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Development of Sound Wave E-learning Material by Integrating Contextual Teaching with Smartphone to Improve Students' Critical and Creative Thinking Skills

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Abstract. Twenty first century skills are necessary for students to solve problems and be successful in learning. One of the core subjects of 21st century skills is learning and innovation skills. Learning and innovation skills include critical thinking and creative thinking skills. Problems found in the field show that students' critical and creative thinking skills are still low. The solution is to develop sound wave E-learning material by integrating contextual teaching with smartphones to improve students' critical and creative thinking skills. The purpose of this study was to determine the results of the needs analysis, the validity test, and the practicality test of the use of e-learning material. The research method used is the Hannafin and Peck development model which consists of needs analysis, design, and development and implementation. The research data were in the form of questionnaires, performance questions, validation and practicality instruments. Data analysis used a Likert scale, using Aiken's V formula to analyze the validity level and statistical analysis formulas to analyze the practicality of e-learning material. The results of the analysis showed that students' critical and creative thinking skills were still low. Then the developed e-learning material are valid with a value of 0.89 and the level of practicality is very good with a value of 86.52. Based on the research conducted, it can be concluded that the sound wave e-learning material by integrating contextual teaching with smartphone are valid and practical so that they can be used in the learning process.
Keywords: E-learning material, sound wave, contextual teaching, critical thinking, creative thinking.

Introduction

Twenty first century skills need to be developed in students to handle the challenges in their lives. One of the core subjects of twenty first century skills is learning and innovation skills (Ayu, 2019). Learning and innovation skills include critical thinking skills (CTC-TS) and creative thinking skills (CTV-TS). CTC-TS is very necessary for the current era of science and technology development because it also raises several problems for humans and the environment (Maknun, 2020). Based on data from the programme for international student assessment, CTC-TS of school students in Indonesia are still very low (PISA, 2018). Fundamentally, CTC-TS is an active process of an individual in thinking about things deeply, asking questions, and finding answers or

relevant information independently (Williams, 2017). CTC-TS can be taught to everyone, one of which is through education because education has an important role in shaping students' attitudes, knowledge and skills (Saputra et al., 2019). Students who have CTC-TS are able to use systems thinking and make decisions and solve problems. CTV-TS are the ability to create new and different ideas or ideas from existing ones (Aryana, 2019). Students with trained CTV-TS will be able to be flexible, can see opportunities and can face the challenges of a rapidly developing world (Rahardjanto & Fauzi, 2019).

Twenty first century learning should be able to build students' skills needed in this century. Twenty first century learning can be said to be learning that prepares the twenty first century generation (Mu'minah & Suryaningsih, 2020; Umayah & Riwanto, 2020). To develop twenty first century learning, teachers must start one step of change, namely changing traditional teacher-centered learning patterns to student-centered learning patterns (Pratiwi et al., 2019). One example is that students are given the opportunity to develop their ability to master information and communication technology. Rapid scientific and technological advances in the globalization era encourage students to acquire various skills, knowledge, and attitudes (Fitriani et al., 2020). That way, students have the skills to use technology in the learning process so that students' thinking and learning skills can can be improved in teaching process (Umayah & Riwanto, 2020).

Information and communication technology (ICT) plays an important role in implementing twenty first century learning. ICT provides a wide, fast, effective and efficient reach for information dissemination. The influence of ICT on twenty first century learning can be felt. The utilization of ICT in twenty first century learning can improve the quality of education, namely by opening wide access to knowledge and providing quality education (Tekege, 2017). The development of technology changes the learning orientation from conventional learning to digital learning. Teachers can maximize the use of technology in learning activities. The use of technology can help teachers improve the efficiency and quality of learning (Asrizal et al., 2022). In addition, the utilization of ICT is also felt by the availability of various variations of learning media and new models that utilize technology (Megahantara, 2017). Examples of ICT utilization in assisting the teaching process are presentation media, learning media such as e-learning, e-learning material, and ICT-based learning material (Asrizal & Utami, 2021). Electronic learning materials can support teachers in implementing the teaching process that is more structured, time-saving, and fun (Asrizal et al., 2023).

