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Physics Learning Chapter E-Book Design Oriented by Critical and Creative Thinking Ability Using a Case-Based Reasoning Approach to Measuring Materials

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ABSTRACT

The limited critical and creative thinking abilities observed in students within the field may be attributed to various factors, such as suboptimal learning approaches and the absence of critical and creative thinking skills in teaching materials. An initiative to enhance these skills involves the creation of an e-book chapter focused on physics learning, emphasizing critical and creative thinking and employing an appropriate approach. This research endeavors to formulate an e-book chapter centered on critical and creative thinking skills, utilizing a valid and practical case reasoning approach. The study is conducted as part of Research and Development (R&D), employing the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model. Validation of the e-book chapter is undertaken with input from three physics lecturers at UNP. Practicality testing involves six physics teachers from Padang 3 Public High School, Padang 5 Public High School, and Padang 16 Public High School, as well as students from Padang 16 Public High School. The outcomes of the practicality test indicate that the e-book falls within the highly practical category, garnering assessments of 94.9% and 88.34% from teachers and students, respectively.

Keywords: e-book chapter, critical thinking skills, creative thinking skills, measurement, CBR.

I. INTRODUCTION

Education plays an important role in improving the quality of human behavior and revealing the potential at all levels of life [1]. The purpose of education in the country is to develop the talent, character and welfare of the country within the framework of respect, and to develop life skills [2]. Achieving these educational goals depends on the use of effective and efficient educational methods [3].

Learning is two-way communication between teachers and students in educational situations to achieve learning goals. Teachers and students are two components that cannot be separated, mutually supportive interactions must be established between the two so that optimal student learning outcomes are achieved [4]. The cooperation and activeness of students in the learning process make it easier for students to understand learning material when it is connected to their daily lives [5]. One of the subjects that studies natural phenomena that occur in life is physics[6]

Physics is a science that plays an important role in forming students' thinking patterns. Physics is very important at every level of education, from high school to college. This is because physics is used by other scientific disciplines as a supporting science, such as in natural sciences, and social sciences and can be used to solve problems in real life [7].The important role of Physics 3 for the development of science and technology, various efforts have been made to improve physics education to be better, including completing facilities and infrastructure, developing and updating the curriculum, holding educational seminars, and providing opportunities for teachers to take further education [8]. Utilization of technology in education, such as developing teaching materials using interactive teaching materials. With interactive teaching materials, the learning process between students and teachers will run well [9].

Based on the revised 2013 curriculum, there are competency guidelines that must be achieved by students in the form of 4C and HOTS, where these 4C and HOTS abilities lead to critical and creative thinking abilities [10]. Critical thinking ability is the ability to reach the right conclusions with structured and grounded thinking to produce many alternatives in every thought [11]. Meanwhile, the ability to think creatively is the ability that arises in a person to produce something new [12]. This ability to think critically and creatively is very supportive in learning physics because in principle physics concepts require the ability to analyze, and find solutions to a problem [13].

To achieve critical and creative thinking skills as planned by the government in the curriculum, several efforts can be made, both in the use of learning approaches and the use of teaching materials. One of the approaches recommended in Curriculum 13 is scientific which has the 5M components (observe, ask, try, manage, and communicate), but the use of a scientific approach does not rule out the possibility of using other approaches in the learning process [14]. One form of the approach used is the Case-Based Reasoning approach.

Case-Based Reasoning (CBR) is remembering cases that have occurred now that have occurred in the past, and looking for solutions so that the problems that occur can be resolved. In this CBR approach, students are required to be able to analyze new cases by relating them to old cases [15]. In making new products such as e-books that use the CBR approach, there are several steps, namely the first, is retrieve, which means remembering cases that are similar to previous cases. Second, is reuse, which is the stage that reuses solutions from old cases for problems. new but has high similarity. Third, Revise, namely the stage of reviewing the solutions provided in the previous stage and carrying out testing. Fourth, Retain is the final stage in CBR which stores new solutions that have been used in problems [16].

Apart from using the right approach, another factor that can support the achievement of students' critical and creative thinking abilities is the use of teaching materials in the learning process. The ability to think critically and creatively will be achieved if the teaching materials used contain indicators of the ability to think critically and creatively so that the use of teaching materials and the application of the learning approaches used in the classroom are in line, this will lead to more optimal achievement of critical and creative thinking abilities. students [17].

