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by Agus Suyatna

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Development of Interactive E-book on Energy Resources to Enhance Student's Critical Thinking Ability

Muhammad Fikri Hasan*, Agus Suyatna, Wayan Suana
Faculty of Education and Teacher Training, Universitas Lampung, Indonesia

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***Correspondence Address:**
m.fikrihasan.fh@gmail.com

Abstract: This research aimed to develop a valid interactive e-book using Learning Content Development System (LCDS) with scientific approach on energy resources to enhance student's critical thinking ability, to know readability and the ease of operating the developed e-book. The method used is research and development. The implementation of procedures adopted from Sugiyono's design which consisted of 7 adjusted steps that were potency and problem assessment, data collecting, developing preliminary form of product, expert validation, design revision, one-on-one test, and product revision. Developed e-book contains pictures, animations, simulations, learning video, essay question, and interactive test. The e-book has been validated in content and design with results "very appropriate" in quality and "proper to use" as the recommendation for students in learning energy resource topic with scientific approach to foster critical thinking ability. One-on-one test's results show that e-book is very easy to operate with score 3,68 and has very good readability with score 3,60.

INTRODUCTION

The development of education system in Indonesia requires students to adapt to the conditions that they will face in the future such as globalization, environmental problems, the advancement of information, and the convergence of science and technology. One of many things developed by the government in the field of education in Indonesia is the 2013 curriculum. Kemendikbud states that the 2013 curriculum is a development product of curriculum that requires students to fulfill several future competencies such as communication skills and critical thinking skills that will be very useful to encounter global problems in the future (Kemendikbud, 2014).

One of the environmental issues that Indonesia and other countries encounter is the use of electricity. The use of electricity in Indonesia, which continues to increase every year, is still largely sourced from non-renewable energy resources such as coal, petroleum, and natural gas. The non-renewable energy is in critical condition which will be exhausted in the next decades (National Geographic, 2015). This requires the Indonesian people to save on using electricity and change the use of non-renewable energy sources into renewable energy as primary energy that will be converted into electricity.

Teenagers also contribute to the rise of using electricity in everyday life such as the use of laptops, cell phones, televisions, and other entertainment

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devices. However, behavior towards the use of electricity in teenagers is still relatively low (Agung, 2012). This has a bad impact on the availability of electricity sourced from non-renewable energy. This is also in line with the Indonesian government that put the Energy Resources topic in the 2013 curriculum for grade XII in even semester so that students (teenagers) can analyze the impact of electricity use.

Learning physics in the 2013 curriculum requires the use of scientific approach in the learning process with steps such as observing, questioning, experimenting, reasoning /analyzing, and communicating. Based on those steps, students are asked to think critically, creatively, and innovatively. Critical thinking is applied to students to solve problems systematically, innovatively, and to design fundamental solutions. Through critical thinking, students analyze what they think, synthesize information, and conclude (Rehena & Tumbel, 2010).

Krathwohl stated that the indicators used to measure critical thinking in taxonomy bloom are analyzing (C4), evaluating (C5), and creating (C6) (Krathwohl, 2002). Based on the explanation above, it is said that critical thinking skills which also includes in High Order Thinking Skills for both direct learning and online are the skills in which students need to answer global challenges and environmental problems because the indicators used to require students to analyze, evaluate, and create.

In its application, students use learning media to foster critical thinking. Along with the development of technology, learning media especially, books have been electronically accessible or better known as electronic school book (e-book) which can be downloaded by all students as a source of learning support in addition to printed books. However, the existence of e-book in Indonesia regarding content is not too different from printed books, or in other words, it is static, and its only different is the form of the book itself which from traditional book to electronic book so that it is easy to carry (Darlen, Sjarkawi, & Lukman, 2015).

Based on the rapid technological development, e-book should contain a compilation of learning videos, animation, audio, and images. So that the contents of e-book are not monotonous, interesting, interactive, and can foster students' critical thinking skills through the interaction obtained from the use of the e-book, especially in the topic of energy resources that require many representations of images or videos in learning. This is supported by research conducted by Husein et al. showing that using interactive multimedia in learning physics for high school students can enhance students' critical thinking (Husein, Herayanti, & Gunawan, 2015).

The questionnaire was given to 24 students and one physics teacher in class XII related to physics learning in even semester of grade XII. The results of needs analysis show much as 96% of students used student worksheet from one publisher, 33% of students used printed books from the school, the existence of e-book in the form of pdf files is only used by 17% of students, and 4% uses interactive e-book. It concluded that students are not very familiar with a variety of learning resources, especially interactive e-book for physics subject.