The results of the initial study revealed problems in physics teaching that are relevant to twenty first century learning. The real conditions encountered in the field are not in accordance with the expected ideal conditions. The first real condition is the low use of physics e-learning material in schools and the absence of CTL integrated e-learning material. The second real condition related to critical thinking skills and creative thinking of grade XI students is still in the low category, namely with a value of 51 and 43. This is in line with several studies that show students' CTL-TS and CTV-TS are still low. The first study explained that in general, learning activities in the classroom have not emphasized the process of training CTC-TS. Learning that occurs only refers to how students are able to do questions or tasks from the teacher quickly and accurately and are able to answer test questions (Fahmi, 2018). Likewise with CTV-TS, students have not been trained optimally. The second study explained that students' CTV-TS were low. This shows that students' CTV-TS must be a serious concern to be developed (Sugiyanto & Masykuri, 2018). The third real condition is related to the sound wave material in class XI, where students still have difficulty mastering the sound wave material (Zubaidah, 2022; Heldawati, 2022). The fourth real condition is related to student learning

outcomes, seen from the average value of the odd midterm exam for students in grades XI IPA 1 to 6, which is 57.33 and is in the low category.

Several studies have offered solutions in the form of CTL-integrated e-learning material. First, a study entitled the development of contextual-based high school physics learning material on temperature and heat (Astiti, 2019). Second, a study entitled the development of contextual physics learning material in increasing student learning motivation (Haryadi & Nurmala, 2021). Third, the development of contextual-based learning material to remediate misconceptions on force material and Newton's law of motion (Pasaribu & Saparini, 2017). Fourth, a study entitled CTL-based physics e-modules using the Kvisoft flipbook maker application to improve the science literacy of class XI SMA/MA students (Nurhasnah & Sari, 2020). Fifth, a study entitled the development of contextual physics learning material to improve students' concept mastery (Oktaviani et al., 2017). The five studies developed learning material products and e-modules in learning, applied them to SMA/MA students, measured the level of learning motivation, the level of science literacy, and mastery of student concepts. This previous research is a fundamental source in conducting this research.

However, some previous studies are still limited. There are some differences between previous research and this research. Some of these differences are also the novelty of research from previous studies. First, the learning material used are ICT-based or electronic. Second, the learning material developed integrate CTL which links teaching with the real world. Third, the learning material developed can be accessed online via smartphones. Fourth, these learning material measure two components of 21st century skills, namely CTC-TS and CTV-TS of students. The developed E-learning material also contain videos, images, worksheets, google forms, and interactive questions that make this learning material more interesting.

The first theoretical review of the solution relates to E-learning materials. E-learning materials are material or resources that are systematically arranged to assist students and teachers in carrying out the teaching process (Satriawan & Rosmiati, 2017). E-learning material consist of learning material that are systematically arranged to achieve teaching objectives that are presented or published in electronic format (Ridho et al., 2020). The stage of preparing learning material depends on the characteristics of the material to be developed in teaching activities. There are several scopes of learning material, including the following: 1) title, class, semester, and identity of the author, 2) core competencies and basic competencies, 3) achievement indicators, 4) learning material, 5) exercise questions, 6) competency test, 7) reference (Kemendiknas, 2010).

The second theoretical review of the solution concerns the contextual teaching known as CTL or contextual teaching and learning. CTL is a teaching process that links daily life with the material that students learn so that students are helped to understand the material. CTL is teaching that prioritizes students' real understanding and experience (Nareswari, 2021). The main purpose of CTL is to help students in the right way to connect meaning to student learning at school. CTL has seven components that must be considered, including constructivism, discovery, questioning, learning communities, modeling, reflection, and authentic assessment (Hasibuan, 2014). Teaching that can help teachers relate material to real conditions is CTL (Sastriani & Halim, 2014). The application of CTL is also influenced by the teacher's teaching ability (Dewi & Primayana, 2019). Some reasons CTL can be successful in teaching process because it is in accordance with students' daily lives, the CTL approach is able to link new information

with existing knowledge, in accordance with how nature works, so that the application of CTL is expected to make learning more effective and efficient (Nurhidayah et al., 2016).

The third theoretical study is related to the utilization of smartphones in teaching. Today students have grown up using devices such as computers, smartphones, tablets and laptops for almost every activity. The development of smartphones is not only as a communication tool. Smartphones can also be used in the world of education, namely as media and learning resources (Imania & Bariah, 2020). Given the high use of smartphones by students, teachers should facilitate students using it as a medium to support the teaching process. Teaching with the help of smartphones has the potential to help students increase learning motivation (Hess, 2014). If this opportunity can be utilized properly, teaching process will become more flexible and interactive. The implication is that teaching is no longer dominated by the teacher, so students have a role in determining success in the teaching process.

Based on the background, it can be stated that the development of e-learning material for sound waves integrated with CTL needs to be done. This is in accordance with the real conditions in the field showing that the use of E-learning material is still low and has not integrated CTL. Then the results of students' critical and creative thinking skills are also still low. The purpose of this research is to determine the results of the preliminary study, the results of the validity test, and the results of the practicality test of the use of CTL-integrated e-learning material with smartphones.