Based on the analysis of the 2019 national evaluation data from the Ministry of National Education and Culture Puspendik data, a nationwide examination was conducted to assess the percentage of students accurately responding to questions at the country, state, and city levels. In the initial data, the correct response rates for students across the three levels—country, state, and city—were 45.93%, 47.74%, and 50.12%, respectively. For the second textbook, "Wave and Optics," national, state, and city university students achieved correct response rates of 49.66%, 45.68%, and 44.42%. In the third set of data, covering three-phase thermodynamics at the country, state, and city levels, students achieved correct response rates of 44.73%, 41.92%, and 42.50%. Regarding the fourth material, "Electricity, Magnetism, and Modern Physics," college students across the country, state, and city attained correct response rates of 53.03%, 50.18%, and 48.09%. Among the four subjects examined, it is evident that only students studying electricity, magnetism, and modern physics predominantly provided correct answers in the 2019 national exam, while thermodynamics recorded the lowest correct response rates.

In the mechanics material, the percentage of National Examination scores produced is also in the low category, while the measurement material is included in the mechanic's group, therefore it can be seen that students' high-level thinking abilities are still low, this requires effort to trigger better critical and creative thinking abilities. This low National Examination score can be caused by a learning process that does not lead to critical and creative thinking skills and the teaching materials used do not support the achievement of critical and creative thinking skills [18]. From the results of observations in the field, the teaching materials used in schools are only printed books or PDF files, modules or LKPD. However, in this research, the author is interested in focusing more on teaching materials in the form of books because books are teaching materials that are available in schools so the percentage of their role in improving creative and critical thinking is higher.

According to the analysis of previous scholars of books, the thinking ability and thinking ability in the book are also divided into two groups: sufficient and inadequate. The percentage of critical thinking skills is 50% - 58%, and the percentage of creative thinking skills is 44% - 53%. Based on the questions written by the teacher, he followed the 5M steps very well and used the research study method. However, when we look at the current national exam data, it turns out that students can answer the questions correctly. still very little. Therefore, the authors are considering creating an e-book on critical thinking and critical thinking using the CBR approach. E-books can contain information such as images, text, videos, etc. It is an interactive electronic document that presents E-books that can be accessed from electronic devices such as laptops, computers and smartphones, and

can be accessed anytime and anywhere. This study focuses on the development of e-book chapters related to physics education [19].

E-book chapters from e-book articles and chapters. An e-book is an e-book that contains information in the form of images, text and video, and a chapter is a small part of a book [20]. E-books that use critical and creative thinking skills, such as the CBR approach, can make learning more effective by increasing students' initiative in learning. I-Spring application is an application that can be used to create learning materials in the form of interactive e-book chapters. E-book chapters are aimed at critical and creative thinking using the CBR method of the I-Spring application, which prevents students from getting bored during the lesson because it uses the newly found method in the I-Spring application [21].

The I-Spring application is an application that can convert PowerPoint files into interactive Flash files [22]. In the I-Spring application, there are many menus, such as the quiz menu which can be used to test students' abilities, where an assessment of the student's evaluation results will appear, and is equipped with problem-solving. In the I-Spring application, many menus will increase students' interest in learning because the teaching materials are made interesting and enjoyable and do not only consist of monotonous words and forms [23].

In connection with the conditions above, the author will develop interactive teaching materials on measurement material with the research title "E-book Design for Physics Learning Chapters Oriented to Critical and Creative Thinking Skills with a Cased Based Reasoning Approach to Measurement Material"

II. METHOD

These studies include Research and Development (R&D) studies, that is, research and development studies. This research model adopts the ADDIE (Assessment, Design, Development, Implementation and Evaluation) development model and aims to create products. The resulting product is an e-book designed for critical thinking and creativity and uses meeting-based theory to evaluate the product. The resulting product is first tested for suitability.

This study aims to prepare an e-book for thinking skills and good thinking, using the information obtained from thinking in KD 3.2, including the use of physical measurements, facts, facts and important pictures, and the research topic. signature. The research steps to create ADDIE in this study are shown in Figure 1 below.

