

## **Developing Science Teaching Book with a Scientific Approach to Analyze the Concept of Energy in the 7th Grade Junior High School**

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### **Abstract**

The observation in the Junior High Schools (SMP/MTs) in Malang City found that students had difficulties in understanding energy in the life system's topic. It is because learning is centered on the teacher, and the students only accept concepts explained by the teacher. Therefore, a science teaching book is needed to support student understanding of the energy in the life system's material and the student-centered learning achieved. This study aims to produce a science teaching book with a scientific approach to analyze the concept of energy for seventh-grade junior high school that is valid and suitable for use in learning. The feasibility test is done through media validation, material validation, and limited readability tests. Media and material validation were carried out by one science education lecturer, and limited readability testing was carried out by three junior high school teachers and ten seventh grade junior high school students who had taken energy topic in the life system. The results of the study showed that the science teaching book with a scientific approach developed is valid and appropriate to use in the future.

### **I. Introduction**

Science studies natural phenomena with scientific processes to produce scientific products [8]. In the scientific process, there is a scientific attitude and problem-solving skills using scientific procedures and methods. Student-centered learning can enhance student scientific skills to be able to produce scientific products. Students can develop conceptual understanding and the ability to investigate through this learning [3]. Students do not only know the concept or theory, but students are also invited to be active in finding the concept as a scientific product in Science learning. The results of scientific products can be concepts, principles, and theories.

A natural science topic that is considered difficult and abstract based on research by Insani [2] is photosynthesis. The teacher felt the topic as an abstract topic because it cannot be sensed directly

by students. The material is included in Basic Competence 3.5 of 7<sup>th</sup> grade, analyzing the concept of energy, various sources of energy, and changes in the form of energy in life including photosynthesis. The topic consists of energy, energy sources, and changes in the form of energy which are generally very close to students' daily life. The application of this topic is often found by students so that to better understand the concept can be associated with life. In addition to photosynthesis there are also energy subjects that are close to student life, such as free falling objects, lights, and food changes to become energy used for daily activities. Another obstacle is teacher-centered learning. Students only accept the concept based on the teacher's explanation, in other words students do not actively participate in learning.

A scientific approach is a learning approach that can encourage students to be active during learning activities [4]. Student participation can develop science concepts, principles, and law. The scientific approach consists of learning stages that must be followed to produce a complete product. The stages of learning include observing, asking, trying, associating and communicating [6].

Teaching materials are a tool that can support learning. Teaching materials employed the scientific approach are limited. In addition, the teaching material generally is still fragmented based on the field of study [5]. Therefore, there is a need for teaching materials that can support learning and encourage students to discover the science concept. Besides teaching materials can also be studied independently by students to deepen the concepts.

Based on the description, it is necessary to develop science teaching materials that can invite students to be active in learning accompanied by varied learning activities and in accordance with the development of students' skills and knowledge. Therefore, researchers developed teaching materials in a research development conducted entitled "Development of Scientific Approach Natural Science Teaching Materials to Analyze Energy Concepts for 7th Grade of Junior High School".

## **II. Methods**

Research on the development of teaching materials with scientific approached to analyze energy concepts for 7th Grade of Junior High School using the Thiagarajan Four-D Model (4-D) research method [7] which consists of defining, designing, developing, and dissemination (disseminate). In this study carried out until the development stage, it suitable with research purposes to developed proper teaching materials.

The instrument used in this development research is questionnaires data. The assessment was carried out through the validation stage and readability limited test. Validation was carried out by material expert validators and media expert validators. After being declared valid and feasible by the validator, readability tests are limited to teachers and students. Data obtained from the results

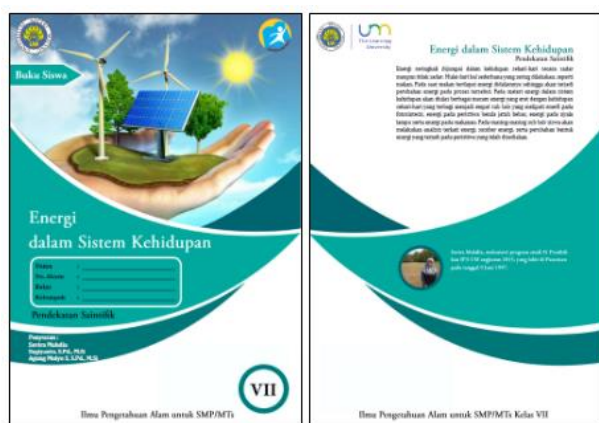
of validation and limited readability tests in the form of quantitative and qualitative data. Quantitative data used the Guttman scale, while qualitative data are in the form of comments and suggestions given. The data analysis technique performed was descriptive analysis technique with an average score of answers on each aspect of the product being assessed [1].