The development of this interactive e-book is also strongly supported by the conditions faced by students based on the results of needs analysis questionnaire, such as, the amount of time that students have to learn physics material in grade XII in even semester is very limited and the material of energy resources, in basic competency of 3.13, is a new material added by the Indonesian government in the 2013 curriculum syllabus. It results in a learning process that did not run maximally regarding time availability, the

learning process that is lack of opportunity for students to think critically, the teacher who only explain the material that matters and about to come out on the exam, and even some material are passed by students.

Also, research by Suyatna concluded that interactive e-book on the topic of relativity theory using LCDS improved strudents' critical thinking ability even better compare to static books and could overcome the problem of limited time in learning physics (Ayuningtias, Suyatna, Suyanto, & Nwineh, 2018; Suyatna, Distrik, Herlina, Suyanto, & Haryaningtias, 2018). Physics, as a subject, represents content not only by words and equations but also through a graph, pictures, videos, simulations, and analogies. All those representations are in line with the advancement of technology for learning physics and can be accessed through integrated multimedia which one of them is the Learning Content Development System (LCDS).

The use of multimedia such as pictures, animations, videos, and simulation in learning physics also can improve to understand concepts (Kiboss, 2002). E-book, designed with the scientific approach on a topic of wave, which contains videos, animations, and simulations can improve sciences process skills and learning outcomes (Yurika, Suyatna, & Viyanti, 2014). Based on the description, it is very important to develop a valid interactive e-book development with an LCDS-based scientific approach to the material of energy resources that aims to foster students' ability to think critically, have good readability, and are easy to operate.

METHOD

The research method used in this study is research and development. Research and development method is a research method used to produce products and test the effectiveness of these products (Sugiyono, 2015). In this study, the developed product was an LCDS-based interactive e-book with scientific approach on energy resources to enhance critical thinking for high school students of grade XII in even semester. In the interactive e-book product development, not all stages of Sugiyono's R & D methodology were used, but only seven stages were used and adapted to the needs of researchers.

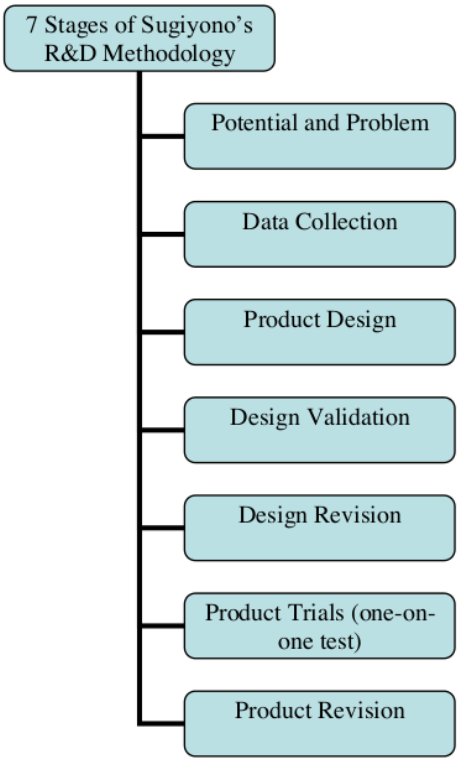

Figure 1. Seven Stages of R&D Methodology

A validation test was done by two tests, namely the design expert test and material expert test. Design and material expert tests were given to two lecturers of Physics Education and three teachers who were certified educators. In the questionnaire assessment of instrument expert validation test, there are four answer choices with a score of 1 to 4 as a

response to the questions given. The assessment score of the validation test can be seen in Table 1 (Suyanto & Sartinem, 2009).

Table 1. Expert Validation Score for Design and Material Test

Score	Quality
4	Very Appropriate
3	Appropriate
2	Less Appropriate
1	Not Appropriate

Product trials are conducted by one on one test. One on one test is conducted to determine the level of readability and ease of operation of the developed interactive e-book on energy resources. This one-on-one test was conducted on six students consisting of three male students and three female students. Each male and female student has different learning achievement under categories of the low, medium, and high. Scoring assessment can be seen in Table 2 (Suyanto & Sartinem, 2009).