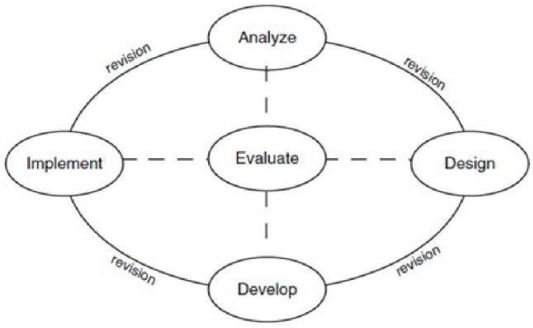

Figure 1. Steps in the ADDIE development model [24].

Based on Figure 1, the ADDIE stages consist of analysis (needs, curriculum and student characteristics), design, development, implementation and evaluation of e-book chapters.

The data collection instruments for this research include

1. Requirements instruments in the form of questionnaires and interviews.
2. Validation instrument modified from the e-book chapter validation instrument oriented toward critical and creative thinking skills with a developed Cased Based Reasoning approach [25].
3. Practicality Instrument

The data analysis methods used in this study are:

1. Needs analysis
   The score for each indicator is obtained by the equation:
   $$P = \frac{\sum x}{\sum xi} \times 100\% \quad (1)$$
   Data:
   P = Percentage

x = Average Score
xi = Number of Responses

2. Validity Analysis
The resulting data will be analyzed using the index compiled by Aiken using the following formula:

$$V = \frac{\sum s}{n(c-1)} \quad (2)$$

$$s = r - I_0 \quad (3)$$

Data:
V = Interrater Agreement Index
I_0 = Minimum Number of Validity Assessments
c = Maximum Number of Validity Assessments
r = Number assigned by the Assessor
n = Multimeter

3. Practicality Analysis
The data calculation for the final value of the instrument is expressed in percentages determined using the formula:

$$Nilai\ praktilitas = \frac{skor\ yang\ diperoleh}{skor\ maksimum} \times 100\% \quad (4)$$

III. RESULTS AND DISCUSSION

This chapter describes the development of the e-book section based on the improvements made and the results obtained at each stage of the research. This work is research and development (R&D) using the ADDIE development model (analysis, design, development and implementation). The result achieved during development is a physics e-book that focuses on thinking skills and creativity, can be used while studying, and uses a reflective thinking process, based on valid and used data.

1. Analysis Stage
   a. Needs analysis stage

      During the needs analysis phase, the researcher examined the status of the teaching materials used to support the study through observation, interviews with physics teachers of the National High School in Padang City, and questions written by the teachers. Below are the test results of the higher-order thinking test (HOTS), which includes problem-solving, decision-making, critical thinking and positive thinking scales. See Figure 1

Table 1. HOTS data analysis of books commonly used in high schools in Padang City

Textbook	HOTS Analysis Percentage
Book A	49,37%
Book B	56%
Book C	54,34%

According to Table 1, it can be concluded that the results of evaluating the HOTS validity of the text using the problem-solving, decision-making, positive thinking and creativity indicators used by the teachers vary between 49.37% and 56%. The presence of HOTS in the text affects students' ability to think and be creative. The analysis results regarding thinking skills are shown in Table 2.

Table 2. Analysis of literature on critical thinking skills

Textbook	Percentage of Critical Thinking Analysis
Book A	50,28%
Book B	57,50%
Book C	55,28%

As can be seen from Table 2, the results of evaluating the positive opinions in reference books seem reasonable as they vary between 50.28% and 57.5%. This shows that the books used in the education process still do not include all thinking skills. In addition to students' critical thinking

skills, critical thinking skills should also be developed. The analysis results regarding thinking ability are shown in Table 3.

Table 3. Review of critical thinking skills textbooks.

Textbook	Percentage Analysis of Creative Thinking Ability
Book A	44,10%
Book B	51,22%
Book C	52, 43%

As can be seen from Table 3, the creative talent assessment results in reference books are sufficient, because they are in the range of 44.1% to 52.43%. Thus it can be concluded that the textbooks used in the learning process still do not fully contain creative thinking skills.

b. Curriculum Analysis

In this data analysis phase, the researcher focused on the characteristics of the data used in various schools in Padang City. The aim is that the production of the product is based on practical instructions. At this stage, an examination of the use of the product to be developed and a review of the study materials will be made.