Methods

This research can be classified into research and development method. In developing the E-learning material by integrating CTL with smartphones, the Hannafin and Peck model was applied. The Hannafin and Peck model is one of the learning design models whose presentation is done simply, so it does not require a long time. The Hannafin and Peck model has three phases: needs analysis phase, design phase, and development and implementation phase (Hannafin & Peck, 1988). All phases of the Hannafin & Peck model must involve a process of evaluation and revision (Joshua et al., 2020).

The object of this research is to investigate the sound waves e-learning material by integrating CTL with smartphones to improve students' critical and creative thinking skills. The research subjects consisted of three validators, namely three lecturers of the Physics Department FMIPA UNP, physics subject teachers, and 11th grade high school students. The sample determination used purposive sampling method. A total of 30 11th grade science students at SMAN 5 Bukittinggi were selected as samples. The research was conducted at SMAN 5 Bukittinggi in May 2023.

The first phase is the needs analysis phase. The needs analysis was carried out by identifying the needs in developing e-learning material. The needs analysis carried out included analyzing of teacher constraints on the use of ICT in learning material, student characteristics, teaching objectives, teaching settings, and student skills and student knowledge. Analysis of student characteristics includes background, learning interests, learning motivation, and student learning styles. Analysis of teaching objectives includes audience, behavior, condition, and degree indicators. Analysis of teaching settings includes opening activities, core activities, and closing activities of teaching carried out by teachers at school. Analysis of student skills includes students' critical and creative

thinking skills. Analysis of student knowledge is analyzed from student learning outcomes.

The second phase is the design phase. In this design phase, information from the analysis phase is transferred into the form of documents that will be the purpose of making electronic learning material. The design phase is carried out by making an outline design or framework of e-learning material. The applications used in making this e-learning material are microsoft word, canva, and PDF flip professional. The topic selected is the sound wave material of physics class XI semester 2 senior high school. In making e-learning material, the teaching approach is integrated, namely the CTL approach. The structure of e-learning material made consists of cover, preface, table of contents, learning guidance, core competence and basic competence, indicators and teaching objectives, learning material, worksheets, practice questions, evaluation questions, and references.

The third phase is development and implantation. The development and implementation stages will produce products in the form of sound waves e-learning material by integrating CTL with smartphone. At the development and implementation stage, the validity test and practicality test of e-learning material are carried out. E-learning material were validated by 3 validators. The validation test aims to determine the validity or invalidity of the e-learning material developed. Furthermore, e-learning material are refined according to suggestions and input from validators. After being declared valid, the next stage is the practicality test of the developed product. The practicality test aims to determine the practicality of using e-learning material in teaching process.

Data collection in the study used several instruments. First, a questionnaire of teachers' difficulties on the utilization of ICT in learning material. This questionnaire was given to 2 high school physics teachers. Second, performance assessment questions given to students to measure students' CTC-TS and CTV-TS. Third, document analysis in the form of physics lesson plans of teachers to analyze teaching objectives and settings. Fourth, student learning outcome documents to analyze student knowledge. Fifth, the validation sheet of e-learning material. The validity instrument contains 5 assessment components, namely material substance, visual communication display, learning design, software utilization, and CTL assessment. Sixth, the practicality sheet of e-learning material according to students. The practicality instrument consists of an assessment of the components of usefulness, ease of use, attractiveness of presentation, clarity, and cost-effectiveness.

The data analysis technique used in the research is descriptive analysis technique, namely by describing the results of needs analysis, validity test analysis, and practicality test analysis in the form of tables or graphs. Analysis of teacher constraints on the use of ICT in teaching material, analysis of student skills and knowledge is presented in tabular form. Analysis of student characteristics, teaching objectives, teaching settings, validity tests and practicality tests are presented in the form of graphs. The assessment for this study 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 (DA), and 1 means strongly disagree (SDA).

The product validation test was analyzed using a Likert scale by giving a score for each answer item very good (4), good (3), less (2), and very less (1). Then giving the validity value by using the Aiken's V formula.

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

Based on equation (1), s = r - Io, Io is the lowest validity assessment number in this case is 1, c is the highest validity assessment number in this case is 4, and r is the number given by the validator. The categories to determine the validity of e-learning material integrated with the CTL that has been developed can be seen in Table 1.

