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Development of Alternative Energy Digital Teaching Material Integrated PBL Model with Canva to Promote Students' Critical Thinking Skills

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ABSTRACT

Critical thinking is a crucial 21st-century skill that students need to develop. However, initial studies indicate that students' critical thinking skills are still relatively low. This study aimed to develop digital teaching materials integrated with the Problem-Based Learning (PBL) model that are both valid and practical to improve students' critical thinking abilities. The research followed a Research and Development (R&D) design using the Hannafin and Peck development model. The development process reached the limited trial stage, conducted with Grade X students. Data were collected through expert validation sheets and student practicality questionnaires. Descriptive statistical analysis was used to describe the validity and practicality results in the form of tables and graphs. The findings showed that the digital teaching materials were valid and practical. Expert evaluations resulted in an average score of 83.6, indicating excellent validity in content, visual design, instructional design, software functionality, and PBL integration. Students gave an average score of 82.2, reflecting very high practicality in terms of usefulness, ease of use, clarity, appeal, and affordability. Based on these results, the alternative energy-themed digital teaching materials integrated with the PBL model are considered effective for supporting classroom learning and enhancing students' critical thinking skills.

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INTRODUCTION

Education is needed to improve human quality. Education is very important in shaping quality human character and potential in various aspects of life and is a benchmark for the progress of a nation (Izhar et al., 2022). The progress of a nation can be seen from the high quality of education to create superior human resources and adapt to the times. Good quality education will create quality human resources for the next generation of the nation (Sugiarti

et al., 2018). Education is an investment in the future by continuously improving, developing, and innovating learning (Desyandri et al., 2019). Through education, humans strive to develop themselves following the advancement of science and technology to support sustainable development (Widarti et al., 2020). In addition, education is the right way to build and support the realization of national development goals (Athiyah, 2018). Education will give birth to humans who have the competence and skills to be developed in society (Sitepu, 2017).

Learning implementation should be able to improve students' 21st-Century Skills. Education in the 21st century is oriented towards activities to train skills in students by leading to the learning process. Education should prepare students to have 21st-Century Skills (Asrizal, 2020). This requires the implementation of education that can develop life skills in the 21st century, known as 4C skills (Anggreni & Yohandri, 2022). 4C skills are skills that can train students to communicate, think critically, think creatively, and collaborate in learning (Hufri et al., 2022). Critical thinking skills are skills to carry out various analyzes, assessments, evaluations, reconnections, and decision-making that lead to rational and logical actions (Rifa Hanifa Mardhiyah et al., 2021). The importance of mastering 21st-Century Skills is because at this time students are required to be able to develop life skills and soft skills in addition to mastery of learning materials and concepts at school (Nabilah & Nana, 2020). Formulating the knowledge and skills that students need for the 21st century is very important. A learning paradigm that can meet the challenges of the 21st century must provide opportunities for learners to apply their knowledge and skills to varied contexts and problems (Mashudi, 2021).

The utilization of technology and communication in education is an urgent need in this day and age. Education is one of the fields that use and utilize information and communication technology (Afada & Nuraini, 2021). The utilization of communication technology in the field of education is needed to support the learning process. The education system tends to utilize digital technology which is used as an effective, efficient, interesting, and interactive learning process tool with the help of the internet (Asrizal et al., 2022; Fimala et al., 2022). This is because digital-based media will be an urgent need in the future. Teachers must be able to utilize information and communication technology for learning purposes (Asrizal & Ashel, 2023; Fikriyah & Sukmawati, 2022). The use of technology in education will create students who have 4.0 competencies, namely critical, creative, and high-level thinking. Teachers need to present teaching materials or materials in the learning process to make it easier for students to learn. In other words, students are allowed to show creativity and critical thinking through the use of technology (Novitra et al., 2021). Teachers must have the skills to design creative, innovative, and effective learning (Effendi & Wahidy, 2019).

The real conditions found in schools do not match the ideal conditions expected. This is known from the results of the initial study conducted at MAN 1 Payakumbuh City. The real condition relates to the critical thinking skills of eight class X students who are still in the low category with an average score of 56,23. This is in line with research conducted by (Affandy et al., 2019; Asniar et al., 2022; Priyadi et al., 2021) which states that students' critical thinking skills in physics learning are still relatively low. The results of the initial study that has been carried out show that there is a gap between the ideal situation and the real situation in the field. This shows that there is a problem that must be researched. The low student learning outcomes are due to the lack of application of student-centered learning and the absence of real-world problems presented in the learning process. The lack of student learning resources such as teaching materials also affects the low student learning outcomes. So that indirectly it has an impact on students' critical thinking skills. One solution to overcome this problem is to develop digital teaching materials integrated with the PBL model for students. Previous research that has designed solutions to overcome these problems is to develop PBL model-based worksheets (Maulidiya & Mercuriani, 2023).