Table 2. One on One Test Scoring Assessment

Score	Readability Assessment Criteria	The Ease of Operation Assessment Criteria
4	Very good	Very easy
3	Good	Easy
2	Low	Less easy
1	Not good	Not easy

RESULT AND DISCUSSION

Potential and Problems

The potential and problem assessment stage was done to explore information on learning in schools. At this stage, data is collected by field study and questionnaire. The results obtained from observation and questionnaires indicate that there is a gap between the real and ideal conditions that urged to develop an alternative instructional material in the form of interactive e-book, especially on energy resources.

Based on the results of needs analysis from teachers and students, it is known that the material of energy resources is classified as material that is often not taught by a teacher in the classroom due to lack of time and less of variations in learning media used that are interactive. Both of time and media issues contribute to the lack of critical thinking skills during the learning process. The above problems should not exist regarding the existence of technological developments that happens rapidly in Indonesia, not to mention some facilities provided by the school are many and supportive to have technology-based learning using Interactive e-book, such as computers, LCD projectors, internet (wifi), and students already have their laptops.

Data Collection

The data collection stage was carried out through literature study and questionnaire distribution which aimed to find information that supported the development of interactive e-book on energy resources. Literature studies include reading and reviewing articles of learning resources, cognitive learning theory, e-book criteria, interactive multimedia, LCDS, scientific approaches, critical thinking and material of basic competency number 3.11 namely energy resources.

The next step is testing the material component to experts. The test of e-book component was carried out to obtain a mapping in developing the product. Based on the results of the analysis of component test which conducted on 3 lecturers of Physics Education. It can be concluded that the e-book of energy resources should contain the use of interactive multimedia such as images, graphics, animation and simulation, a summary of the material, assignments, and forms of tests that are tailored to the material presented in the e-book in the form of multiple responses and short essays.

Product Design

The stage of developing preliminary product (product design), in order to fulfill the criteria of interactive e-book, used several supporting program. The program used to develop the product are LCDS 2.8, Microsoft Powerpoint 2013, Macromedia Flash 8, Pinnacle Studio 12, and Ispring Quiz Maker.

LCDS 2.8 is used as a base application in making interactive e-book energy resources. This application serves as a place to compile material in the form of text, images, audio, video, animation, simulation, or even interactive questions. LCDS 2.8 is an application that can accept various forms of file extensions so that in developing the interactive e-book that requires interactive media such as video, animation, or experimental simulations to foster critical thinking abilities can be achieved.

Microsoft Powerpoint 2013 in developing interactive e-book is used to produce compiler material in the form of images that can also contain text or writing and it also provides variations of writing and customed themes so that the presentation in interactive e-book energy resources becomes more attractive.

Macromedia Flash 8 is used to create mobile animation as in the developed interactive e-book, there are dams, solar cells, windmills, and several sub-menus that aim to make e-book become interactive. Pinnacle Studio 12 is used to create or edit a video. In the interactive e-book developed, several videos for energy resources topic are produced such as on the Electric Energy menu and the Source of Electrical Energy, Energy Resources, and Power Plants. Ispring QuizMaker is used in making interactive questions in the form of multiple responses and consists of five questions derived from learning indicators on e-book.

The interactive LCDS-based e-book of energy resources for initial product can be seen in Figure 2. The developed interactive e-book contained introduction, main content, and references. In the introduction section, the interactive e-book contains instructions, core competencies, basic competencies, indicators, and learning objectives. There are two instructions on interactive e-book, namely usage instructions and learning instructions that serve to facilitate students in operating interactive e-book individually.

Figure 2. Product 1 of Interactive E-book

Validation Test

Product 1 which developed in the form of HTML is still hypothetical so that expert validation tests are carried out namely design test and material test. Design expert tests are carried out to determine whether the design used is appropriate such as selection in color combinations, fonts, clarity of simulation, and clarity of images as outlined in interactive e-book to foster critical thinking skills. The tool used for the validation expert test is a questionnaire.

Based on the results of the average score obtained in the design expert test, it can be concluded that the developed interactive e-book is feasible and very well designed. It shows that the components in the energy resources interactive e-book design test are clear, can be understood, has no ambiguous meaning, can be explored independently, foster critical thinking in learning, and have clear instructions.