Table 1. Validity test rating categories

Value	Category
≥ 0.6	Valid
< 0.6	Invalid

(Source: Azwar, 2015)

The product practicality test was analyzed using descriptive statistical analysis techniques. The practicality of using the product will be analyzed to determine the level of practicality of using the product developed. The practicality of a product is analyzed using the following formulation.

$$Value = \frac{Score}{Maximum\ Score} \times 100 \quad (2)$$

Table 2. Practicality test rating categories

Interval	Category
30 – 39	Failed
40 – 55	Less
56 – 65	Simply
66 – 79	Good
80 – 100	Excellent

(Source: Arikunto, 2013)

Results and Discussion

Needs Analysis Results

Based on the Hannafin and Peck development model, the first phase conducted in this study is a needs analysis. The first needs analysis is an analysis of ICT utilization problems. The instrument used is a questionnaire given to 2 physics teachers. There are some teacher constraints on the utilization of ICT in learning material. Analysis of teacher difficulty on the use of ICT in learning materials can be seen in Table 3.

Table 3. The analysis of teacher difficulty on the use of ICT in learning material result

Teacher Difficulties on the Utilization of ICT in Learning Material	Value
Difficulty in creating electronic learning material	81.25
Challenges in mastering electronic learning material	71.88
Obstacles in mastering software	84.38
Difficulty in creating electronic learning material with software	81.25
Challenges in using electronic learning material in learning	71.88

Based on Table 3, it can be seen that teachers experience obstacles to the use of ICT in learning material. According to the data from the analysis of teacher difficulty on the use of ICT in learning material in the value range 69-81. The results of the analysis show that teachers are very constrained in mastering software, namely with a consecutive value of 84.38 in the high category. Teachers' constraints in making e-learning material and constraints in making using software are in the high category with a value of 81.25. Meanwhile, teacher difficulties in mastering and using e-learning material in learning are in the sufficient category with a value of 71.88. From the data obtained, it can be concluded that teachers feel constrained and have difficulties in utilizing ICT in learning material.

The second needs analysis is the analysis of student characteristics. The instrument used was a student characteristics questionnaire given to 30 students of class XI MIPA. There are 4 indicators of student characteristics measured, including background (BG), learning interest (IL), learning motivation (LM), and learning style (LS). The analysis of student characteristics can be seen in Figure 1.

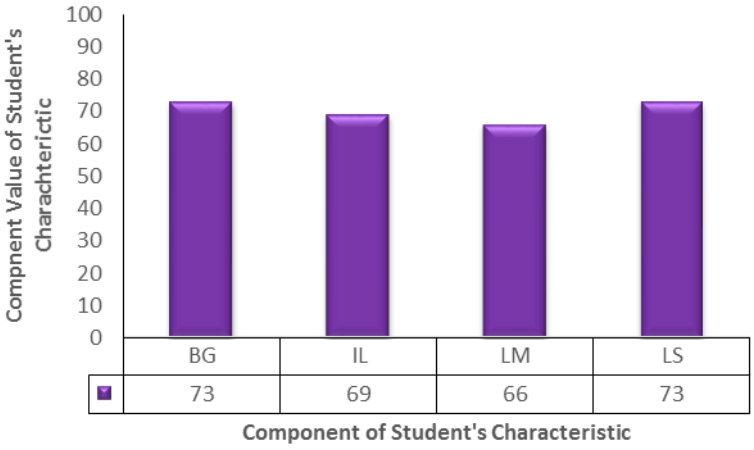

Figure 1. Analysis of student's characteristic result

Based on Figure 1, it can be seen how the characteristics of students in class XI MIPA SMA Negeri 5 Bukittinggi in physics teaching. The results of the analysis show that the value of student characteristics is in the range of 66-73. According to the data, it can be explained that the indicators of student background and student learning style are in the good category with a value of 73. While the indicators of student interest in learning and learning motivation are in the sufficient category, namely with a value of 69 and 66

respectively. This can be interpreted that the internal factors of students have not fully supported the physics teaching process in order to obtain maximum results.

The third needs analysis is the analysis of students' critical thinking skills, students' thinking skills, and students' knowledge. Students' critical thinking and creative thinking skills are obtained from the work assessment sheet, while the value of student knowledge comes from student learning outcomes in the form of mid-term test scores. Based on initial observations during the study, the results of students' CTC-TS, students' CTV-TS, and students' knowledge scores were obtained. The statistical parameter values of these data can be seen in Table 4.

