

# Interactive Physics E-Book Design of Energy Resources to Optimize Self-Directed Learning and Critical Thinking Skill

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**Abstract**— This study is aimed to assess student's and subject teacher's needs in the learning process, to develop an interactive electronic physics source material in energy resources, and to grow critical thinking skills for the 12th grader of Senior High School. This study consists of four procedural steps: Problem identification, data sampling, product design, and design validation. The result of need assessment was obtained from 71 Senior High School students and Physics Teachers from several schools in Bandar Lampung. The result of the questionnaires as a data sampling technique was analyzed in quantitative and descriptive methods. The result shows that a physics textbook as a learning source material hasn't been optimally functioned to grow self-confidence to overcome National Examination. On the other hand, the teacher requires Physics source material, which facilitates the learning process with the scientific approach, can improve critical thinking skills, and possible to be conducted in self-directed learning. The validation test results indicate that the type of source material that can accommodate 12th-grade students and physics teachers is an interactive electronic book that contains feedback. Stimulate activities in understanding concepts through images, animation. And finally complete with examples of problems and competency tests to improve students' conceptual understanding.

**Keywords:** *interactive e-book, self-directed learning, critical thinking skills*

## I. INTRODUCTION

In improving the quality of education in Indonesia, the government continues to develop the curriculum, either by improving the content or process in the learning activities. Learning is the process of interaction among teachers and students, and learning resources in a learning environment, including teachers and students exchanging information. The 21st-century competency framework demonstrates that having

essential knowledge is not sufficient. It must be accompanied by creative-critical skills, strong character, and the ability to utilize information and communicate [1].

According to Pemdikbud (Culture and Education Ministry Regulation) number 65 2013, about the Standard Process of Primary and Secondary Education, it is needed to combine the learning process with the rules of the scientific approach [2]. The elaboration of a scientific approach to learning in it, including the components: observing, asking, reasoning, trying, and communicating [3]. These components should be brought up in every learning practice. The learning process should use a student-centered learning approach. Students are placed as subjects of active learning in developing their interests and potential. It becomes one of the requirements of teachers to face the era of the 21st century, which requires learning to foster critical thinking, creative, communicative, and collaborative skills. High-level thinking skills include the ability to think critically and creatively [4]. Students who are able to think critically can solve problems effectively [5].

Nevertheless, in fact, the learning process conducted so far is still teacher-centered in which most of the methods used in learning are lectures. This phenomenon is proven after observing at two senior high schools in Bandarlampung, in which the result showed that 42 of 71 students stated that the learning method teachers often use lecture and tasks-solving. This shows that it has not optimally utilized the learning resources used for student-centered learning.

Based on the results of further observations, it's found that infrastructure facilities in the form of Liquid Crystal Display (LCD) projectors in each class computer network are available to support the learning activity. Besides, all students can operate the computer well. The criterion of books that the students expected is an interactive textbook containing a

description, simulation, and interactive exercise to improve understanding of learning materials that can be done, whether in the learning process or independently.

Physics learning in the second semester of the 12th grader of Senior High School becomes difficult both for students and teachers. Within a relatively limited time, the students must prepare for the Exam practice, School Exam (US), and the National Exam (UN). Consequently, a great deal of Physics material was not explained comprehensively. Students felt that this semester the teachers tend to explain material briefly in which only the material considered as important is taught. The material taught in the even semester is difficult. The observation result shows that 73% of students found difficulty in learning physics. 65% of students stated that the physics book used in learning was out of expectation. Students' expectations in learning physics are interactive electronic books that can be used independently, which contain instructions for use, learning objectives, learning materials, sample questions and discussions, video illustrations, animations, summaries, and interactive quizzes with feedback. Based on further observations, one of the materials that have not been explained thoroughly is energy resources. Energy resources are a new subject matter that is added to the 2013 Curriculum, so there aren't many available teaching materials.

This research is aimed to create an interactive e-book design through scientific approach with energy resource as the topic which can be implemented in independent learning and improve students' critical thinking ability.

**II. METHOD**

Research and development (R & D) method refers to the design of research and development of the ADDIE model of education, which consists of 5 stages: analysis, design, development, implementation, and evaluation. The research procedure is limited to the validated design stage of the expert. The first phase of the research is analysis. At this stage, student's and teacher's needs analysis of interactive e-books is done. Data collection activities were conducted through questionnaires that have passed the expert test and was used in similar research. Questionnaire techniques to 71 of 12th grader of Senior High School and four teachers from two schools in Bandar Lampung. Questionnaires were disseminated to determine the condition of learning in physics subjects, the difficulties of students in understanding the material, the methods used by teachers, and the learning media used by students in studying the material of energy resources and the availability of facilities and infrastructure (laboratory facilities and internet connection). The data were then analyzed by quantitatively descriptively.

The next stage is making an interactive e-book design. Experts in science education do validation of interactive e-book design by using Expert Test Instrument in the form of an interactive e-book design score sheet. Test validation of this design is aimed to find out the important aspects contained in an interactive e-book such as concepts, formulas, animations, video, and the type of questions that refer to critical thinking. Guidelines for expert validation test scores are presented in Table 1.