Table 3. Results of Design Expert Test

Indicator	Average Score	Quality
Layout design in interactive e-book	3,67	Very appropriate
Typography in interactive e-book	3,60	Very appropriate
Illustration in interactive e-book	3,60	Very appropriate
Interactive e-book for fostering critical thinking ability	3,84	Very appropriate
Instruction for using interactive e-book	3,90	Very appropriate
Average	**3,72**	**Very appropriate**

In the design validation test indicator, the developed energy resources e-book is made by using images, videos, animations, color combinations, language that is easy to understand, and interactively designed using buttons such as back, next, launch, and special buttons on Biomass Power Plant simulations so that students can operate e-book independently. According to Darlen's statement that in developing of interactive e-book, the design of displays must be interesting, languages used must be arranged well, and have efficient navigation buttons (Darlen et al., 2015).

Interactive multimedia used in e-book is to facilitate students to learn abstract material to be more contextual so that students can understand the topic as a whole such as the use of interactive animations and videos which display how renewable and non-renewable energy resources turn into electricity in coal power plants, dams, solar cells, and windmills. The use of interactive animations on e-book is also used to explain more sophisticated points such as process or steps for example in biomass power plant, rotten fruits that turn to electrical energy so that students are easy to understand the whole concept independently, and in comparison, there are no such multimedia interactive in conventional or printed books.

The use of interactive multimedia in the form of animation provided in e-book of energy resources also aims to make the learning process created in e-book even more interesting because it does use not only text but also uses images, animation, videos, and audio. This statement is supported by Mayer that human beings process information based on two channels, which are auditory (sound) and visual (picture) not just text (Mayer, 2003). In research conducted by Agustina also said that in learning dynamic fluid topic, using dynamic images (animation) can improve student learning outcomes (Agustina, Suyatna, & Suyanto, 2017). Student learning outcomes with the same learning method on the material of rotational dynamics, dynamic fluids, and impulse-momentum show differences that using dynamic image is better than using static images (Suyatna, Anggraini,

Agustina, & Widyastuti, 2017). Based on the results of the design validation test, it shows that the quality of illustrations used in the developed interactive e-book is very appropriate in representing physical material of energy resources through interactive video or animation.

The interactive e-book of energy resources developed with the goal of enhancing students' critical thinking ability. It is designed with learning indicators which are indexed in High Order Thinking Skills C4, C5, and C6 so that students can analyze, evaluate, and create. It is supported by the statements of Ritdamaya and Suhandi which states that both the process and assessment of physics learning must be oriented to develop students' critical thinking skills as stated in Permendikbud number 64 of 2013 (Ritdayama & Suhandi, 2016). In interactive e-book students are asked to be able to analyze the needs of electricity use in Indonesia, to identify differences in electricity resources in Indonesia, to analyze the problem of electricity that is generated from non-renewable and renewable energy, to deduce the impact of electricity use, to consider the types of electricity that are effective in Indonesia, and to make essays about wise energy sources for Indonesia and how to use electricity positively.

The interactive e-book developed also contains interactive questions which designed to foster critical thinking for students. Interactive questions are divided into two parts, essay questions and multiple responses, which use indicators ranging from C4, C5, and C6 and are made using supporting media such as pictures and videos as stimulus. This is done for the purpose of after students learn the material in e-book students can do given test regarding the understanding of the material that they have learned. The statement is in line with research from Damayanti which said that interactive tests using multimedia and scientific approaches could foster critical thinking in students (Damayanti, Suyatna, Warsono, & Rosidin, 2017).

Expert test in material examines several indicators listed on interactive e-book which are completeness, immensity, and depth of material, accuracy of material, accuracy of interactive tests, material updates, and suitability of the material with the scientific approach. The expert test was also carried out by the same validator in the product design validation test. Based on the results of the material expert test in Table 3, it gets an average score of 3.72, so it can be concluded that the material contained in this interactive e-book is feasible and highly accurate with the existing provisions that are adjusted to the competencies in the 2013 curriculum.

Table 4. Results of Material Expert Test

Indicator	Average Score	Quality
Completeness, immensity, and depth of material	3.65	Very appropriate
Accuracy of material	3,77	Very appropriate
Accuracy of interactive test	3,80	Very appropriate
Material update	3,70	Very appropriate
Suitability of the material with scientific approach	3,70	Very appropriate
Average	**3,72**	**Very appropriate**

Learning materials on interactive e-book of energy resources are also presented by the steps of the scientific approach namely observing, questioning, trying/experimenting, reasoning, and communicating in the learning scheme created in an interactive e-book on energy resources. The statement was supported by Kemendikbud which stated that the 2013 curriculum requires learning physics

in high schools carried out with scientific approach (Kemendikbud, 2016).