Table 4. Statistical parameter values for need analysis data

Statistical Parameters	Critical Thinking Skills	Creative Thinking Skills	Knowledge
Number of students	30	30	30
Average	51	43	41
Mode	55	38	40
Median	50	38	40
Lowest score	30	25	20
Highest score	70	63	83
Range	49	38	63

Based on Table 4, it can be explained that the lowest scores of the assessment of students' CTC-TS, CTV-TS, and knowledge were 30, 25, and 20, respectively, while the highest scores were 70, 63, and 83, respectively. The average of students' critical thinking skills is 51, students' creative thinking skills is 43, and students' knowledge is 41. This shows that the average value of students' CTC-TS, CTV-TS, and knowledge is in the low category. The range of values from the assessment results of students' CTC-TS, CTV-TS, and knowledge are 49, 38, and 63, respectively. The values that often appear in the assessment of students' CTC-TS, CTV-TS, and knowledge are 55, 38, and 40, respectively. These three values are in the low category. The middle scores of the research on students' CTC-TS, CTV-TS, and knowledge were 30, 25, and 20. These three scores were also in the low scores. Based on these three assessments, it can be seen that CTC-TS, CTV-TS, and student knowledge have not achieved the expected results so that this requires innovation in learning so that later the results obtained are more optimal and in accordance with expectations.

The fourth needs analysis is the analysis of teaching objectives. The results of the analysis of teaching objectives were obtained from the analysis of lesson plan documents used by physics teachers at SMA Negeri 5 Bukittinggi. Indicators of teaching objectives assessed consist of 1) audience (A), 2) behavior (B), 3) condition (C), and 4) degree (D). The results of the analysis of teaching objectives can be seen in Figure 2.

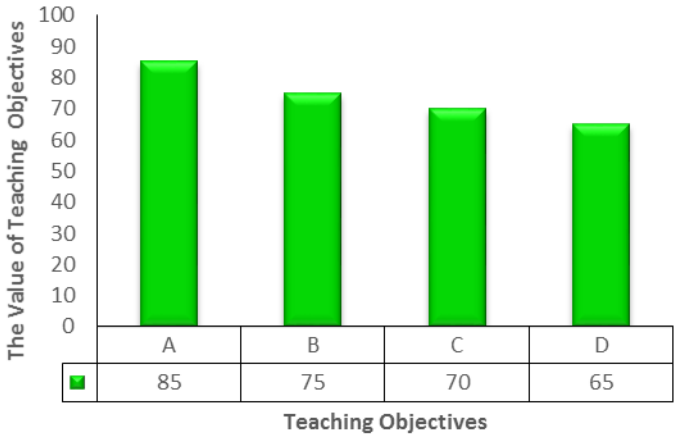

Figure 2. Analysis of teaching objectives result

Based on Figure 2, it can be seen that teaching objectives can be achieved if they fulfill at least four components. The four components include audience, behavior, condition, and degree. The analysis shows that the average assessment of learning components in the lesson plan is 74 and is in the good category. However, the assessment results on the condition and degree components are still in the sufficient category. Therefore, in order to achieve teaching objectives in accordance with the 2013 curriculum, it must include the four components and be carried out in accordance with the objectives that have been designed.

The fifth needs analysis is the analysis of teaching settings. The results of the teaching setting analysis were obtained based on the physics teacher's lesson plan which included introductory activities, core activities, and closing activities. The results of the teaching setting analysis can be seen in Figure 3.

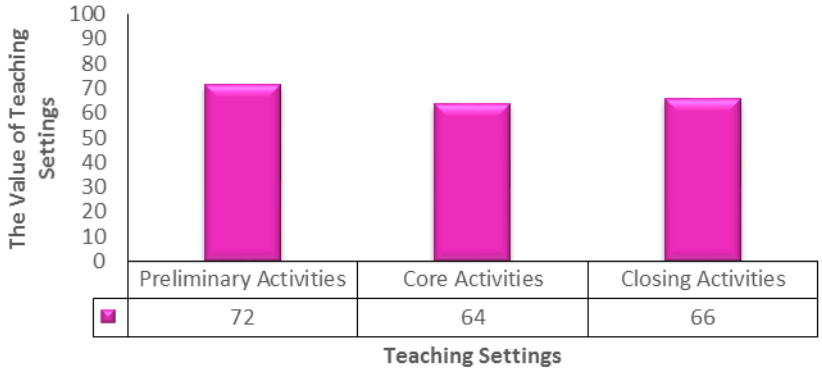

Figure 3. Analysis of teaching settings result

Based on Figure 3, it can be seen that the results of the analysis of the physics teacher's learning setting which includes preliminary activities, core activities, and closing activities. Introductory activities are in the good category with a value of 72. Core activities and closing activities are in the sufficient category with consecutive values of 64 and 66. The average analysis of teaching settings is in the sufficient category, namely with a

value of 67. This shows that the teaching settings at SMA Negeri 5 Bukittinggi are quite in accordance with the implementation of ideal teaching. However, it is necessary to improve and increase the core activities and closing activities so that the implementation of teaching is further improved. Some of the problems above show that there needs to be new solutions and innovations to support teaching. In accordance with the results of research which prove that entering a new era, the teaching process in schools requires new innovations to support the teaching process. One of them is developing electronic or digital material (Putri & Asrizal, 2023).