The content of the material presented in teaching materials in the form of e-book chapters must be by the competency demands that must be mastered by students. Therefore, it is necessary to study the KI and KD of physics learning. The material chosen in this research is measurement. KI and KD are prepared based on Permendikbud No. 37 of 2018, an amendment to Permendikbud No. 24 of 2016 concerning KI, and KD. The KDs used are KD 3.2 and KD 4.2. Based on the exposure to KI and KD, indicators and learning objectives can be prepared. Indicators and learning objectives are prepared based on cognitive domain guidance, namely from C4-C6

c. Analysis of Student Characteristics

At this stage, researchers obtained data from questionnaires filled out by students. Student characteristics are related to students' interests and learning styles regarding the teaching materials used during learning. This is done to develop products that are made by the characteristics of students.

Table 4. Results of Analysis Using a Questionnaire Regarding Student Characteristics in the Learning Process

Need	Percent
Audio	56%
Audio Visual	85%
Pictures and Diagrams	84%
Interactive Teaching Materials	83%
The need for interesting teaching materials	95%

According to Table 4, it can be concluded that many students need to learn in audio-visual form rather than audio only. Audio learning is learning that explains the material with sound recordings. Meanwhile, audio-visual learning is learning that explains material using a combination of sound and image displays such as videos. It can be seen from these results filling out the questionnaire, the percentage of students who want learning that presents material in the form of pictures, diagrams, animations, audio and so on or what is called an audio-visual learning style is 85%. Meanwhile, the percentage of students who want the audio learning style is only 56%.

Furthermore, regarding the teaching materials used, from Table 17 it is known that 95% of students need interesting teaching materials to better understand physics material compared to less interesting learning resources. Students also need interactive teaching materials during class. It is seen that 83% of the students say that interactive teaching materials can increase students' interest in learning and that teaching materials can be accessed anytime and anywhere.

2. Design Stage

The results obtained at this stage are shown as e-book chapters completed by the Ministry of National Education in 2008. The e-book chapters displayed were created based on the design of the e-book. The cover section is called "Product Evaluation", the foreword describes the ebook's conclusions, content, teacher's guide, instructions for use, main points and key sources, symbols, learning objectives, content, questions, worksheets, reviews, glossary, written biography, and information. All items are equipped with icons and other features to facilitate access to e-book chapters.

3. Development Stage

This development phase includes usability testing. In the validity test, 3 physics teachers were asked to give advice. From the test run. In the validity test, 3 physics teachers were asked to give advice. The results of the validity analysis of the seven elements of the e-book evaluation show that they are valid. The seven elements of certification include physical characteristics, visualization, design, software implementation, affective assessment, affective assessment, and CBR assessment.

The results of the validity analysis of the seven elements of the e-book evaluation show that they are valid. From the seven elements of e-book evaluation in Chapter 5, it can be concluded that these elements are classified as good results, such as physical products, communication presentations, study design, software application, and cognitive ability assessment. Meanwhile, the critical thinking ability assessment components and CBR assessment are included in the valid category. The following are suggestions given by validators for the e-book chapters developed in Table 5.

Table 5. E-book chapter Validator Suggestions

Validator	Saran- saran
Validator 1	1. To be more contextual 2. Student's thinking abilities are more facilitated 3. References for students' learning provisions to be added
Validator 2	The presentation is good, but the distinction between facts, concepts, principles and procedures needs to be emphasized.
Validator 3	1. Achievement of critical and creative thinking indicators is not yet clearly visible in the e-book chapter 2. The evaluation questions provided cannot refer to creative and critical indicators 3. There is an unsystematic menu order 4. Writers need to prepare answer keys and scoring rubrics for evaluation 5. Minimize the use of videos from sources other than your own

Based on reviewer feedback, the following improvements have been made to the ebook review tool:

Improvements to the e-book chapter sub-material section. Based on the validator's suggestion, namely prioritizing the sub-material regarding quantities, units, and then the sub-material regarding measuring instruments. So the order of the sub-material was changed, initially, the sub-material of measuring instruments was located at the beginning, with the order of measuring instruments, quantities, units, dimensional analysis, significant figures, scientific notation, measurement, uncertainty, and accuracy and accuracy so now it is changed to quantities, units, measuring instruments, dimensional analysis, significant figures, scientific notation, measurement, uncertainty, and precision and accuracy.