Digital teaching materials are one of the non-print teaching materials which have the

meaning as a tool in learning that continues to develop they contain learning materials, boundaries, methods, and ways to evaluate which are designed in a principled, attractive, systematic manner to achieve learning competency targets (Lestari et al., 2017; Praswoto, 2013). Digital teaching materials are teaching materials that are compiled and developed using computer information technology tools to process data, including processing, obtaining, compiling, storing, and manipulating data in various ways to produce quality information. Digital teaching materials have a general structure consisting of identity, competency standards and basic competencies, achievement indicators, teaching materials, practice questions, competency tests, and references (Kemendiknas, 2010). Digital teaching materials can improve students' thinking skills, critical thinking, and problem-solving abilities to achieve 21st-century learning goals (Dewi et al., 2021).

The problem-based learning model is a learning model that uses real-world problems that exist in everyday life as a basis for acquiring knowledge and concepts through critical thinking and problem-solving skills (Fakhriyah, 2014; Happy & Widjajanti, 2014). The characteristics of the problem-based learning model are that there is a dependence on the problem, and the problem presented is ill-structured so that students can solve it individually or in groups. The teacher only acts as a facilitator and then students are only given instructions on how to solve the problem (Sumartini, 2016). The syntax of the Problem-Based Learning model is orienting students to the problem, organizing students to learn, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating the problem-solving process (Al-Tabany, 2017).

Several studies have offered solutions in the form of digital teaching materials integrated with the PBL model. First, a study entitled the development of teaching materials based on the problem-based learning Model on the subject of environmental pollution (Wahyudi et al., 2014). Second, a study entitled the development of digital-based teaching Materials in English Subjects (Farhana et al., 2021). Third, a study entitled the development of electronic energy and momentum teaching materials (Fitria & Asrizal, 2021). Fourth, a study entitled the development of teaching materials based on information technology. (Sholeh & Basuki, 2019). Fifth, research entitled Making ICT-based physics modules to integrate character education values (Mardyansyah et al., 2013). The five studies developed digital teaching materials and e-modules in learning, applied them to SMA/MA students, and measured critical thinking, problem-solving, and student learning outcomes. This previous research is the basis for conducting this research.

However, some previous studies are still limited. There are some differences between previous research and this research. The difference is also the novelty of the research from previous studies. First, this research is development research with the Hannafin & Peck development model. Second, the product developed is digital teaching materials using the Canva application. Third, the physics learning material in digital teaching materials is alternative energy material. Fourth, this teaching material contains one of the learning models, namely the problem-based learning model that links learning with the real world. Fifth, this teaching material measures the 21st-century skills component, namely critical thinking. The developed digital teaching materials also contain images, videos, worksheets, live worksheets, and interactive questions that make this teaching material more interesting.

Based on the background, it can be stated that the development of digital teaching materials integrated with the PBL model plays an important role in achieving learning objectives. The development of digital teaching materials has the aim of improving students' critical thinking skills. Digital teaching materials integrated with PBL models can be used as guidelines for teachers and students in the implementation of learning so that teachers do not only focus on textbooks. With this digital teaching material, it is expected to motivate students to learn and make learning more efficient, interesting, and effective. The purpose of this

research is to determine the results of the initial study, determine the results of the validity test, and determine the results of the practicality test of using digital teaching materials integrated with the PBL model with Canva.

METHODS

The research method used in this research is research and development (R&D). This research is used to develop new products and improve existing products. The research and development method is a method used to test the validity, practicality, and effectiveness of the products made (Sugiyono, 2019). This research produces products in the form of digital teaching materials based on the Canva-integrated PBL model to improve students' critical thinking skills. This research includes the Hannafin and Peck development model. This model consists of three main stages so that it will be easier to understand and develop in a short time but evaluation and revision at each stage will make this development model will keep going in the desired direction.

The research uses the Hannafin and Peck development model. This model consists of three steps, namely needs analysis, design, development, and implementation, and in each stage through a process of evaluation and revision (Hershey, 2019). The first stage in this research is the needs analysis stage. The activities carried out at this stage are analyzing learning problems, analyzing student characteristics, analyzing learning objectives, and analyzing learning settings. The second stage in this research is the product design stage. The activities carried out at this stage are collecting all the sources that will be used as references in developing the product. At this stage will produce a storyboard or design of alternative energy digital teaching materials integrated with the PBL model. The third stage in this research is the development and implementation stage. The activity carried out at this stage is to develop products in the form of digital teaching materials for alternative energy integrated with the PBL model. The resulting product is then validated by 3 validators so that teaching materials are obtained that meet the needs and can be used in learning. Then if the alternative energy digital teaching materials integrated with the PBL model have been declared valid, the teaching materials can be used in learning. The next activity carried out is to conduct a practicality test of the product developed. This practicality test was carried out by MA X class students who had tried digital teaching materials. The Hannafin and Peck model can be seen in Figure 1.

