Based on Figure 7, information is obtained on the average value of each teaching material validation indicator. The value of the feasibility indicator for the content of teaching materials is in the excellent category, the indicator value for the use of language in teaching materials is in the very valid category, the indicator value for the presentation of teaching materials is in the very valid category, and the indicator value for completeness of teaching materials is in the same category. Valid. Based on this, all teaching material validation indicators are in a very valid category with a high level of validity.

3. Teaching Material Practicality Test Results

According to the teacher, the practicality test sheet has four indicators. The four indicators are 1) content of teaching materials, 2) presentation of teaching materials, 3) benefits of teaching materials for teachers, and 4) opportunities for implementing teaching materials. The number of teachers who gave responses to teaching materials was five people, so the lowest score for each statement was five, and the highest score was 25. The score for each statement obtained was converted into grades so that the lowest score became 20 and the highest score became 100. Based on the value of each, the practicality test indicators of teaching materials on the practicality test sheet, according to the Physics teacher, can be determined by the average value of the statements contained in each indicator. The value of the indicator for the content of teaching materials was 91.33, the value for the indicators presented in the teaching materials was 83.20, the value for the indicators for the benefits of teaching materials was 83.33, the value for the indicators for the opportunity to implement teaching materials was 85.60. Based on these data, all indicators are in the very practical category. According to the teacher, the average value obtained from the practicality test results is 85.87. Based on these values, all indicators of the practicality test of teaching materials are in the very practical category.

The results of the students' practicality test were analyzed based on the student's practicality test sheet on the teaching materials based on the elaboration strategy. Three indicators were analyzed based on the practicality test sheet according to the student. The three indicators are 1) benefits obtained, 2) ease of use, and 4) time effectiveness. The number of students who responded to the teaching materials was 28 (the number of students in class XI IA 2 SMAN 2 Padang Panjang), so the lowest score for each statement was 28, and the highest score was 140. The scores obtained were converted into grades so that the lowest score became 20 and the highest score was 100. According to students, the value of each indicator of teaching materials on the practicality test sheet can be determined by the average value of the statements contained in each indicator. The value of the indicator of the benefits obtained was 84.17, the value of the indicator for the ease of use of teaching materials was 84.88, and the value of the indicator for the effectiveness of time was 82.86. The value of the results of the practicality test of teaching materials according to students can be determined by finding the average of all indicators. The average value obtained from the results of the practicality test according to students is 83.97. Based on these values, it can be stated that all indicators of teaching materials are in the very practical category

The results of the practicality test of teaching materials in learning are known from analyzing the implementation of the aspects that have been determined. In the practicality test instrument, thirteen aspects are observed during Physics learning. All these aspects were analyzed during six meetings and grouped based on preliminary, core, and closing activities. Each aspect is given a score from 1–4 according to the level of implementation observed by the observer. The score obtained is converted into a value so that the lowest score for each aspect is 25 and the highest is 100. The value obtained for each aspect can be graphed. The practicality test results in learning have values ranging from 75.00 to 91.75. Twelve of the thirteen observed aspects were included in the well-implemented category, and one other was in the implemented category.

The results of the three practicality tests (practicality test according to the teacher, practicality test according to students, and test the implementation of teaching materials in the learning process) can be presented in Figure 8:

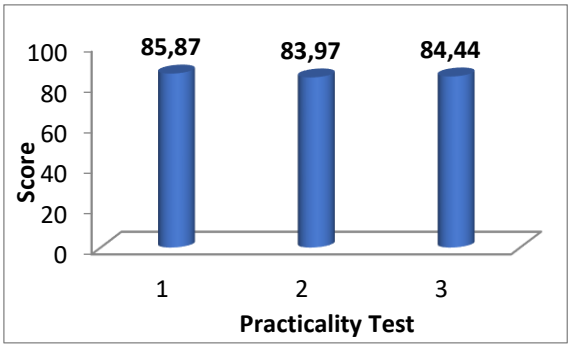

Figure 8. Display of the Value of the Practicality Test

The value of the three practical tests carried out. The average value of the practicality test indicators, according to the teacher as a practitioner, is in the very practical category, the average value of the practicality test indicators according to students is in the very practical category, and the average value of the practicality test of teaching materials in learning is already in a very practical category. These three values are already in the very practical category.

4. Results of Teaching Materials Effectiveness Test

Data on student learning outcomes before using teaching materials based on elaboration strategies: mean: 45.57, variance: 196.84, standard deviation: 14.02, lowest score: 24, highest score: 68, median: 48, mode: 32, range of scores: 44. Data on student learning outcomes after using teaching materials based on elaboration strategies: mean: 76.43, variance: 87.38, standard deviation: 9.34, lowest score: 60, highest score: 96, median: 76, mode: 72, range of values: 36. Based on the data obtained, there was an increase in the average value of student learning outcomes after using teaching materials based on elaboration strategies from 45.57 to 76.43. A correlation comparison analysis can be sought based on the descriptive data from the pre-test and post-test. The ttable value is 1.7, while the tcount value is 19.04. The value of tcount in the research is more significant than ttable, meaning that the elaboration strategy can improve student learning outcomes.

Based on the research data described, information is obtained that the product in the form of teaching materials based on the elaboration strategy made is valid, practical, and effective. Teaching materials that are made can improve student learning outcomes. It is because this teaching material is structured based on an elaboration strategy where the material in this teaching material is presented systematically by elaborating material from general to specific matters (Peranginangin et al., 2020). It also aligns with the theory that elaboration describes ways of organizing learning content by following general rules to details(Thaariq et al., 2021). The material is described from general to specific matters. The components of the elaboration strategy have been integrated into teaching materials. This teaching material is used in learning physics in schools, helping teachers and students in learning. Through teaching materials, it will be easier for teachers to carry out learning, and students will be more helpful and easy to learn (Octaviani, 2017). Using thermodynamics teaching materials based on elaboration strategies facilitates students and teachers in learning and can improve learning outcomes.

CONCLUSION

Based on the research results, several conclusions can be put forward as follows: 1) the validity of teaching materials based on elaboration strategies by experts is high with a value of 84.32, 2) the use of teaching materials based on elaboration strategies in learning is very practical with 85.87 based on the physics teacher's assessment and 83.97 based on student assessments, 3) the use of teaching materials in learning is effective marked by an increase student learning outcomes from 45.57 to 76.43..

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