Improvements to the validator suggestion material section to add material to the section on screw micrometer measuring instruments, vernier calipers, standard units, non-standard units, single measurements, repeated measurements, relative and absolute uncertainty, then added material on how to read vernier caliper and screw micrometer measuring instruments, how to determine Nst caliper, material regarding frozen and unfrozen units, repeated and single measurements, as well as relative and absolute uncertainty.

Next, there are improvements to the evaluation section, here the validator asks for improvements to the question editors. Changes to the question editor: initially students just read the measurements in the picture in the question, then they are replaced by adding what is known to the question and students have to look for the diameter of the marble and whether it meets the requirements to take part in the competition or not. The next improvements to the questions being evaluated were replacing the images

with clearer questions and redacting the questions. Editing the question before revision "Mutia wanted to know the specifics of the stone, so an experimental tool was designed", Changes after revision "Mutia wanted to know the specifics of the stone, one of which was determining the density" and also changed the type of writing on the question.

The next improvement to the questions in the evaluation was changing the questions. This question has been replaced because the question in the next number has the same question as question number 8. The next improvement to the evaluation questions is to change the editorial of the question, the editorial before revision is to know the tension in the string and its equality which produces how much energy and to ask for the unit conversion for the energy known in the question. The change after revision is that the maximum rope tension and its units and equality are known and what is asked is whether the rope breaks or does not move the bricks with the energy it has.

The next improvement is changing the questions. Before the revision of the questions, students already knew the answers from the question editor without needing to look for them, this made students not think critically and creatively in looking for answers, so it was replaced with the problem of finding density and changing the type of writing used in the questions.

The next change to the question is changing the question. Before the revision, the questions displayed were about unit conversion questions, then after they were revised they were replaced with questions that asked about grouping types of quantities and units as well as changing the type of writing used. Apart from that, the evaluation also revised the options provided and changed the form of questions from illustrations, after revision it was changed to cause and effect questions and chose the correct answers 1, 2, 3.

4. Implementation Stage

The results of the test for teachers in each school are shown in Table 6.

Table 6. Results of students with good performance in Physics

Rating	Mean (%)	Category
Practitioner A	94,28%	Very Practical
Practitioner B	95,23%	Very Practical
Average	**94,75%**	**Very Practical**

According to Table 6, the Electronic-Book Department was conducted for 3 students with average achievement in Physics from Padang 16 Public High School. Students are selected based on the 10 students with the highest physics grades in the class, known to the classroom teacher. Looking at the student's performance test, the data shows that the e-book section containing the test data is very effective, with an average of 86.3%. In this way, the data obtained from the student's performance test shows that the e-book chapters are easy to understand, interesting and effective.

Table 7. Test scores of students with medium physics

Rating	Mean (%)	Category
Practitioner D	92,20%	Very Practical
Practitioner E	91,10%	Very Practical
Practitioner F	91,10%	Very Practical
Average	**91,50%**	**Very Practical**

According to Table 7, the resultsbof the e-book chapter practicality test were carried out on 3 students at Padang 16 State High School with hight physics scores. Students are selected based on the 10 students with the highest physics grades in the class, known to the classroom teacher. Looking at the student's performance test, the data shows that the e-book portion of the test data is very good with an average performance of 91.5%. In this way, the data obtained from the students' performance test shows that the e-book chapters are easy to understand, interesting and effective.

Table 8. Test scores of students with low physics scores

Rating	Mean (%)	Category
Practitioner G	93,30%	Very Practical
Practitioner H	77,80%	Practical
Practitioner I	92,20%	Very Practical
Average	**87,80%**	**Very Practical**

The teacher, who is familiar with the physics scores in the class, was informed about the results of the practicality test conducted on students. According to the obtained data from the practicality test, the e-book chapter covering measurement material was found to be highly practical, with an average percentage of 87.8%. This indicates that, based on student feedback, the e-book chapters were deemed easy to understand, interesting, and efficient. The comprehensive outcomes of the teacher practicality test are illustrated in Figure 2.