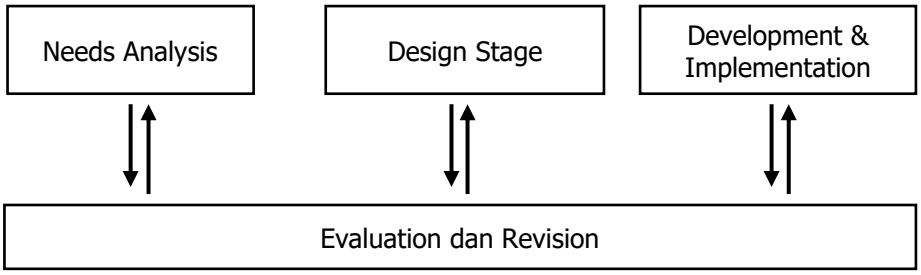

Figure 1. Hannafin and Peck's Model

The instruments used for data collection in this research consisted of two instruments, namely expert validation sheets and practicality sheets according to students. Data collection was carried out to see the implementation of the use of alternative energy digital teaching materials integrated with the problem-based learning model. The validity instrument aims to determine the validity of the components of digital teaching materials. The validation components used include five aspects, namely material substance, learning design, visual communication, software utilization, and integration of problem-based learning models.

These components are translated into indicators to make it easier to analyze the advantages and disadvantages of the design that has been made. On the other hand, for the practicality instrument used, namely the practicality test sheet by students. The practicality test sheet by students aims to determine students' opinions on the applicability and ease of application of digital teaching materials integrated with problem-based learning models in physics learning. The practicality instrument is seen from five components, namely the benefit component, the easy-to-use component, the attractiveness component, the clarity component, and the low-cost component received by students when using digital teaching materials integrated with the problem-based learning model.

The data analysis technique used in the research is descriptive statistical data analysis technique, namely by describing the results of the validity and practicality of using digital teaching materials in tables or graphs. This study assesses the validity and practicality of alternative energy digital teaching materials integrated with PBL models with Canva to improve students' critical thinking skills. The data from the validity and practicality tests are presented in graphical form. The assessment for validity and practicality uses a Likert scale with a score of 1 - 4 with the following conditions: 4 means Strongly Agree (SA), 3 means Agree (A), 2 means Disagree (DS), 1 means Strongly Disagree (SDS). The validity value category of the digital teaching materials developed refers to the category of assessment results, namely: 80 to 100 is excellent, 60 to 80 is good, 40 to 60 is sufficient, 10 to 40 is less, and below 10 is a failure. On the other hand, the practicality category refers to the category of assessment results, namely: 81 to 100 is very high, 61 to 80 is high, 41 to 60 is quite high, 21 to 40 is low, and 0 to 20 is very low (Riduwan, 2019). The results of validation and practicality were analyzed descriptively quantitatively, where the validity score was determined by calculating the number of scores given by the validator then dividing by the maximum number of scores, and the value of the division result was multiplied by 100%.

RESULTS AND DISCUSSION

Based on the research on the development of alternative energy digital teaching materials integrated with the PBL model with Canva that has been carried out, 3 research results and discussions are obtained for each stage of research and development. The first result is the results of the needs analysis. The results of this need analysis consist of analyzing the problems of using ICT in physics learning, analyzing student characteristics, analyzing learning objectives, and analyzing learning settings. The second result is the result of product validation of integrated digital teaching materials developed PBL model. The third result is the result of the practicality of the developed PBL model integrated digital teaching material products. For an explanation of each of the results of this study can be seen as follows.

Needs Analysis Result

Based on the Hannafin and Peck development model, the first stage conducted in the research is needs analysis. The first result of the needs analysis is the problem of using ICT in learning at school. The instrument used is a questionnaire given to two physics teachers. There are several obstacles for teachers in utilizing ICT in teaching materials. The results of the analysis of teacher constraints on the utilization of ICT in teaching materials can be seen in Table 1.

Table 1. The Analysis of Teacher Difficulty in the Use of ICT in Learning Material Result

No	Teacher Difficulty on the Utilization of ICT in Teaching Material	Value
1	Difficulty in mastering software	80
2	Difficulty in designing digital teaching materials	80
3	Difficulty in creating digital teaching materials with software	90
4	Difficulty in mastering digital teaching materials	80
5	Difficulty in using digital teaching materials in learning	85

Based on Table 1, it can be described that teachers experience obstacles to the use of ICT in teaching materials. The results of the analysis show that teachers are very constrained in making digital teaching materials using software, namely with a value of 90 in the high category. Teacher constraints in making digital teaching materials, mastering digital teaching materials, and mastery of software are in the high category with a value of 80. Teacher constraints in using digital teaching materials in learning with a value of 85 in the high category. From the data obtained, it can be concluded that teachers have constraints and difficulties in utilizing ICT in learning.