### III. Result and Discussion

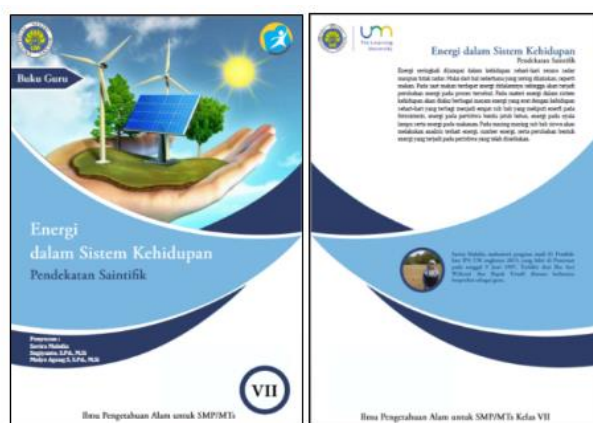
#### A. Description of Research and Development Results

The development product is printed teaching materials consisting of student books and teacher books for activities to analyze the concept of energy for 7th grade of junior high school. Teaching materials developed contain an opening page consisting of cover pages, introductory words, table of contents, and instructions for using books. The teacher's book is also equipped with a syllabus and lesson plan. The cover page of both the student's and the teacher book's contains the same information but there are a different title and colour, the cover page of the student's book can be seen in Figure 1(a) and for the teacher's book in Figure 1(b).

In the contents contains student worksheets for each sub-topic in accordance with the scientific stages, namely observing, asking, trying, associating, and communicating. The teacher's book is accompanied by an answer key and assessment techniques for each worksheet. At the observing stage, students are invited to observe the video or animation provided. Student observations are written on the Let's Observe worksheet, which consists of energy, energy sources, and changes in the form of energy contained in the video/animation. The appearance of the observing worksheet can be seen in Figure 2(a).



(a)



(b)

Figure 1. (a) Cover Page of Student's Book; (b) Cover Page of Teacher's Book



### Ayo Mengamati

Perhatikan dengan seksama video mengenai fotosintesis berikut. Analisislah energi, sumber energi dan perubahan bentuk energi yang terjadi.

(Sumber video : <https://www.youtube.com/watch?v=ogeWwL05PNw&t=431s> )

Tulislah hasil analisis kamu mengenai energi, sumber energi dan perubahan bentuk energi di bawah ini !

Energi :

Sumber Energi :

Perubahan Bentuk Energi :

(a)



### Ayo Bertanya

Berdasarkan video yang kamu amati, buatlah pertanyaan mengenai energi, sumber energi dan perubahan bentuk energi pada fotosintesis dan tuliskan pertanyaanmu di sini !

(b)



### Ayo Mencoba I

#### Informasi II

Sesuai dengan tujuan pembelajaran, pada materi kali ini kalian akan melakukan percobaan fotosintesis Sachs yang akan kalian lakukan bersama kelompok. Pada fotosintesis tumbuhan membutuhkan sumber energi agar dapat melakukan fotosintesis, yaitu berupa cahaya matahari dan karbondioksida ( $\text{CO}_2$ ) di udara yang nantinya akan terjadi perubahan bentuk energi. Pada percobaan fotosintesis kali ini untuk membuktikan bahwa pada proses fotosintesis membutuhkan cahaya matahari dengan menutupi sebagian daun dengan aluminium foil serta membuktikan adanya atau tidaknya karbohidrat pada hasil fotosintesis. Pembuktian ada atau tidaknya karbohidrat pada hasil fotosintesis dapat dilihat melalui perubahan warna yang terjadi pada saat ditetesi larutan yodium, jika terdapat perubahan warna menjadi berwarna kehitaman maka menunjukkan bahwa fotosintesis menghasilkan karbohidrat, semakin pekat perubahan warna yang dihasilkan maka semakin banyak karbohidrat yang dihasilkan pula. Untuk lebih jelasnya mari kita lakukan percobaan "Perubahan Energi pada Fotosintesis".

#### PERUBAHAN ENERGI PADA FOTOSINTESIS

Identitas

Kelompok :

Hari, tanggal :

Alat :

1. Pembakar spiritus
2. Kaki tiga
3. Gelas beker
4. Tabung reaksi
5. Cawan petri
6. Pinset
7. Pipet tetes
8. Gunting

(c)

Figure 2. (a) Observing; (b) Asking; and (c) Trying Stage

#### Informasi III

Kalian telah melakukan percobaan fotosintesis dan telah mengetahui bahwa energi dapat berubah ke bentuk yang lain, dimana fotosintesis merupakan penerapan dari hukum kekekalan energi. Simaklah penjelasan berikut.