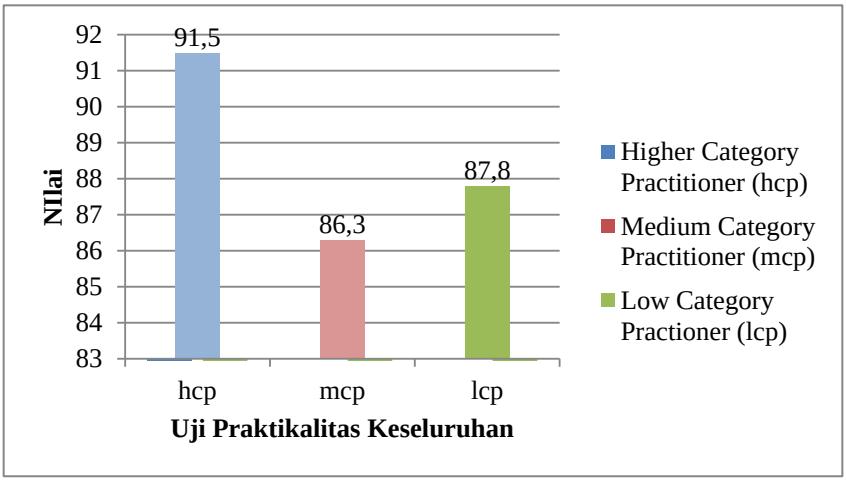

Figure 2. Overall Student Practicality Test Results

According to Figure 2, it can be concluded that all of the students who performed the test showed good performance in the products they created and were in the very good usage category. This shows that the material can be used as teaching material in education.

The practicality test results were gathered from six practitioners, identified as practitioners A, B, C, D, E, and F. The practicality instrument sheet encompassed three components: ease of understanding, level of interest, and efficiency. As [26] has pointed out, the practicality test should consider factors such as the effectiveness and efficiency of the learning implementation time, ensuring that the e-book chapters produced can capture students' interest in the learning process. Similarly, according to [27] research, the practicality level of interactive teaching materials plays a crucial role in enhancing students' critical and creative thinking abilities, particularly in the aspects of effective and efficient utilization during the learning process.

[28] asserted that a product can be deemed practical when all the essential aspects of teaching materials are addressed in the learning process. These practical aspects include the material being easy for students to comprehend and being effective and efficient in its usage. For a product to be considered practical for students during the learning process, it must offer a pleasant experience, characterized by teaching materials that are both easy to understand and efficient to use. Such an experience tends to heighten students' interest in learning, resulting in improved academic outcomes. With the completion of validity and practicality tests, the e-book chapter developed using the I-Spring application for measurement material is confirmed as valid and highly practical for use in the physics learning process within the classroom. This accomplishment aligns with the author's objective in creating the e-book chapter, which can now be employed in the teaching and learning process for measurement material.

In alignment with [29] research, which involved the development of a physics e-book using sigils that proved to be both valid and practical for use in the learning process, the assessment focused on content, alignment with the curriculum, and the visual presentation of the media. Similarly, [26]study resulted in the creation of a flash-based e-book called Kvisoft flipbook, which was found to be valid, practical, and effective. The evaluation criteria encompassed the aspects of media quality, material relevance, and language appropriateness. Additionally, [30] conducted research leading to the development of an Android-based e-book titled "play, learn & advance," which was deemed valid and practical. The evaluation criteria for this product included aspects such as media quality, content relevance, and language suitability. These studies collectively

highlight the importance of considering multiple dimensions, including content, alignment with the curriculum, media quality, material relevance, and language appropriateness, when assessing the validity and practicality of educational e-books.

The limitations of this research are the obstacles faced in the e-book chapter development stages using the ADDIE model, namely first at the analysis stage, collecting data regarding the teaching materials used during learning experienced problems because the learning carried out in high schools throughout Pada City was still online, so making it difficult to meet teachers and obtain data such as data on teaching materials used, interviews, filling out questionnaires, by teachers and students.

IV. CONCLUSION

Research results show that physics learning e-book chapters analyze the results, oriented towards critical and creative thinking skills with the Cased Based Reasoning approach to measurement material have a very valid and very practical validity value for practicality test results both according to teacher and student assessments with a score of 94.9 % and 88, 34% respectively.

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