The second result of this needs analysis is the analysis of student characteristics. The instrument used is a student characteristics questionnaire consisting of four components, namely background (BG), learning interest (IL), learning motivation (LM), and learning style (LS). From the analysis of student characteristics, it can be seen how the characteristics of students will be considered in developing teaching materials. Analysis of student characteristics can be seen in Figure 2.

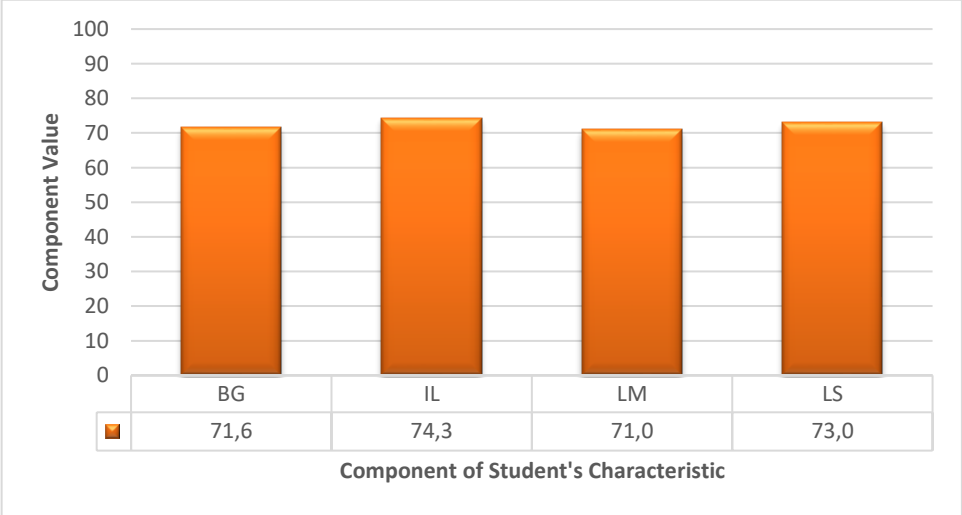

Figure 2. Analysis of Student's Characteristic Result

Based on the picture, it can be stated that interest in learning is physics learning. The results of the analysis show that the value of student characteristics is in the value range of 71.0 – 74.3. Student learning interest is in the good category where the average value is 74.3. The high interest of students in learning physics makes students motivate themselves more to be able to learn. The existence of student interest in learning physics and assisted by a good learning style will make students enthusiastic about learning. This can be seen from the results of the analysis that the learning style of students is in a good category with a value of 73.0. Overall, student characteristics with an average value of 72.5 are in a good category. Overall, student characteristics can affect students' thinking skills.

Analysis of student characteristics also relates to students' skills and prior knowledge.

The value of student knowledge comes from student learning outcomes in the form of student daily assessment scores and student critical thinking skills obtained from giving questions in the form of discourse. Based on preliminary studies, the results of students' critical thinking skills and knowledge scores were obtained. The statistical parameter values of the data can be seen in Table 2.

Table 2. Statistical Parameter Values for Need Analysis Data

Statistical Parameter	Critical Thinking Skills	Knowledge
Number of Students	27.00	27.00
Average	58.07	35.25
Mode	57.00	67.25
Median	60.00	35.50
Lowest score	35.00	6.00
Highest score	70.00	70.00
Range	35.00	64.00

Based on Table 2, it can be described the value of students' critical thinking skills and knowledge. The lowest score on the critical thinking skills assessment was 35.00 and the highest was 70.00. The lowest score for the knowledge score was 6 and the highest was 70.00. The average student critical thinking skills were 58.07 and student knowledge was 35.25. Based on the average scores, it shows that students critical thinking skills and knowledge are still in the low category. The value range of students' critical thinking skills and knowledge scores are 35.00 and 64.00, respectively, which are in the low category. The median values of students' critical thinking skills and knowledge scores of 60.00 and 35.50 are also in the low category. The mode values of critical thinking skills and knowledge of 57.00 and 67.25 are in the low and moderate categories. Based on this, it can be seen that students critical thinking skills and knowledge still have not achieved satisfactory results.

The third needs analysis is the analysis of learning objectives through ATP used by teachers in physics learning. This learning objective analysis refers to the Decree of the Head of the Standards Agency, Curriculum, Assessment, Education, Ministry of Education, Culture, Research and Technology Number 033/H/KR/2022. In the decree, the expected learning outcomes (CP) have been made. This learning objective analysis consists of four indicators, namely audience (A), behavior (B), condition (C), and degree (D). The results of the learning objective analysis can be seen in Figure 3.