Description of Electronic Learning Material

The second phase is the product design stage in the form of E-learning material. The result of this phase is product design. The product developed in the form of E-learning material for sound waves integrated with the CTL approach with smartphones to improve students' critical and creative thinking skills. The following display of the designed E-learning material can be seen in Figure 4.

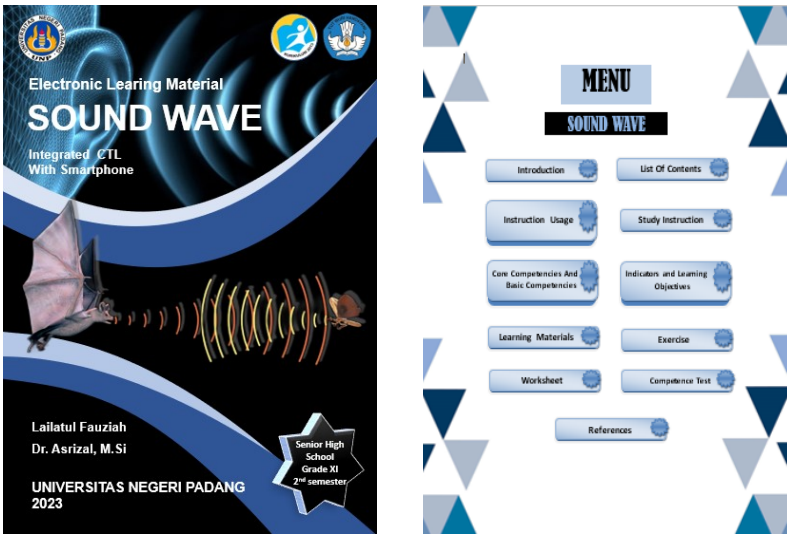

Figure 4. Display of cover and menus of e-learning material

Figure 4 is the initial part of the e-learning material, namely the cover and menu. On the cover there is an identity of e-learning material in the form of the title of e-learning material, the author's name, the curriculum logo used, the author's university logo, the tut wuri handayani logo, class and semester, and illustration designs that match the contents of e-teaching material. Then in the menu section of the sound wave e-learning material contains buttons that can be pressed and connected to the desired page. The menu on e-learning material consists of a preface, table of contents, instructions for use, learning instructions, core competence and basic competence, teaching objectives and indicators, learning material, practice questions, worksheets, evaluation questions, and references.

To produce quality e-learning material, the validator provides some suggestions and input for improving e-learning material. There are several suggestions from validators that are used as an initial step in improving e-learning material. First, the image description on the e-learning material is incomplete. Second, the error in writing "n" on page 19. Third, there is a blank page after the reference page. Fourth, the evaluation questions

should be adjusted to the indicators and teaching objectives. Fifth, evaluation questions should have feedback.

Improvements to e-learning material are made according to validator suggestions and input. The first improvement made was to complete the image description on the e-learning material. Second, correcting writing errors on page 19. Third, deleting blank pages after references. Fourth, adjusting evaluation questions with indicators and learning objectives. Fifth, adding feedback on evaluation questions. The improvements that have been made aim to produce valid electronic learning material.

The product in the form of e-learning material is equipped with material, images, videos, and practice questions. The electronic learning material contain CTL components and stimulate students to have critical and creative thinking skills. Through the CTL component in the e-learning material, students can find their own physics concepts and connect them to the real world. The presentation of material in the form of videos and images is also more interesting for students to understand the material. E-learning material is also made more interactive in the competency test section. Practice questions and competency tests train students to think critically and creatively. E-learning material is presented online so that they can be accessed by teachers and students via smartphones. This research is relevant to research whose research results are in the form of e-learning material using Flip PDF Professional on optical equipment material in high school (Sriwahyuni et al., 2019). Furthermore, this research is also in line with research whose research results are multimodel-based e-learning material on optical equipment material to train students' analytical skills (Nida et al., 2021).

Validity Test Results

The third stage is the development and implementation stage of e-learning material. At this stage, product assessment and revision are carried out. Electronic learning material for sound waves integrated with the CTL approach were validated by 3 physics lecturers from FMIPA UNP. The validation results are obtained from the validator's assessment of the sound wave e-learning material product using a validation instrument sheet. Instrument validation was carried out on a limited basis by the supervisor. The validation instrument sheet contains 5 components including material substance (MS), visual communication (VC), teaching design (TD), software utilization (SU), and CTL assessment (CA). The average validation results of e-learning material for sound waves integrated with the CTL approach can be seen in Figure 5.