The use of scientific approach in interactive e-book of energy resources is developed with the help of several interactive multimedia to foster students' critical thinking skills. At the five-step scientific approach, students can foster critical thinking in every step after the process of observing the material in developed e-book as in some critical thinking abilities according to Ennis'.

First, in the skill of focusing questions and analyzing arguments, students can identify conclusions from the information presented through videos, pictures, and texts and consider the possible answers to essay questions given in e-book. Second, the skills to consider whether sources can be trusted or not and to observe and to consider observation reports are presented with questions that the answer can also be found in other sources through given links. Students also can operate animation and simulation from the process of renewable energy resources (raw material) change into electricity interactively and report the results. Third, the deduction and consideration of deduction skills and also determining the results of consideration are presented by some graphs, a news snippet is presented and given questions to students about the prediction of electricity use in Indonesia and the world. Fourth, in the skill of identifying the assumptions presented by material and questions about the impact of the use of electricity. Fifth, the skill to determine an action is presented in the form of a short essay entitled Wise Energy Source for Indonesia and Positive Behavior in Using Electricity. This related to research that teaching science should encourage students to be able to aware of science and to take action in maintaining and preserving the environment wisely (Parmin, Sajidan, Ashadi, & Sutikno, 2015).

Based on the description of the results of the analysis from material and design expert tests, it shows that the development of interactive e-book on LCDS-based on energy resources with a scientific approach is valid and feasible to be used as teaching materials that foster the ability to think critically for students. These results are supported by Ambarwati and Suyatna in their research shows interactive electronic book that contains interactive multimedia can foster critical thinking skills for students (Ambarwati & Suyatna, 2018). Also students in solving a problem or learning new concepts, they use supporting representation.

Study from Wuri and Mulyaningsih said that the application of a scientific approach in physics learning can improve critical thinking skills for students and strengthened (Wuri & Mulyaningsih, 2014) by the research from Suyatna which states that the use of interactive e-book on the material of relativity theory is designed with a scientific approach can foster students' thinking skills (Suyatna et al., 2018). Regarding the explanation above, the developed e-book on energy resources can improve students' critical thinking ability because it's designed with scientific approach in learning scheme which every step is inherently connected to exercise critical thinking skills.

Design Revision

An e-book that has been validated by design and material experts getting an average score of 3.72 with very good quality and are very appropriate even though there are some improvements that are recommended by the experts for the betterment of developed e-book. This stage is designed revision of the product 1, revision of e-book based on the improvement suggestions from the examiner can be seen in Table 5.

Tabel 5. Improvement of Validation Test Recommendation

No	Indicator	Recommendation	Improvement
1.	The suitability of the composition of the layout elements (title, author, illustration, logo, etc.), text, and images in the interactive e-book cover has been balanced and in tune with the layout of the contents.	The size of the logo and text must be proportional.	The cover section of the Unila logo has been fixed, and the photoelectric effect title is written down by reducing its size.
2.	The suitability of the illustration is clear that can reveal the meaning of objects, proportional, accurate, and realistic.	The illustration can be in the form of an analogy or flow chart.	An illustration has been added in the form of a flow chart on the menu of renewable energy resources.
3.	Interactive e-book contains indicators indexed by HOTS C4, C5, and C6 in learning activities.	Operational verbs adapted to the level of depth and immensity of material.	The use of operational verbs has been adjusted to the indicators of achievement with the level of depth and breadth of the material.
4.	The suitability of the displayed image can be seen clearly and logically.	The image on the e-book must be proportional.	The images on the e-book have been improved.
5.	Suitability of competency achievement indicators in interactive e-book with Core Competencies (KI) and Basic Competencies (KD).	Use effective sentences on the indicator.	The sentence has been corrected in the indicator section of learning to be an effective sentence.
6.	Accuracy of conceptual explanation of material.	Put the negative impact of using nuclear energy on the environment.	Material has been added regarding the impact of nuclear energy use on the environment.
7.	The accuracy of the updated reference	References must be updated	Recent references have been added to developing interactive e-book.

One on One Test

One on one test was done to find out the readability and the ease of operating interactive e-book. Test is done by giving the questionnaire to three male and three female students who had different learning achievements which are low, medium and high right after they studied using interactive e-book of energy resources. The interactive e-book used is a revised e-book by the recommendations from the results of material and design experts, and also from the six students who are asked for their opinions through questionnaires.