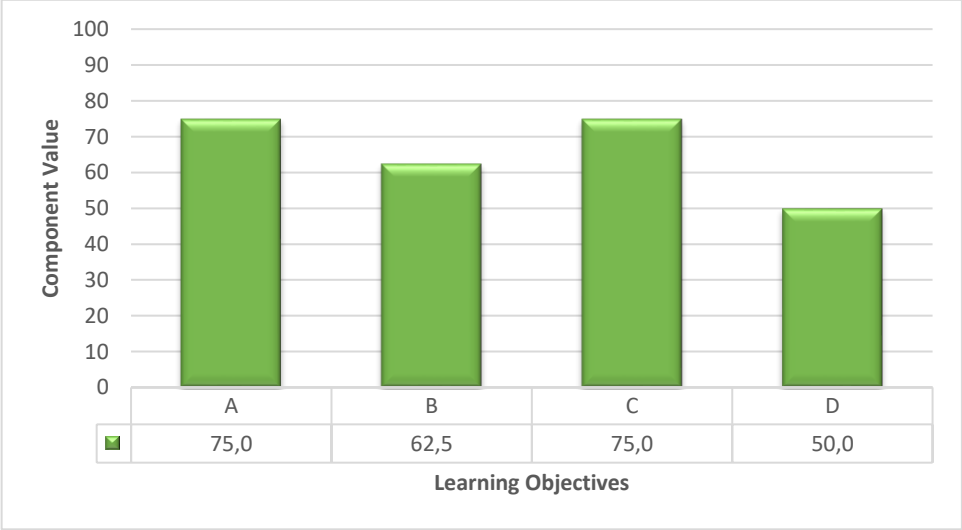

Figure 3. Analysis of Objectives Learning Result

Based on Figure 3, it can be stated that the learning objectives that have been prepared by teachers are not by the expected components. The analysis shows that the average assessment of learning components in ATP is 65.6 and is in the sufficient category. The audience and condition components are already in the good category with a score of 75.0. However, the behavior and degree components are still in the sufficient category with scores of 62.5 and 50.0. Therefore, to achieve learning objectives that are by the independent curriculum, must include all four components and be carried out by the learning objectives that have been designed so that the learning process is getting better.

The fourth needs analysis is the analysis of learning arrangements. The analysis of learning arrangements is carried out by analyzing documents in the form of teaching modules available to teachers. In the teaching module, there are learning arrangements consisting of introductory activities, core activities, and closing activities. The results of the analysis of learning arrangements can be seen in Figure 4.

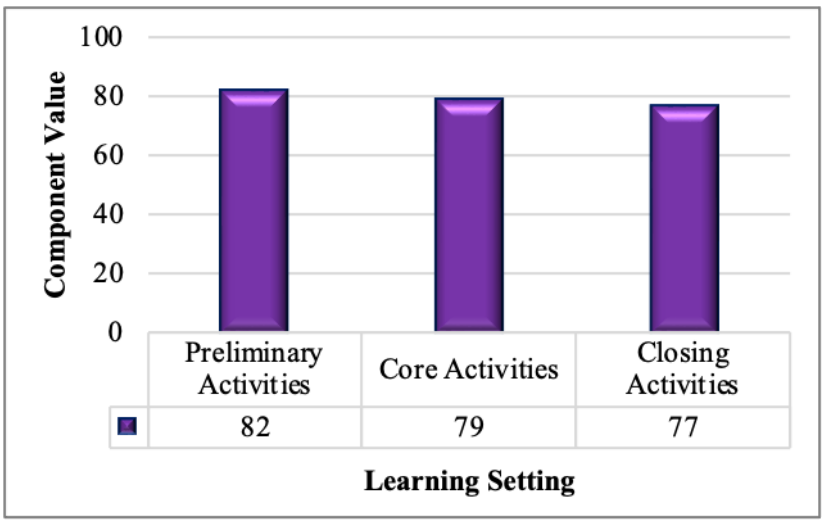

Figure 4. Analysis of Learning Settings Result

Based on Figure 4, it can be described that the results of the analysis of physics teacher learning arrangements consist of introductory activities, core activities, and closing activities. Introductory activities are in the excellent category with a score of 82. Core activities and closing activities are in a good category with scores of 79 and 77, respectively. The average analysis of learning arrangements is in a good category with a score of 79. This shows that learning arrangements at MAN 1 Payakumbuh City are ideal for learning implementation. However, there is still a need for improvement and improvement in the core activities and closing activities so that the implementation of learning is getting better.

Description of Digital Teaching Material

This stage is carried out by preparing a digital teaching material design framework tailored to the product specifications that have been planned previously. Digital teaching materials are made based on the guidelines for preparing digital teaching materials by the Ministry of National Education in 2010. Digital teaching materials are equipped with Learning Outcomes and Learning Objectives and material coverage that refers to the applicable learning outcomes, namely the Merdeka Curriculum. The material provided in class X semester 2 material, namely Alternative Energy material. Digital teaching materials are designed with components: identity which includes title, class, semester, and compiler identity; learning outcomes and flow of learning objectives; teaching materials; practice questions; competency tests; and references. This teaching material is made digitally with the help of the Canva application. Overall, this digital teaching material contains a problem-based learning model.