TABLE I. ASSESSMENT COLUMN OF EXPERT VALIDATION TEST

Option	Score
Very Important	5
Important	4
Important Enough	3
Less Important	2
Not Important	1

The average of assessment results are then searched by using the formula:

$$\text{Average Score} = \frac{\text{Total Score}}{\text{Amount of Experts}}$$

Having obtained the average, then converted to the assessment statement. The conversion of the score into an assessment statement is presented in Table 2.

TABLE II. CONVERSION OF THE SCORE INTO AN ASSESSMENT STATEMENT

Average Score	Statement
4,20 – 5,00	Very important to put in the interactive e-book
3,40 – 4,19	Important to put in interactive e-book
2,60 – 3,39	Sufficiently important to put in the interactive e-book
1,80 – 2,59	Less important to put in the interactive e-book
1,00 – 1,79	Not important to put in interactive e-book

**III. RESULTS AND DISCUSSION**

Based on the questionnaire of needs analysis, the arrangement of an interactive e-book is designed using a scientific approach to energy resource materials (Figure 1). An interactive e-book is designed as a learning resource that students can use independently. It contains instruction manuals, learning materials, sample questions and discussion, video illustrations, animations, summaries, and interactive quizzes with feedback.

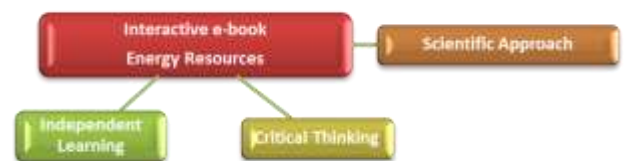


Fig. 1. Diagram of Interactive e-book Design

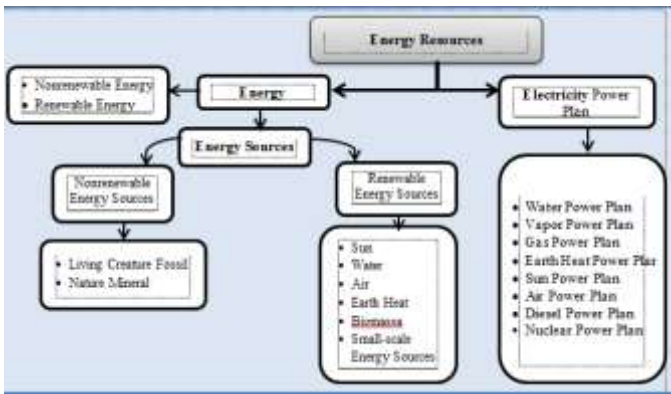


Fig. 2. Energy Resources Material

Based on the result of the expert validation test, the scope of energy resources consists of energy definition, the main forms of energy, the concept of energy conversion, and, for example, various power plants. Furthermore, the scope of renewable and non-renewable energy source material and the impact of energy on the environment and its preservation.

The results of expert validation were then obtained by the formation of interactive e-book designs from energy resource materials (Figure 3), which contained instructional use, learning objectives, learning materials, sample questions and discussions, and interactive quizzes with feedback. Learning material in the design of interactive e-books is equipped with images, animations, simulations, and videos. These energy resource materials are subject matter without the newly added prerequisite subject to the revised 2013 curriculum. The scope of the material does not only focus on aspects of knowledge, such as knowing various renewable and non-renewable energy sources. More than that, students are expected to think critically to analyze alternative energy as a form of solutions from limited sources of renewable and non-renewable sources and awareness of energy conservation or energy savings.

Due to the short period of time in the 2nd semester of 12th graders of Senior High School, it is required innovation in learning. Using multimedia in teaching and learning systems can enable learners to think critically, become problem solvers, more likely to seek information, and be more motivated in the learning process [6]. The use of technology in education provides a good learning environment for learning and helps improve student motivation. Computer-based teaching has had an impact on the development of educational technology for the most part in the twenty-first century and has resulted in the

production of computer-based instruction software [7]. An interactive e-book can be equipped with interactive multimedia or animation features to make it easier for students to capture the subject matter [8]. The existence of a developed e-book can direct students' attention and encourage students' interest to learn. It allows students to be able to realize what they have learned from a patient tutor (computer) that adapts to students' abilities [9].

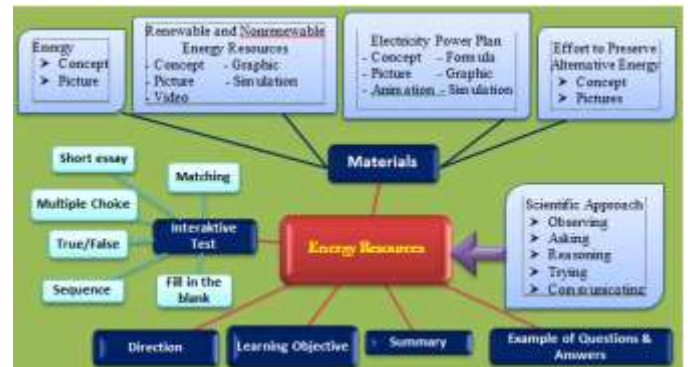


Fig. 3. Design of interactive e-book about Energy Resources material

a scientific approach conducts learning activities, so the e-book is packed with activities observing, asking, reasoning, experimenting, and presenting the results of a series of learning activities that have been done. Such learning activities are expected to encourage and train students in improving students' critical thinking skills.