Based on the data in Figure 5, the results of the validation of E-learning material based on five validity components can be explained. The five components, namely material substance, visual communication display, teaching design, software utilization, and CTL assessment are in the valid category with a range of Aiken's V values from 0.81 to 0.93. The average result of Aiken's V analysis based on five components is 0.89 with a valid category. This shows that the validity of E-learning material for sound waves integrated with the CTL approach is in the valid category and feasible to use in teaching. Indicators of material substance components consist of 1) correctness, 2) material coverage, 3) currentness, and 4) readability. The results of the indicator analysis on the material substance component are in the value range of 0.78-1.00 with an average value in the valid category of 0.89. The visual communication component indicators consist of 1) navigation, 2) font, 3) media, 4) color, 5) animation, and 6) layout.

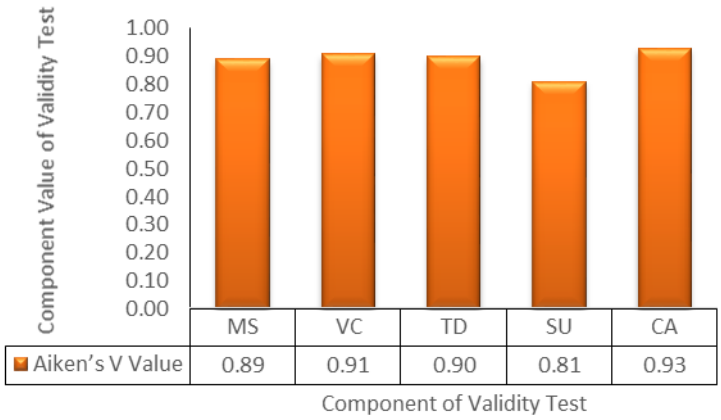

Figure 5. The average value of the component validity test of e-learning material

The results of the analysis of indicators on the visual communication component are in the value range of 0.78-1.00 with an average value in the valid category of 0.91.

Indicators in the teaching design component consist of 1) title, 2) core competence and basic competence, 3) teaching objectives, 4) material, 5) sample questions, 6) exercises, 7) worksheets, 8) compilers and 9) references. The results of the analysis of indicators in the teaching design component are in the value range of 0.84-1.00 with an average value in the valid category of 0.90. Indicators on the software utilization component consist of 1) interactivity, 2) supporting software, and 3) originality. The results of the analysis of indicators on the software utilization component are in the value range of 0.73-0.85 with an average value in the valid category of 0.81. Indicators on the CTL assessment component consist of 1) contextual nature, and 2) contextual components. The results of the analysis of indicators on the CTL assessment component are 1.00 and 0.86 with an average value in the valid category, namely 0.93. Overall, e-learning material have integrated CTL well.

Validation of e-learning material for sound waves integrated with the CTL approach with smartphones to improve students' critical and creative thinking skills was carried out by three physics lecturers as experts. A product is said to be valid if the product is in accordance with the guiding structure. The results obtained illustrate that e-learning material have met all the indicators developed in the validation of e-learning material. This is in accordance with several studies. First, the research which states that the product in the form of e-module Flip Book based on critical thinking skills has been successfully developed is very valid (Marlina et al., 2022). Second, learning material get good validation scores from media experts and material experts so that they can be said to be suitable for the teaching process (Laksono and Wibowo, 2022). Third, the developed product is included in the category of very valid (worth using) and very good (Munzil et al., 2022). Fourth, learning material are feasible to use and can be applied with a very valid category (Wati & Syafriani, 2023).

Practicality Test Results

Products that have been valid are then tested for practicality of use. At this stage, a field test was conducted to see the practicality of sound waves E-learning material by integrating CTL with smartphones to improve students' critical and creative thinking skills. The practicality test was carried out using an instrument for the practicality of using e-learning material filled in by students. The practicality instrument contains four

components, namely benefits (BF), ease of use (EU), presentation attractiveness (PA), clarity (CL), and cost-effectiveness (LC). The average results of the practicality test of e-learning material for sound waves integrated with the CTL approach can be seen in Figure 6.