Interactive problem exercises are made using live worksheets. The goal is to make students more interested in working on it to increase their knowledge and critical thinking skills. The digital teaching materials developed can be presented as interestingly as possible to make it easier for students to learn physics. The following display of digital teaching materials designed can be seen in Figure 5.

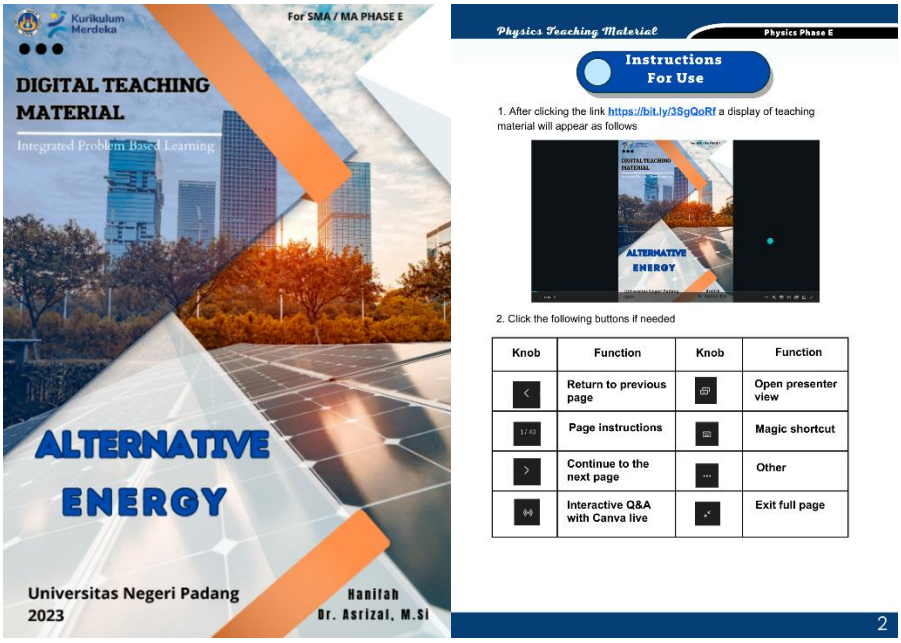

Figure 5. Design of the Title Page and Main Menu of Digital Teaching Material

Based on product assessment by experts, there are suggestions for improving alternative energy digital teaching materials. Suggestions for improving digital teaching materials after being accumulated by the three experts, namely the problems presented in digital teaching materials are still less contextual, practice questions are less by learning objectives, and there are obstacles in video displays. The follow-up to the suggestions given by experts is to revise the digital teaching materials developed. The improvements made were to find and replace the problems presented to be more contextual. Then improve the exercise questions by the learning objectives. Furthermore, improving the video display settings so that it is easy to access and does not slow down the display of digital teaching materials. The existence of suggestions and improvements in the development of this digital teaching material will make the resulting product better and can be used in supporting the learning process.

Digital Teaching Materials Validity Test Results

At this stage the activity carried out is to test the validity of the PBL model integrated digital teaching materials developed for grade X students in Physics subjects. The validity results were carried out by three validators. Product validation aims to determine the feasibility and quality of digital teaching materials. The validation was carried out by related experts. The validation component consists of 5 aspects, namely the material substance component (MS), learning design (LD), visual communication display (VC), software utilization (SU), and PBL model integration (MI). These components are translated into indicators to make it easier to analyze the advantages and disadvantages of the design that has been made. The average plot results for all validation test components can be seen in Figure 6.

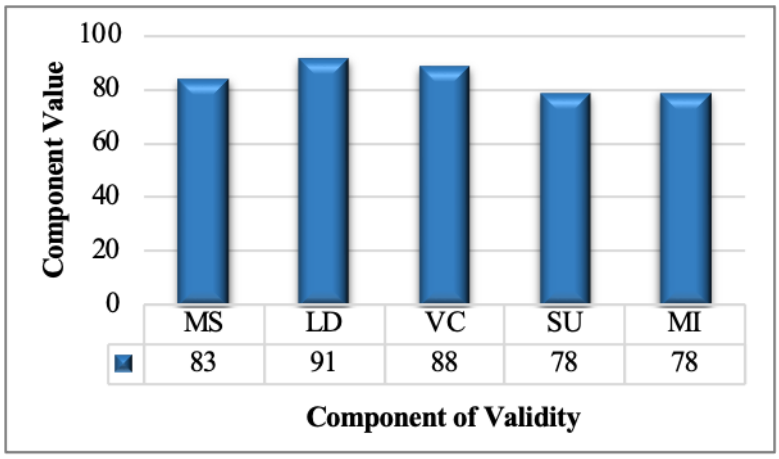

Figure 6. Validation of Digital Teaching Material

The first validity component according to the expert is the substance of the material. The value of the material substance component is in the range of 75 to 92. The lowest score is 75 obtained on the indicator that is by the development of science. The highest score was 92 on the indicator that was by facts in everyday life. Based on the values of the thirteen indicators, the average value for the material substance component is 83 with a very good category. The validator stated that the material substance component should use language that is easy to understand and use proper spelling (Anggraini et al., 2022). The second validity component according to experts is learning design. The range of values obtained from the learning design component indicators is 75 to 100. The lowest value is 75 obtained on the indicator that there are exercises that are by the learning objectives. The highest score is 100 on the indicator that there are learning outcomes. Based on the value of the eight indicators, the average value for the learning design component is 91 with a very good category.