The systematic format of the e-book is started from the description of the physics phenomenon about energy limitation or renewable energy resources, especially in Indonesia. After that, students are invited to have a discussion, including delivering questions. Moreover, students gathering data by comparing several energy resources in solar cell experimentation in looking for specific relation and explanation. The last, students present the conclusion of the experiment.

Interactive multimedia applications are designed to display specific results and provide feedback quickly. As well as interactive multimedia, the interactive e-book media is a combined medium that is a way to generate and deliver material that combines several forms of media controlled by a computer [10]. Using learning can encourage students to learn and improve their awareness and attitudes about environmental issues [11].

TABLE III. THE RESULT OF EXPERT VALIDATION TEST ON INTERACTIVE E-BOOK DESIGN OF ENERGY SOURCE

No	Component of Material	Result of Expert Validation Test	Statement
A	<i>Concept of Energy</i>		
	Concept of Energy		
	Definition of Energy	4	Important
	Illustration	3,33	Important
	Types of Energy		
	Definition of Renewable and Non-renewable Energy	4	Important
B	<i>Sources of Energy</i>		
	1. Sources of Non-renewable Energy	3,33	Important

	Pictures of Fuel Energy, Coal, Natural Gas, and Nuclear Fuel Sources	4,33	Very Important
	Video of Non-renewable Energy Sources	4,33	Very Important
	2. Renewable Energy Sources		
	Pictures of Sun, Water, Soil, and Air as Energy Sources	3	Important Enough
	Video of Renewable Energy Sources	2,44	Important Enough
	Simulation of Renewable Energy energy on Solar Panel	3,33	Important
<b>C</b>	<i>Kinds of Electricity Power Plan</i>		
	Concept of Various Electricity Power Plan Utilizing Sun, Water, Soil and Air	5	Very Important
	Pictures of Various Electricity Power Plan	4,33	Very Important
	Video of Various Electricity Power Plan	3,33	Important Enough
<b>D</b>	<i>Preservation of Energy Sources</i>		
	Concepts of Various Energy Sources Restrictiveness	5	Very Important
	Illustration of Concept of Alternative Energy Utilization	4,33	Very Important
	Graphic of Development of Alternative Energy Utilization	3,33	Important
	Video of Negative Effects of Resources	3	Important Enough

The 'multimedia' component is characterized by the presence of text, images, graphics, sound, animation, and video [12]. Based on expert validation, component concepts, graphics, formulas, images, animations, video illustrations are required in an interactive e-book of energy resource materials (Table 3). Along with the development of information and communication technology (ICT), e-learning has emerged as an innovative approach to promote learning to students for continuing to higher education. E-learning provides an alternative to traditional classroom education and allows students to access information without time constraints [13]. The electronic book is one of e-learning that can be used independently. E-books as an electronic form of a book with features similar to a printed book include pages that can "change," and digital features can help readers like word pronunciation, text highlighting, and hypermedia (e.g., video, animation, and sound) [14].

Visualization generally equips students with more information and involves a higher level of interactivity compared to learning presented in text or lecture format [15].

Interactive test types that are considered to be very suitable in interactive e-books include the type of multiple-choice, true/false, fill in the blank, matching, and short essay. The type of interactive test is tailored to the characteristics of the material. Computer-Based Instruction (CBI) allows students to learn by themselves by evaluating and reflecting on their learning. CBI motivates children to learn better by providing direct feedback and reinforcement by creating a fun and exciting atmosphere [7,16].

One of the important learning goals is to improve students' critical thinking skills, make rational decisions about what is believed to be done. When students are accustomed to becoming passive learners simply by memorizing and remembering information, it may be difficult at first to involve them in active learning situations that require critical thinking skills [17]. Essential thinking skills are essentially problem-solving skills. For students to be more effective in the work environment and personal life, students must be able to solve problems to make effective decisions, and they must be able to think critically [18]. The development of critical thinking as a result of desirable education requires teaching methods that

help learners improve their ability to think critically [18]. To be able to solve problems and make decisions effectively with only insufficient knowledge or information, students must be able to think critically [20].

On the one hand, e-learning is not limited to geographic barriers. Students can engage in self-learning, and learning resources can be used repeatedly [21]. With the use of interactive e-books can attract students' attention. Students feel happy and enjoy the lesson. At the same time, they can develop their potential continuously [11, 22].

#### IV. CONCLUSION

Expert validation results show that interactive e-book design with a generated scientific approach can foster students' critical thinking skills. Several aspects considered including the instruction manual, learning objectives, learning materials, sample questions and discussion, video illustration, animation, summary, and interactive quizzes with feedback, and can be used independently.

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