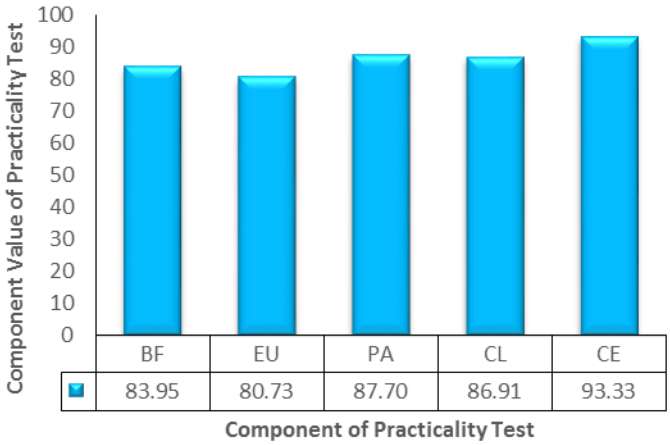

Figure 6. The average value of the component practicality test of e-learning material

Based on Figure 6, it can be explained that the results of the practicality test of e-teaching material are in a very high category with a value range of 80.73 to 93.33. The average results of the analysis of the practicality test of e-learning material are in the excellent category with a value of 87.52. Indicators in the benefits component consist of 1) can be used to achieve teaching objectives, 2) can be used wherever and whenever as needed, 3) can be used as a learning resource, 4) can be used to accelerate mastery of physics material, 5) can be used to stimulate curiosity, and 6) can be used to control learning activities. The results of the analysis of the benefits component are in the excellent category, namely with a value of 83.95. Indicators in the easy-to-use component consist of 1) making it easier to understand learning material, 2) making it easier to apply physics concepts in everyday life, 3) making it easier to carry out experiments, 4) electronic learning material are easy to implement, and 5) making it easier to master technology. The results of the analysis of the easy-to-use component are in the excellent category with a value of 80.73.

Indicators in the presentation attractiveness component consist of 1) attractive cover, 2) attractive illustration display, 3) attractive concept images and videos, 4) attractive content display, 5) attractive color combination on the cover, 6) activities on interesting worksheets, and 7) attractive toolbar and background colors. The results of the analysis of the presentation attractiveness component are in the excellent category with a score of 87.70. Indicators on the clarity component consist of 1) the objectives are clear, 2) the material is clear, 3) the information is clear, 4) the work step activities are clear, 5) real-world phenomena are clear, 6) the instructions given are clear, and 7) the use of writing fonts is clear. The results of the analysis of the clarity component are in the excellent category with a score of 86.91. Indicators on the cost-effective component consist of 1) does not require expensive costs, 2) can be used repeatedly, 3) practical and easy to carry, 4) can be used anytime and anywhere, and 5) does not require costs

to print. The results of the cost-effective component analysis are in the excellent category with a score of 93.33.

The practicality of e-learning material is seen from the assessment that has been carried out by students of class XI MIPA SMA after using this e-learning material in teaching process. The results of the practicality test of e-learning material are in the very practical category. This shows that e-learning material is useful, easy to use, attractive, clear, and cost-effective. The results of the practicality of e-learning material are supported by the results of research which states that the learning material developed have benefits for students as users, provide convenience in use, and make learning time effective (Nida et al., 2021). Furthermore, the results of the product design assessment carried out by students through aspects of ease of use, ease of determining concepts, learning independence, efficiency, and attractiveness are on average very practical (Anggreni & Yohandri, 2022).

Based on the description of the research results, the results are obtained in the form of development products and data regarding the level of validity and level of practicality of e-teaching material for sound waves integrated with the CTL approach with smartphones to improve students' critical and creative thinking skills. This is in accordance with the opinion stating that electronic-based teaching material can be used as an alternative choice of providing stimulus to improve critical thinking skills (Suwatra & Suyatna, 2015). In line with research which states that complex thinking skills or critical and creative thinking are important achievements at the senior high school level (Artiwi et al., 2020). Furthermore, research stating that teaching material developed in the form of contextual-based modules on temperature and heat material are feasible, practical and effective in the teaching process. Contextual learning material provide opportunities for students to discover concepts through events related to everyday life (Astiti, 2019).

The limitation in this development is that the e-learning material integrated with the CTL approach with smartphones developed are limited to sound waves. In addition, the e-learning material for sound waves integrated with the CTL approach are limited to critical thinking skills and creative thinking skills. E-learning material have several advantages, namely e-learning material make learning more effective and efficient. In line with research which explains that the use of e-learning material is very useful because it can save learning time and train participants in independent learning (Nida et al., 2021). The e-teaching material developed are used online and can be used on teacher and student smartphones.

Conclusion

Based on the results of the research and discussion, it is concluded that students' CTC-TS, CTV-TS, and knowledge are still low. Then, the average value of the component validity test of e-learning material obtained a score of 0.89 which was categorized valid. Last but not least, the average value of the component practicality test of e-learning material obtained a score of 87.52 which was categorized excellent. Thus, the e-learning material for sound waves integrated with the CTL is valid and very practical to use in the teaching process to improve students' critical and creative thinking skills.

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