The third validity component according to the expert is the visual communication display. The value of the visual communication display component is in the range of 83 to 100. The lowest value is 83 obtained on several indicators, namely the type of font, there are more than one learning media, the color combination is interesting, there are videos related to the material, and the video does not slow down the display. The highest score is 100 on the indicator that there are learning instructions. Based on the value of the nine indicators, the average value for the visual communication display component is 88 with a very good category. The product can be said to be valid if it includes the presentation component and has a high level of validity (Mandasari, 2022). The fourth validity component according to experts is software utilization. The value of the software utilization component is in the range of 67 to 92. The lowest score is 67 obtained on the indicator of activities and work instructions are easy to understand. The highest score is 92 obtained in the indicator that has utilized Canva in the design process. Based on the value of the six indicators, the average value for the software utilization component is 78 with a good category. The last validity component according to the expert is the integrated PBL model. The value of the integrated component of the PBL model is in the range of 67 to 83. The lowest value is 67 obtained in the indicator of the problem presented in digital teaching materials and the results of the investigation of the problem. The highest value is 83 obtained in several indicators. Based on the value of the thirteen indicators, the average value for the integrated component of the PBL model is 78 with a good category.

Based on the data analysis in Figure 6, it can be stated that the results of the product design assessment were conducted by experts through the components of material substance, learning design, visual communication display, software utilization, and PBL model integration. The validity value for each indicator is obtained in the value range of 78 to 91. The

highest value is in the learning design component which is 91 which is in the excellent category. While the lowest value is in the software utilization component and integrated PBL model with a value of 78 which is in the good category. The average value of the five components is 83; 91; 88; 78; and 78. After withdrawing the average value of all components is in the excellent category with a value of 83.6. According to the validator, digital teaching materials can be said to be valid if they meet the criteria of good or very good on the components of digital teaching materials and learning indicators (Izhar et al., 2022). Next (Salim, 2016) explains that well-prepared teaching materials that are categorized as valid can be used to improve students' thinking skills. This means that the validation test of alternative energy digital teaching materials integrated with the PBL model is declared valid and can be used in physics learning. Based on this data, it can be concluded that the validity of the product from expert opinion is very good and the product can be used in optimizing the learning process.

Practicality Test Results of Digital Teaching Material

At this stage, a field test was conducted to see the practicality of digital teaching materials for alternative energy integrated with the PBL model. Practicality is assessed from a questionnaire filled out by class X students. The practicality test was carried out to see how easy and practical the alternative energy digital teaching materials integrated with the PBL model were used in learning. The assessment was carried out by practitioners, namely grade X students. Practicality data is obtained from a questionnaire filled out by students who have applied the use of digital teaching materials. The components of practicality contained in the instrument are benefits (BF), easy-to-use (EU), attractiveness (AP), clarity (CL), and low cost (LC). In each component, there are several assessment indicators related to student responses to digital teaching materials integrated with the PBL model. The results of the average value plot for each component can be seen in Figure 7.

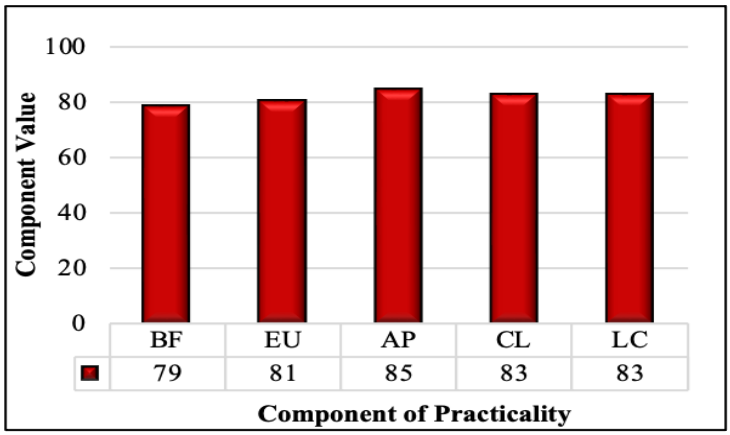

Figure 7. The Practicality of Digital Teaching Material

The first component of practicality according to students is benefits. The lowest score is 70 obtained on the indicator of motivating students. The highest score was 82 on the indicator of improving students' critical thinking skills. Based on the value of the eight indicators, the average value for the benefit component is 79 with a high practicality category. The second component of practicality according to students is easy-to-use. The range of values obtained from the easy-to-use component indicators is 70 to 90. The lowest value of 70 obtained on the indicator makes it easy for students to connect the material with everyday life problems. The highest score is 90 on the indicator can be used anywhere and the indicator can be used anytime. Based on the value of the five indicators, the average value for the easy-to-use component is 81 with a very high practicality category. This is the opinion (Plomp & Nieveen,

2007) that teaching material is said to be practical if the teaching material can be used easily by teachers and students in learning. The existence of real-world facts and problems presented in teaching materials will make it easy for students to connect to the learning context (Hikmah et al., 2022).