Table 6. One on One Test Score

Indicator	Average Score	Quality
Readability of interactive e-book	3,60	Very good
The ease of operating interactive e-book	3,68	Very easy

Based on the one on one test, according to students, interactive e-book is easy to operate because there are instructions for how to use and learn so that students can use interactive e-book independently. This is by the research of Wulandari et al. who suggested that the instructions for using the interactive e-book should also be facilitated in the

learning process (Wulandari, Suyanto, & Suana, 2016). The range of content such as video, animation, and existing simulations as well as the presentation flow is also very easy for students to learn and to understand the contents of developed interactive e-book.

In the readability of the language used in interactive e-book of energy resources have already been understood independently by students, it is communicative and interactive, do not have multiple meanings, and are arranged using the correct sentence structure. The results of one-on-one questionnaire tested on six students grade XII resulted that five of the six students agreed and recommended using an interactive e-book for energy resource as the main teaching material in studying the topic and one other student agreed to be used as a source backup learning source.

Advantages and Disadvantages of Developed Interactive E-book

Based on the results of validation test and one-on-one test, it concluded that the developed interactive e-book has several advantages, namely the concept of electricity generated from renewable and non-renewable energy resources can be visualized by computers through video illustrations, simulations, and animations not only through text and image so that it can help students understand abstract concepts such as processes or steps in biomass and coal power plants. The interactive e-book of energy resources designed to enhance students' critical thinking with scientific approach can be accessed or opened on a laptop without the need for an internet connection because it is made as HTML file. The results are in line with research from Wagner, et al. which stated that teaching physics using multimedia i.e., video and computer can give students to experience sophisticated content in presentation and also it supports evaluation while learning (Wagner, Altherr, Eckert, & Jodl, 2007).

In addition to having advantages, the interactive e-book also have disadvantages in technical issue, namely e-book cannot always be opened especially in the animation, simulation, and learning video parts because of incompatibility of Microsoft Silverlight applications with Mozilla Firefox version used, so it needs to check software compatibility first to be able to study using the developed interactive e-book. LCDS software that is used in creating interactive e-book of energy resources is also lack of the type of letters to use so that developer still uses Microsoft Office Powerpoint to get the customed font to make it more variety and it should be converted first into extensions of jpeg, jpg, or png.

The final product of the interactive e-book of energy resources can be seen in Figure 2 below. The bold font is the revised section based on suggestions or recommendation from the design and material expert validation test from physics lecturers and teachers as well as one-on-one test.