"Energi total tidak berkurang dan juga tidak bertambah pada proses apa pun. energi dapat diubah dari satu energi ke energi lainnya dan dipindahkan dari satu benda ke benda lainnya, tetapi jumlah totalnya tetap konstan."

Sama halnya pada fotosintesis, energi cahaya dari matahari, air, dan energi kimia berupa karbondioksida ( $\text{CO}_2$ ) diubah menjadi bentuk energi lain yang merupakan hasil dari fotosintesis. **Fotosintesis** adalah proses pembentukan karbohidrat dari karbondioksida ( $\text{CO}_2$ ) dan air dengan bantuan energi cahaya matahari. Organisme yang mampu melakukan fotosintesis adalah organisme yang selnya mengandung klorofil (zat hijau daun) yang terletak di dalam kloroplas.

#### Scientist



**Julius Von Sachs** (1832-1897), seorang ahli botani Jerman dari Breslau, Prusia Silesia yang membuktikan bahwa fotosintesis menghasilkan zat gula atau karbohidrat yang disebut amilum.

Lengkapilah kerangka poster di bawah ini dengan mengaitkan hasil percobaan dengan teori yang sesuai pada "Informasi III" mengenai energi, sumber energi dan perubahan bentuk energi yang terjadi, agar kamu lebih mudah memahami materi ini!

(a)

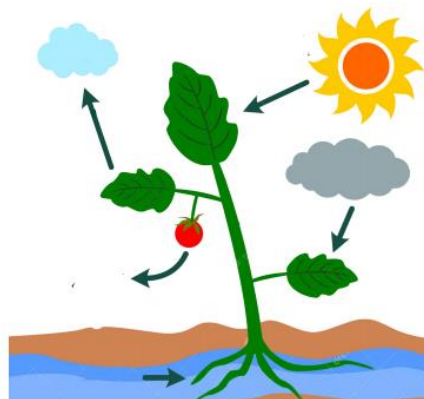


### Ayo Berkomunikasi

Tuliskan informasi baru dari presentasi yang dilakukan oleh temanmu di bawah ini! Jelaskan energi, sumber energi, dan perubahan bentuk energi apa saja yang terjadi.

#### FOTOSINTESIS SACHS

Berdasarkan hasil diskusi yang telah kalian lakukan, lengkapilah kerangka poster berikut!



(b)

Figure 3. (a) Associating Stage: Information and Worksheet; (b) Communicating Stage

The second stage was asking. At this stage, students write questions related to energy, energy sources, and energy changes based on observations in the previous video. The following display of the questioning worksheet accompanied by the delivery of learning objectives, shown in Figure 2(b). Then Figure 2(c) shows the third stage, that is trying. At this stage, there were two variations of learning activities developed. The first, the students in the class was divided into three groups with the same experiment but with different test materials which would then be carried out

discussions by exchanging discussions with different groups at the communicating stage. The second variation was that all groups in the class did the same activity.

The next step was to associate shown in Figure 3(a). At this stage students associated the results of the worksheet at the stage of trying with the appropriate theory. Theories related to the subject are also provided at the stage of associating as information. The last stage of the scientific learning stage is communicating shown in Figure 3(b). In accordance with the stages of trying there are two variations so that at this stage there are also two variations of the discussion. The first is a discussion with the model exchanging between expert groups and the second is classical discussion.

At the end of learning for each meeting, students were invited to conclude the learning that has been done and wrote the topic that was understood and which is not in the learning journal. The page view of the learning journal can be seen in Figure 4(a). Then the final part of the book is equipped with a review of the concept and exercises. Concept reviews contained the entire concepts. Exercises aimed to measure students' understanding of the Energy topic in the Life System. The review page of the concept and exercises can be seen in Figure 4(b).

## **B. Product Validation Results for Teaching Materials**

The product of the results of the development carried out is then validated. The validation stage consists of media expert validation and material expert validation. Data from the results of the validation in the form of quantitative and qualitative data. Quantitative data were obtained from questionnaire scores of validator media experts and material experts. Validation is done on student books and teacher books.

Based on the results of the validation of media experts, the percentage of each aspect assessed was obtained. Content eligibility with a percentage of 95%, design eligibility with a percentage of 100%, and Language eligibility with a percentage of 100%. So the average percentage of eligibility for student textbooks is 98% with a very decent category.