The third component of practicality according to students is attractiveness. The value of the attractiveness component is in the range of 78 to 92. The lowest score is 78 obtained on the indicator of color combination on the cover. The highest score was 92 on the indicator of clear enough pictures and work instructions. Based on the values of the six indicators, the average value for the attractiveness component is 85 with a very high practicality category. The fourth component of practicality according to students is clarity. The value of the clarity component is in the range of 73 to 88. The lowest value is 73 obtained on the indicator of activities and work instructions are easy to understand. The highest score was 88 obtained on the indicator of the type of font read clearly. Based on the values of the seven indicators, the average value for the clarity component is 83 with a very high practicality category. The last practicality component according to students is cost-effective. The value of the cost-effective component is in the range of 77 to 87. The lowest score is 77 obtained in the indicator does not require the cost of printing. The highest value is 87 obtained in the indicator that can be used repeatedly. Based on the values of the five indicators, the average value for the cost- effective component is 83 with a very high practicality category.

Based on the data analysis in Figure 7, it can be stated that the results of the product design assessment conducted by students through the aspects of benefits, ease of use, attractiveness, clarity, and low cost. The highest value is in the attractiveness component, which is 85, which is in the very high practicality category. While the lowest value is in the benefits component with a value of 79 which is in the high practicality category. The average values of the five components are 79; 81; 85; 83; and 83. After withdrawing the average value of all components is in the very high practicality category with a value of 82.2. So, it can be concluded that the practicality of the product from the student's point of view is already at very high practicality and the product can be used in optimizing the learning process.

Based on the results of the needs analysis research, the learning process carried out has not followed the demands of the independent curriculum. The research results obtained are from previous research which states that the learning process is still teacher-centered, where the teacher tells more stories or lectures (Nasution et al., 2021). Apart from teacher-centered learning, the learning strategy or model applied will also affect students' critical thinking skills (Purwanto & Winarti, 2016). This is one of the reasons why students' critical thinking skills are low (Ratnawati et al., 2020). The results of students' critical thinking skills at MAN 1 Payakumbuh City are still in the medium category. Students' critical thinking skills in physics learning are still in the low category as evidenced by giving questions in the form of discourse and students are unable to describe the answers correctly (Permata et al., 2019; Priyadi et al., 2021).

The results showed that the digital teaching materials integrated with the PBL model were declared valid and practical in supporting the learning process and could improve students' critical thinking skills. This is to research conducted by (Hidayaturrohman et al., 2017; Malik, 2021; Paramita et al., 2021; Sutanto et al., 2022) that digital teaching materials can improve students' critical thinking skills. The PBL model helps students understand learning based on real-world problems presented. With these real-world problems, students can be more motivated to learn and learning will also be more interesting. The application of the PBL model in learning will also improve students' critical thinking skills. This is to previous research which states that the PBL model can improve students' critical thinking skills (Fristadi & Bharata, 2015; Hartati & Sholihin, 2015; Prayogi & Asy'ari, 2013; Satwika et al., 2018).

This research focuses on the development of digital teaching materials. The digital

teaching materials made integrated the problem-based learning model in improving students' critical thinking skills as a finding in this study. Digital teaching materials can motivate students to expand their knowledge and explore learning materials to develop critical thinking skills in each student. The results of this study imply that teachers must be able to provide encouragement and motivation to learn and guide students to develop knowledge through digital teaching materials that contain problem-based learning models. The development of this digital teaching material is limited only to alternative energy material in class X at MAN 1 Payakumbuh City which was developed through the help of Canva software.

CONCLUSION

Based on the results of the research and discussion, two conclusions can be stated. First, the validity of digital teaching materials integrated with the PBL model is in the excellent category. Second, the practicality value of digital teaching materials integrated with the PBL model according to students is included in the very high practicality category. Digital teaching materials integrated with the PBL model are declared valid in the components of material substance, visual communication display, learning design, software utilization, and integrated PBL model. Students also stated that the presentation of digital teaching materials integrated with the PBL model with high practicality in the components of benefits, ease to use, attractiveness, clarity, and low cost. Alternative energy digital teaching materials integrated with the PBL model with Canva to improve students' critical thinking skills are very good and very high practicality is used to optimize the physics learning process. The results of this study imply that teachers must be able to provide encouragement and motivation to learn and guide students to develop student knowledge through digital teaching materials by integrating problem-based learning models.

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