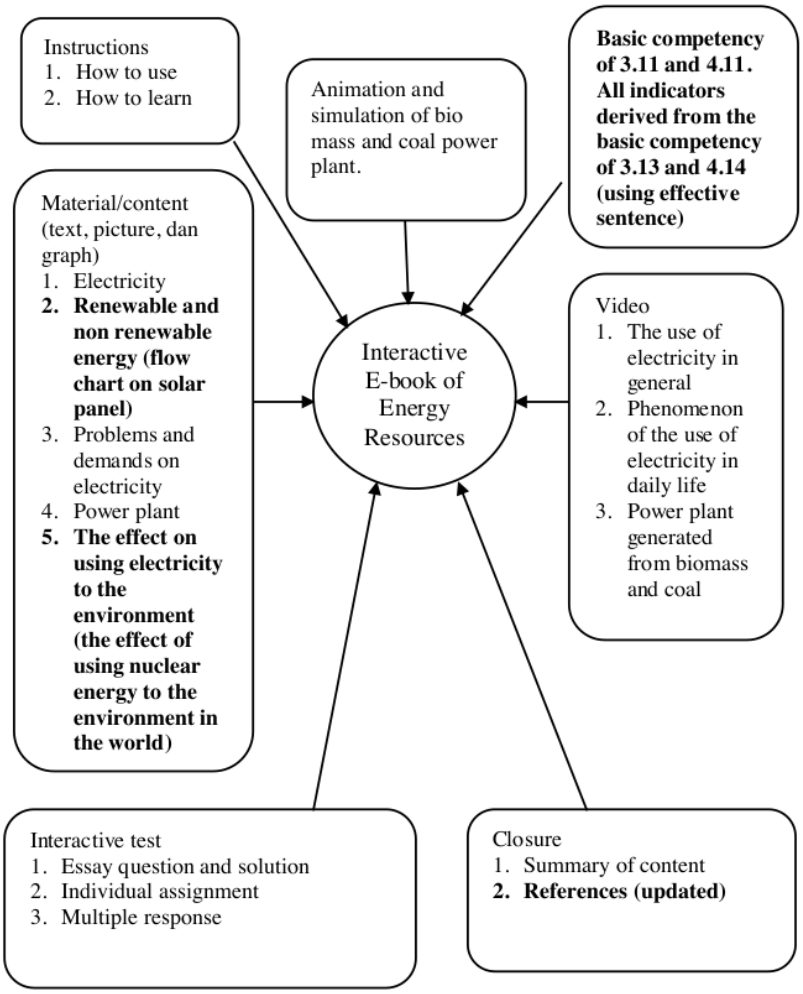

Figure 3. Product 2 (Final Product)

The developed e-book was created for students as a source to learn energy resources material with using scientific approach which also can enhance their critical thinking skill while learning with the developed e-book. The above picture, the final product, shows that there are several aspects that were put into consideration as revision from experts test. Be it the content by bold sections in the flow chart on the solar panel, effect on using nuclear energy, and also references used in e-book itself.

Interactive e-book on energy resources material can also enhance sstudents' critical thinking skills. The multimedia such as video, animation, simulation, and interactive test used in the interactive e-book helps to foster critical thinking skills even more compared to conventional media (Gerven, P. W. M. Van, Paas, Van, Hendriks, & Schmidt, 2003). The use of interactive multimedia which designed using scientific approach will lead students to analyze concepts sophisticatedly by using learning videos, animation, and simulation, evaluate by graphics presentation and essay question. Using electronic book will create interesting, challenging and stimulating

experiences for students, as well as increasing students' interactions with learning content in e-book (Yang, Wang, & Chiu, 2015) and also increasing students' participation by allowing them the to write comments and do observations (Gong, Chen, Wang, Zhang, & Huang, 2013).

CONCLUSION

This research concludes that the development of interactive e-book based on Learning Content Development System (LCDS) has been validated as a teaching material on energy resource topic using scientific approach to enhance students' critical thinking skills. The interactive e-book contain material in the form of texts, images, graphs, animations, simulations, learning videos and interactive test by utilizing several applications then combined into an interactive e-book using LCDS software. Interactive e-book on energy resources is easily operated with a score of 3.68 with very easy quality, and interactive e-books have good readability with a score of 3.60 with very good quality. For further development, it is important to test the developed e-book to massive classes to find the effectiveness of developed e-book. Also in line with technology advancement, it is suggested to always improve on user interface and user experience for students' comfortability.

REFERENCES

Agung. (2012). Perilaku Hemat Listrik di Kalangan Remaja Masih Rendah.

Agustina, D., Suyatna, A., & Suyanto, E. (2017). Perbandingan Hasil Belajar Siswa Menggunakan Media Gambar Bergerak Dengan Gambar Diam. *Jurnal Pembelajaran Fisika*, *5*(3), 25–34.

Ambarwati, D., & Suyatna, A. (2018). Interactive Design for Self-Study and Developing Students' Critical Thinking Skills in Electromagnetic Radiation Topic. *Journal of Physics: Conference Series*, *948*, 1–8.

Ayuningtias, M. D., Suyatna, A., Suyanto, E., & Nwineh, L. (2018). Development of LCDS-Based Interactive Electronic School Book on Blackbody Radiation as Self-Instructional Materials for Fostering Students Critical Thinking. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *07*(October), 183–193. https://doi.org/10.24042/jipfalbiruni.v7i2.2518

Damayanti, R. A., Suyatna, A., Warsono, & Rosidin, U. (2017). Development of Authentic Assessment Instruments for Critical Thinking Skills in Global Warming with A Scientific Approach. *International Journal of Science and Applied Science*, *2*(1), 289–299.

Darlen, R. F., Sjarkawi, & Lukman, A. (2015). Pengembangan E-Book Interaktif untuk Pembelajaran Fisika SMP. *Tekno Pedagogy*, *5*(1), 13–23.

Gerven, P. W. M. Van, Paas, F., Van, J. J. G., Hendriks, M., & Schmidt, H. G. (2003). The Efficiency Of Multimedia Learning Into Old Age. *British Journal of Educational Psychology*, *73*(4), 489–505.

Gong, C., Chen, G., Wang, X., Zhang, X., & Huang, R. (2013). The Functions of E-textbooks for Utilizing in K-12 Classes: A Case Study in Beijing. *Advanced Learning Technologies*, 479–480.