Whereas in the teacher's book, the three aspects assessed in the validation get a very decent category. Aspects assessed include feasibility of content with a percentage of 97% feasibility, design feasibility with a percentage of 100% eligibility and language eligibility with a percentage of 100%. So that an average percentage of 99% is obtained. Then the material validation is carried out by the material expert validator. Material validation consists of material validation and concept tests. Material validation tests include the appropriateness of the material, the suitability of the scientific stages and the suitability of the developed assessment instruments of the three aspects, each of them gets a very decent rating with a percentage of 100%.

In the concept test aspects assessed are the truth of the concept and the depth of the material.

Isilah Jurnal Belajarmu di bawah ini dari kegiatan belajar materi energi pada fotosintesis!

Hari, Tanggal	
Kegiatan Belajar yang Dilakukan	
Hasil Belajar	
Kendala Saat Belajar	

(a)

## 1. Energi



Kalian telah mempelajari energi, sumber energi, dan perubahan bentuk energi pada masing-masing penerapannya. Menurut kalian, apakah yang dimaksud dengan energi? Apakah semua makhluk hidup yang ada di alam semesta ini memerlukan energi?

Dalam kehidupan sehari-hari kita akan selalu berkaitan dengan energi. Seperti mobil memerlukan energi untuk dapat melaju di jalan raya. Seorang atlet badminton membutuhkan energi yang cukup saat mengikuti suatu pertandingan. Bahkan saat kita



### Latihan Soal

#### A. Berilah tanda silang (x) pada huruf untuk jawaban yang benar

- Unsur yang diperlukan tumbuhan pada fotosintesis adalah ...
  - Karbondioksida, air, oksigen
  - Cahaya matahari, oksigen air
  - Cahaya matahari, klorofil, air
  - Cahaya matahari, karbondioksida, air
- Karbohidrat hasil dari fotosintesis akan diangkut oleh ...
  - Floem menuju akar
  - Xylem menuju akar
- Energi yang bergantung pada kedudukan suatu benda adalah ...
  - Energi gerak
  - Energi kinetik
  - Energi mekanik
  - Energi potensial
- Durian bermassa 1,5 kg berada pada pohon dengan ketinggian 5 meter. Jika percepatan gravitasi bumi sebesar  $9,8 \text{ m/s}^2$ , maka energi potensial durian tersebut

(b)

Figure 4. (a) Learning Journal; (b) Concept and Exercises Page

Where both aspects obtain very valid assessment results with a percentage of 100%. Based on the results of the validation of the media and material, the developed teaching material gets a very appropriate assessment, so it can be used in learning

## C. Readability Test Results

Readability test conducted to determine the quality and readability of teaching materials by users. The legibility test was conducted at the Universitas Negeri Malang (UM) Laboratory Middle School. The participants of the readability trial included three science teachers and ten students of 7th grade. Data from the teacher's readability test results are presented in Table 1.

Table 1.

Readability Test Results of Teacher's Book

No.	Product Aspects	Persentase	Appropriateness
1.	Device Learning	96%	Very Worthy
2.	Observing Stage	93%	Very Worthy
3.	Asking Stage	100%	Very Worthy
4.	Trying Stage	96%	Very Worthy
5.	Associating Stage	100%	Very Worthy
6.	Communicating Stage	100%	Very Worthy
7.	Learning Journal	100%	Very Worthy
8.	Explanation of Assessment Techniques	100%	Very Worthy
9.	Exercises	89%	Very Worthy
Average		97%	Very Worthy

Table 2.

Data Readability Results Student Books

No.	Product Aspects	Persentage	Appropriateness
1.	Device Learning	100%	Very Worthy
2.	Observing Stage	100%	Very Worthy
3.	Asking Stage	100%	Very Worthy
4.	Trying Stage	95%	Very Worthy
5.	Associating Stage	95%	Very Worthy
6.	Communicating Stage	95%	Very Worthy
7.	Learning Journal	97%	Very Worthy
<b>Average</b>		<b>96%</b>	<b>Very Worthy</b>

Based on the data in Table 1, the developed teaching material is declared feasible. The readability test results of student books are presented in Table 2. It can be concluded based on the readability test of the material developed is suitable for use in learning.

#### IV. Construction of References

This development research produced print teaching media with scientific approach to energy material in the living system for 7th Grade of Junior High School. Based on the results of media validation, the feasibility of the media is 99% and the material eligibility is 100%. Based on the readability test of teacher's books, the percentage of eligibility is 97% and 96% for student books. It can be concluded that the developed teaching material is valid and feasible. Suggestions for users and developers of further science teaching materials is develop teaching materials similar to other materials, and further research can be done to test the effectiveness of science teaching materials in learning

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