Husein, S., Herayanti, L., & Gunawan. (2015). Pengaruh Penggunaan Multimedia Interaktif terhadap Penguasaan Konsep dan Keterampilan Berfikir Kritis Siswa pada Materi Suhu dan Kalor. *Jurnal Pendidikan Fisika Dan Teknologi Universitas Mataram Program Studi Pendidikan Fisika*, *1*(1), 7–10.

Kemendikbud. (2014). *Konsep dan Implementasi Kurikulum 2013*. Jakarta: Kementrian Pendidikan dan Kebudayaan.

Kemendikbud. (2016). *Silabus Mata*

Pelajaran Sekolah Menengah Atas/Madrasah Aliyah. Jakarta: BPSDMPK-PMP.

Kiboss, J. K. (2002). Impact of a Computer-Based Physics Instruction Program on Pupils' Understanding of Measurment Concept and Methods Associated with School Science. *Journal of Science Education and Technology*, *11*(2), 193–198.

Krathwohl, D. R. (2002). A Revision of Bloom's Taxonomy; An Overview. *Theory Into Practice*, *41*(4), 212–218.

Mayer, R. E. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist*, *38*(1), 43–52.

National Geographic. (2015). Mahasiswa Asean Membahas Energi Fosil di Mojokerto.

Parmin, Sajidan, Ashadi, & Sutikno. (2015). Skill of Prospective Teacher in Integrating The Concept of Science With Local Wisdom Model. *Jurnal Pendidikan IPA Indonesia*, *4*(2), 120–126.

Rehena, J. F., & Tumbel, F. M. (2010). Strategi Pembelajaran yang Memberdayakan Kemampuan Berpikir Siswa. *Kompetensi*, *1*(1), 12–19.

Ritdayama, D., & Suhandi, A. (2016). Kontruksi Instrumen tes Keterampilan Berpikir Kritis Terkait Materi Suhu dan Kalor. *Jurnal Penelitian Dan Pengembangan Pendidikan Fisika*, *2*(2), 87–96.

Sugiyono. (2015). *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif dan R&D*. Bandung: Alfabeta.

Suyanto, E., & Sartinem. (2009). Pengembangan Contoh Lembar Kerja Fisika Siswa dengan Latar Penuntasan Bekal Awal Ajar Tugas Studi Pustaka dan Keterampilan Proses untuk SMA Negeri 3 Bandar Lampung. In *Prosiding Seminar Nasional Pendidikan 2009*. Lampung: Universitas Lampung.

Suyatna, A., Anggraini, D., Agustina, D., & Widyastuti, D. (2017). The Role of Visual Representation in Physics Learning: Dynamic Versus Statis Visualization. *Journal of Physics Conferences Series*, *909*(1), 1–7.

Suyatna, A., Distrik, I. W., Herlina, K., Suyanto, E., & Haryaningtias, D. (2018). Developing Interactive E-book of Relativity Theory to Optimize Self-Directed Learning and Critical Thinking Skills. In *AIP Conference Proceeding* (pp. 1–9).

Wagner, A., Altherr, S., Eckert, B., & Jodl, H. (2007). Multimedia in Physics Education: Teaching Videos About Aero and Fluid Dynamics. *European Journal of Physics*, *28*(1), 33–37.

Wulandari, S. R., Suyanto, E., & Suana, W. (2016). Modul Interaktif Dengan Learning Development System Materi Pokok Listrik Statis. *Jurnal Pembelajaran Fisika*, *4*(2), 22–34.

Wuri, O. R., & Mulyaningsih, S. (2014). Penerapan Pendekatan Saintifik pada Pembelajaran Fisika Materi Kalor Terhadap Keterampilan Berpikir Kritis Siswa. *Jurnal Inovasi Pendidikan Fisika*, *3*(3), 91–95.

Yang, K., Wang, T., & Chiu, M.-H. (2015). Study The Effectiveness of Technology-Enhanced Interactive Teaching Environment on Student Learning of Junior High School Biology. *Eurasia Journal of Mathematics, Science & Technology Education*, *11*(2), 263–275.

Yurika, J., Suyatna, A., & Viyanti. (2014). Pemanfaatan Media Teknologi Informasi dan Komunikasi Tutorial Sebagai Suplemen Eksperimen. *Jurnal Pembelajaran Fisika*, *2*(1), 15–26.

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